CHARACTERISTICS OF EXCELLENCE IN ENGINEERING TECHNOLOGY EDUCATION

Final
Report

of

The Evaluation

of

Technical
Institute
Education

American Society for
Engineering Education
1962

Additional copies of this report may be obtained from professor W. Leighton Collins, Secretary, The American Society for Engineering Education, University of Ulinois, Urbana, Illinois.

Price: Individual copies, $ 0.25 each; in lots of 50 to 100, $ 0.20 each; in lots of 100 or more, $ 0.12: each.

FOREWORD

In the past few years much has been written about the technical manpower shortage in the United States. In the mass media and sometimes even in the technical press one can see an unfortunate tendency to equate this short- age with a shortage of scientists and engineers. We tend to lose sight of the fact that a substantial part of the problem can be attributed to a shortage of engineering technicians. There are even those who claim that if technicians were properly utilized, there would be no short- age of engineers. Be that as it may, there is no serious disagreement that as the short supply of engineers continues, there will be greater and greater use made of engineering technicians.

The potential impact of the technician shortage upon national defense and the nation's economic growth has induced national, state, and local legislation to supply funds for the expansion of some levels of technical education. The total effect of this legislation is, as yet, diffi- cult to assess since many states are essentially still in the planning stage. However, it now appears obvious that with government support as a stimulus we may ex- pect to see a continuing growth in the number of technical curricula being offered.

Enrollment pressures on the colleges and universities have already caused the public to face the fact that not all high school graduates are suited for or interested in college programs at the baccalaureate level. Throughout the country the number of junior colleges, community colleges, technical institutes, and other institutions offering two-year programs of higher education has increased greatly. Four-year colleges and universities have in- creasingly shown interest in offering two-year programs leading to the associate degree or a similar award. A substantial number of these curricula are aimed toward educating technicians. The U. S. Office of Education publication, *Organized Occupational Curriculums,* shows that the number of curricula for technician education in- creased from 694 in 1956 to 1,127 in 1959. There is every indication that the trend will continue.

This rapid expansion of technical education has brought about a great diversity in both the level and quality of technical curricula. In the minds of educa- tors this has quite naturally led to confusion, misunderstanding, and conflict as to the definition, scope, means, and ends of technical education. The technical education community , of course, does and should insist upon a high degree of variety and diversity within the field, but it also recognizes that within this variety and diversity there must be a core of agreement if chaos is not to result. It is in search of this core of agreement in a seg- ment of the technical education spectrum that this study has been prepared.

The General Council of the American Society for Engineering Education recognized that engineering techni- cian education in the United States was seriously in need of re-evaluation of standards of both level and quality . Consequently, in the spring of 1959 it appointed a steer- ing committee to plan and oversee an evaluation of tech- nical institute education. ASEE was encouraged to undertake this evaluation by its own Technical Institute Division and by the Engineers' Council for Professional Development. The project was financed by a grant to the Society by the National Science Foundation. A working committee of nine members was appointed, a project director was named, and the project was officially begun September 1, 1961. This study does not duplicate the work of the National Survey of Technical Institute Education (1957-59) or of other studies to determine the current status of technical education. Its task has been to draw conclusions from these other studies, to solicit expert advice, and to formulate a set of educational criteria for engineering technology curricula. It is hoped that these criteria will be useful for strengthening existing engineering technology curricula and for constructing new ones. It is hoped also that these criteria will be of value to the Engineers' Council for Professional Development in its program of accreditation of engineering technology curricula.

The working committee, in a series of meetings in the fall and winter of 1961-62, prepared a tentative draft of educational standards for review by the steering com- mittee. In the spring of 1962 five conferences were held in selected geographical regions to examine, discuss, criticize, and recommend modifications to the prototype criteria. In addition to those who attended the meetings a number of persons submitted their criticisms by mail. The preliminary draft, therefore, has been reviewed by persons from institutions that offer ECPD-accredited engineering technology programs, junior college administrators involved in technical education, representatives of engineering colleges and professional societies, and employers of engineering technicians in both industry and government (a list of these reviewers is contained in the appendix). The draft has been revised in the light of comments obtained, but the working committee and the steering committee have made the final deter- mination of the content of this report.

The Committee wishes to express appreciation to the National Science Foundation, without whose generous assistance this study could not have been undertaken. It is grateful also to the regional offices of the United States Office of Education and the United Engineering Center for providing facilities and making arrangements for regional meetings. We extend our thanks also to the University of Dayton for granting Professor McGraw a leave of absence to direct this project and for providing him with a headquarters office. And finally, we wish to especially thank all those who reviewed the preliminary draft at the regional meetings or through correspondence.

JAMES L. McGRAW *Project Director*

COMMITTEE MEMBERS

STEERING COMMITTEE

Cecil C. Tyrrell, *Chairman President*
Broome Technical Community College
Binghamton, New York

H. Russell Beatty President
Wentworth Institute
Boston, Massachusetts

Berthoud C. Boulton
McDonnell Aircraft Corporation
St. Louis, Missouri

Ken August Brunner
Division of Higher Education
U. S. Office of Education
Washington, D. C.

Maurice R. Graney
Dean, School of Engineering
University of Dayton
Dayton, Ohio

G. Ross Henninger
Director of Institutional Research
Oregon Technical Institute
Klamath Falls, Oregon

Howard H. Kerr
Principal
Ryerson Institute of Technology
Toronto, Canada

Charles H. Lawshe
Dean of University Extension
Purdue University
Lafayette, Indiana

Virgil E. Neilly
Continuing Education in Engineering
Pennsylvania State University
University Park, Pennsylvania

William C. White
Vice President and Provost
Northeastern University
Boston, Massachusetts

WORKING COMMITTEE

James L. McGraw, *Project Director*

Technical Institute
University of Dayton
Dayton, Ohio

R. W. Bingham
Dean, Mechanical and Applied Science
Oregon Technical Institute
Klamath Falls, Oregon

George F. Branigan
Dean, College of Engineering

University of Arkansas
Fayetteville, Arkansas

Bonham Campbell
Vice Chairman, Dept. of Engineering
Univ. of California at Los Angeles
Los Angeles, California

Walter M. Hartung
Executive Vice President
Academy of Aeronautics
Flushing, New York

Douglas F. Libby
Asst. Dean of Students and Instruction
Wentworth Institute
Boston, Massachusetts

H. Alex Romanowitz
Head, Electrical Engineering
University of Kentucky
Lexington, Kentucky

C. H. Thompson
The Technical Institute
Oklahoma State University
Stillwater, Oklahoma

William G. Torpey
Exec. Office of the Pres. of the U. S.
Office of Emergency Planning
Washington, D. C.

Thor N. Trolsen
Personnel Recruiting and Development
General Electric Company
Salem, Virginia

CONTENTS

INTRODUCTION

Purpose and Scope

This report outlines quality standards proposed by the ASEE Technical Institute Evaluation Working Committee as guidelines for constructing, improving, and evaluating engineering technology curricula, as defined below. It seeks to define terms related to engineering technology, to examine weaknesses in the present approach to technician education, to suggest minimum standards for selecting faculty and students, and to explore curriculum requirements in both technical and non-technical areas**.**

Designation of Curricula

Many technical educators are dissatisfied with the term technical institute curriculum as a designation for programs of the type discussed in this report. Much of this dissatisfaction is traceable to the ambiguity of the word *institute*, which is more often associated with an institution than with a type of program. Programs of this type have historically been offered by a variety of institutions, not all of which are called technical institutes. The Committee does not wish to take a position regarding the appropriate title for the institution but it does recommend that in view of its imprecision and ambiguity the term technical institute curriculum be dropped and that *curricula* of the type discussed in this report be called engineering technology curricula. It also recommends that the terms engineering technology and engineering technician be adopted to represent the field of study and the practitioner, respectively. The following definitions of these terms are proposed.

Definitions

Engineering technology is that part of the engineering 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 occupational area between the craftsman and the engineer at the end of the area closest to the engineer.

(a) Engineering technology is identified as a *part* of the engineering field to indicate that it does not by any means encompass the entire field and also to differentiate it from other types of technology in areas such as medicine and the biological sciences. The engineering field is viewed as a continuum extending from the craftsman to the engineer. Engineering technology falls, in the continuum, between the craftsman and the engineer and closer to the engineer than to the craftsman.

(b) Engineering technology is concerned primarily with the *application* of established scientific and engineering knowledge and methods. Normally engineering technology is not concerned with the development of new principles and methods.

(c) Technical skills such as drafting are characteristic of engineering technology. Engineers graduated from scientifically oriented curricula (See ASEE *Report on the Evaluation of Engineering Education*, 1955) may be expected to have acquired less of these skills than previously and the engineering technician will be expected to supply them.

(d) Engineering technology is concerned with the support of engineering activities whether or not the engineering technician is working under the immediate supervision of an engineer. It may well be that in a complex engineering activity he would work under the supervision of an engineer, a senior engineering technician, or a scientist.

An engineering technician is one whose education and experience qualify him to work in the field of engineering technology. He differs from a craftsman in his knowledge of scientific and engineering theory and methods and from an engineer in his more specialized background and in his use of technical skills in support of engineering activities.

(a) The Committee does not wish to suggest job or position titles for use by employers. Position titles will vary from one company to another and would normally be functional titles. The Committee recommends, however, that the generic term for those in this field be engineering technicians.

(b) If the term engineering technician is restricted in its application to the upper portion of the range between the craftsman and the engineer, considerable future confusion can be avoided.

An engineering technology curriculum is a planned sequence of college-level courses, usually leading to an associate degree, designed to prepare students to work in the field of engineering technology.

(a) The term *college-level* in the definition of an engineering technology curriculum indicates the attitude with which the education is approached, the rigor, and the degree of achievement demanded, and not *solely* or even necessarily that the credits are transferable to baccalaureate programs.

(b) Although throughout this report the generic term engineering technology curriculum is used, there are many specific branches of engineering technology in which curricula are offered. Commonly encountered are such curriculum titles as mechanical engineering technology, electronic engineering technology, architectural engineering technology, chemical engineering technology, and civil engineering technology.

Distinction Between Quality and Level

A large number of programs has been inaugurated in recent years under the name of technical curricula. They have had a variety of goals and a corresponding diversity of educational levels. This diversity has been a source of disagreement among educators and of confusion to the public, legislators, employers, parents, and students. The Committee believes that a distinction should be made between the quality of a program and its educational or difficulty level.

The level of a program is determined by its objectives, and the quality by how well it achieves these objectives. If, for example, the objective of a program is to train retarded persons to perform simple household tasks, it may excel at accomplishing this objective. On the other hand, a graduate program in a highly abstract field may well be of poor quality.

Some technical curricula intend to cover their subject matter at a level close to that of the engineering college, or at least that of the engineering college of a few years ago. Others set their objectives at essentially the same level of difficulty as the secondary school. Between these extremes we find a well-distributed range of objectives and levels. The sole point of agreement, and even that is not unanimous, is that technical education is post-

high school. Almost all technical curricula are admittedly *after* high school, but misunderstanding arises because the term post-high school is chronological rather than indicative of level of difficulty.

The level at which a technical program is cast depends largely on the type of position for which the graduates
are being educated. In the early years of the technical education movement it may have been assumed that the range of positions between the craftsman and the engineer was narrow enough for a single level of curricula to prepare students to occupy positions throughout the entire range. This can no longer be t a ken for granted.

Recent occupational analyses[1] have indicated that the range between the craftsman and the engineer includes positions which vary considerably in the level of technical education required. The diversity in educational levels mentioned above is undoubtedly a reflection of this occupational diversity.

Confusion has resulted in many instances, however, because institutions have continued to generalize in their statements of objectives and have at least implied that they are trying to cover the entire range. As a consequence differences in level have often been interpreted as differences in quality.

c The distinction between quality and level is prerequisite to the formulation of educational standards. The Committee believes that quality standards can be stated only for a given level of education.

---

[1] Donald D. Dauwalder, *Education and Training for Technical Occupations* (Los Angeles: Los Angeles City Junior College District, 1961).
Instrument Society of America, *Final Report of the Instrument Society of America's Task Force on Instrumentation Technicians.* (Hollywood, California: Instrument Society of America, 1961).
U. S. Dept. of Labor, *Technical Occupations in Research Design and Development* (Washington, 1961).

Some technical educators have suggested that two levels of technicians be recognized and that one level be called the engineering technician and the other level the industrial technician or the highly-~killed technician. It may well be that there is need for even further division of the range. In any case, this report deals only with education for the end of the range close to engineering, defined above as engineering technology. Perhaps similar standards should be formulated for other levels and types of technical education.

Premises

Engineering technology curricula must continue to be sensitive to changes in adjoining sectors of education. There has been in recent years a steady increase in the mathematics and science level of the curricula of both the secondary school and the engineering college. Consequently, if engineering technology curricula of the near future are to provide a challenging program for the high school graduate and produce a technician competent to support the engineer, they cannot remain static. The engineering technician of tomorrow *must* be educated at a higher technical level than he has been in the past.

The standards proposed in this report are based upon the premise that increasingly engineering technicians will need to acquire greater technical ability and that increasingly high school graduates entering engineering technology curricula will be better prepared.

Many engineering technology programs of the past have educated the student solely for the entrance-level position as it existed at the time he attended school. Since the typical graduate has a working life of approximately 45 years, it is unrealistic to educate him merely for the job he holds for the first several years. Moreover, his job constitutes only one part of his life. He has other needs if he is to be an effective citizen and member of society. Though it is difficult to accomplish in the short span of two years, there are certain areas (e.g., mathematics, physical sciences, humanistic-social studies) in which the student must be given a broader base than has heretofore been the common practice.

Beyond doubt some engineering technology curricula already exceed some of the standards put forth in this report. This is both expected and desirable since these are conceived as minimum standards for curricula at the engineering technology level. There is ample opportunity for reasonable variation above the minimum in keeping with differences in regional needs. The Committee is aware that in many cases it will take several years to fully implement these suggested standards. Yet, it anticipates that in the next five to ten years more stringent technical requirements will demand that engineering technology curricula have the characteristics described in this report.

FACULTY

The ultimate quality of a curriculum depends largely upon the quality of its faculty. The attributes desirable in the faculty of an engineering technology curriculum are identical with those desired of all college teachers: intelligence, a genuine interest in developing students, personal and professional integrity, a capacity for communicating ideas in oral and written form, a thorough knowledge of the subjects taught and of relevant supporting subjects, and skill in the fundamentals of the teaching-learning process

It is important that *all* members of the engineering technology faculty be familiar with and sympathetic toward the goals of this type of education. The engineering technology teacher must not only be conscious of a desire to teach his subject, but also to teach it at the engineering technology level. Unless the faculty has this quality an institution can easily find itself overloaded with teachers for whom engineering technology education is at best a secondary interest.

This devotion to the objective is best accomplished if most of the instruction in engineering technology is conducted by full-time teachers whose principal concern is the education of engineering technicians. The use of an unduly large proportion of part-time faculty members or faculty members from vocational or engineering programs is undesirable.

The principles just expressed apply equally to teachers of technical and non-technical subjects. It is in mathematics and the non-technical subjects, in fact, that we are likely to encounter the greatest misunderstanding of objectives. The implied problems are most prevalent in comprehensive institutions that offer engineering technology curricula but that draw indiscriminately on a common staff for teaching vocational, engineering technology , and baccalaureate courses.

Since engineering technology curricula are by definition of college level, it is obvious that a proper proportion of the faculty should have acquired at least a baccalaureate degree. Since these curricula are so closely related to engineering, it is equally obvious that a satisfactory engineering technology faculty must contain a substantial proportion of graduate engineers. It is the Committee's opinion that approximately half the faculty

members *teaching the technical specialties* should be graduate engineers or the equivalent.

If the curriculum is to keep pace with technology, it is not feasible to depend to any great extent upon faculty members whose technical competence is only slightly greater than that of the students. However, engineering technicians with considerable industrial experience are an important asset to the faculty. Experience has shown that engineering technology graduates who have continued their education toward a higher degree in their field often make excellent teachers in this type of program. The development of new curricula at some universities to prepare teachers for technical education programs may provide a significant opportunity for engineering technology graduates to enter the teaching field.

Diversity of faculty background provides the student with the opportunity for breadth of view. The Committee, therefore, feels compelled to reiterate the admonition so frequently heard in academic circles against excessive inbreeding by the hiring of too many graduates of anyone institution. If such faculty members are employed, they should be encouraged to obtain degrees at other institutions. It is also undesirable to hire too many faculty members with the same industrial experience, since the student should be given insight into many companies and many specific jobs.

Since engineering technology curricula educate students primarily for specialized occupational areas, it follows that a significant proportion of the faculty must have had relevant industrial experience and that this experience must be reasonably current. In some fast moving technological fields experience over ten years old can be as much a handicap as an asset.

This, of course, leads to the important requirement that faculty members maintain technical competence in their fields. To foster this, faculty members should be encouraged to participate in technical and professional societies and to engage in work in industry or in research. They should be urged to keep up with the literature of their fields, to continue their education, to attend professional meetings, and to experience first-hand what is taking place in the industries related to their specialties. Encouragement of this sort is most effective

1 See page 32 for explanation of technical specialties.

when opportunity is provided in the form of time and financial assistance. Such opportunity is more likely to be seized if promotions are based on a balanced judgement of the instructor's capability to bring a broad experience and academic background to bear on his teaching and not solely on acquisition of higher academic degrees.

STUDENTS

If an effective engineering technology curriculum hinges greatly upon the quality of its faculty, it hinges perhaps even more greatly upon the quality of its incoming students. If the students' high school back- grounds are inadequate, instructors will tend to adjust their course material to these inadequacies. The inevitable result will be that the courses will lose the depth and scope implied in the catalogue and faculty capabilities will not be fully utilized. Any discussion of academic standards, therefore, must be preceded by a statement on admission requirements and student selection.

Admission Requirements

A modern engineering technology curriculum will be based on the assumption that incoming students have been graduated from an accredited secondary school or have had the equivalent education (substantiated by the method recognized in their state). It goes almost without saying that the student should also exhibit some evidence of sufficient ability and the necessary aptitudes for satisfactory achievement in the curriculum. Mere possession of a high school diploma does not, of itself, guarantee sufficient background.

The Committee believes, therefore, that a satisfactory engineering technology program should be based upon the following minimum secondary school units:

(a) Three units of English. The student should at least have been exposed to the rudiments of communications skills.

(b) Two units of mathematics, one of which is in algebra and the other in plane geometry (or the equivalent of these in integrated modern mathematics). The Committee strongly suggests that, in addition to these minimum units, intermediate algebra and trigonometry are desirable.

(c) One unit of physical science with laboratory. Because of the nature of engineering technology it is desirable that wherever possible this unit be in physics or chemistry.

The student should have acquired this minimum back-

ground before entering the engineering technology program itself. An institution which admits students with less than these minimum high school units must be prepared to offer a longer program or an acceptable non-credit pre-technical or remedial program.

Transfer of Credits

Credits submitted for transfer from other institutions of higher education should be evaluated realistically on the basis of comparative course content or of validated, reliable proficiency examinations rather than on an inflexible basis of equivalent credit hours.

Testing

Testing of students as part of the admissions procedure has become a common practice in higher education. However, the use of this valuable tool is not as wide-spread in technical education as it might be. The Committee suggests that institutions offering engineering technology curricula consider using reliable standardized or local tests to aid in student selection, placement, and guidance. Each test should be validated at each institution, whether it is a standard or local test.

Guidance and Counseling

Each institution should develop definite means for providing the student with effective guidance and counseling. The student should be aided in selecting educational and occupational objectives consistent with his interests and aptitudes. He should be advised to revise his educational objectives if he seems more suited to an engineering program, a trade program, or a program in other educational areas. The student who decides to change his field of emphasis after pursuing one curriculum for some time is especially in need of help. For this reason guidance and counseling should be available to the student throughout his education and not just at the time of his enrollment. Besides advising students on educational matters, counselors should provide assistance in dealing with personal and financial problems. To do the job effectively, guidance personnel must be thoroughly familiar with the curriculum and its objective.

Placement

Since engineering technology curricula are occupationally oriented, the student normally expects that some

effort will be made to aid him in contacting prospective employers. The graduate should be given every possible assistance in finding suitable employment. But even beyond this, if those responsible for placement maintain the desirable liaison with industry they will learn of opportunities and will, in fact, be sought out by industrial recruiters. The placement function is, consequently, extremely valuable to the student, the institution, and industry. Placement personnel should know the needs of industry, should be familiar with the curricula offered by their institution, and should be in a position to inform prospective employers of the general types of positions for which the graduates of any particular curriculum are qualified.

Administrative Policy

In closing this discussion of admission requirements and related topics, the Committee considers it appropriate to paraphrase a portion of the ASEE *Report on the Evaluation of Engineering Education* (1955). It recommends that institutions:

(a) State clearly the requirements for admission to their programs.

(b) Admit students with deficiencies only when there is strong indication of probable success and always state specifically what the deficiencies are and how they may be removed.

(c) Maintain records of criteria used to determine admission.

(d) U se these records to improve the screening process.

THE ENGINEERING TECHNOLOGY CURRICULUM

The term curriculum, as used in this report, connotes several ideas and distinctions which are important to any discussion of engineering technology curricula. First, a curriculum is an integrated sequence of organized courses. This would imply that a loose collection of courses, even though all are in a given occupational area, does not constitute a curriculum. Secondly, a curriculum is planned to fulfill a particular objective within a specified time. From this it follows that courses designed for a four-year program in engineering would not, in most cases, be appropriate components of a two- year program in engineering technology .The selection and organization of subject matter would be different, the time devoted to each subject would be different, and the emphasis of the curriculum and of each course in it would be different.

An engineering technology curriculum differs significantly from a pre-engineering curriculum, which is equivalent to the first two years of an engineering program. The one is the preparatory part of a more inclusive pro- gram; the other a complete program in its own right. The first two years of an engineering curriculum are devoted primarily to mathematics, science, and general education. They contain relatively few specialized technical courses. An engineering technology curriculum, on the other hand, must initiate specialized technical courses early in the program if it is to cover its material within the short span of two or three academic years.

The more concentrated demands of time impose upon the engineering technology curriculum a greater need to integrate the courses with each other and to aim the sub- ject matter more directly toward the particular demands of the specialized occupational field. This means that individual courses must usually be designed specifically for the engineering technology curriculum. Only if this is done can a balanced program with adequate coverage of the material be achieved within the time permitted. If courses are designed for the engineering technology curriculum, they will be more likely to give appropriate stress to the application of established engineering principles rather than to theoretical derivations. It is this factor more than any other, incidentally, that underlies the earlier insistence that faculty members under- stand and be sympathetic toward the goals of the engineering technology curriculum.

Credits

The Committee recommends that institutions offering engineering technology curricula use conventional credit units in describing their curricula. Much confusion that currently exists in comparing these curricula could thus be avoided. The generally accepted system is to grant one credit for three hours of study per week, whether in classroom, laboratory, homework, or any combination thereof. An academic hour is usually defined as a 50-minute class period. Thus, one credit is equivalent to one hour of classroom lecture or recitation per week plus approximately two hours of assigned homework. Alternatively, one credit is normally granted for ap- proximately two hours of laboratory work per week plus one hour of assigned homework, or three hours of laboratory work per week with no assigned homework.

If one credit is granted for a period of from 15 to 18 weeks it is normally called a semester credit. If one credit is granted for an academic quarter of 11 to 13 weeks it is normally called a quarter credit. Usually a quarter credit is considered to be two-thirds of a semester credit.

Length

The proportions described in this report assume a curriculum length of two academic years. An academic year is considered to be approximately nine months in length and comprised of two semesters or three quar- ters. The Committee recognizes that there are engineer- ing technology curricula which are longer than two years and some which operate for more than nine months per year. Administrators of such programs should interpret this report in the light of their own programs.

Atypical engineering technology curriculum is prob-

Robert E. Mahn, "Glossary of Terms," in *Handbook of Data and Definitions in Higher Education* (American Association of Collegiate Registrars and Admissions Officers, 1962).

ably about 72 to 75 semester credit hours in length. However, existing curricula vary in length from 61 semester credit hours to over 100. Expressed in terms of time, curriculum lengths vary from two academic years to three calendar years. This situation made it difficult for the Committee to phrase meaningful curricular recommendations in terms of percentages or pro- portions since it is not reasonable to assume that the proportions would be the same for all curriculum lengths. It therefore became necessary to state recommendations in terms of minimum semester credit hours suggested for the various curriculum elements.

The Committee believes it is unrealistic for the published catalogue curriculum to require more than 20 credits in any semester of a full-time program. The average number of credits per semester in the program should probably be less than 20. It should be remembered that in terms of the credits defined above a curriculum requiring more than 20 credits per semester or quarter assumes that the average student studies more than 60 hours per week.

Curriculum Breakdown

For purposes of this study the Committee has divided the curriculum into three major sections: Basic science courses, which include mathematics and physical sciences; technical courses, which include technical skills and technical specialties; and non-technical courses, which include communications, humanities, social sciences, and other life-oriented courses. Each of these is discussed more fully in succeeding sections of this report.

The following table summarizes the minimum semester hour recommendations of this report along with an illustration of their possible application to a 72-hour curriculum. *It should be emphasized that the 72-hour program shown is an example only and should not be interpreted as a recommendation or as an ideal. Many variations are possible.*

BASIC SCIENCE COURSES

In order to promote versatility and future technical growth in engineering technology graduates and to minimize the risk of technological unemployment be-

CURRICULUM SUMMARY IN SEMESTER CREDITS

	*Minimum		Illustration	
Basic Science Courses				
Mathematics (e.g. algebra, trigonometry, calculus)	9			12
Physical Sciences (e.g. physics, chemistry) 6	15		6	18
Non-Technical Courses				
Communications (e.g. English composition, speech, report writing)	6		6	
Humanistic-Social Studies (e.g. economics, literature, history)	6		6	
Other (e. g. management, human relations, or additional humanistic-social studies)	3	15	3	15
Technical Courses				
Technical Skills (e. g. drafting-basic manufacturing processes) 6		6		
Technical Specialities (e. g. semiconductors, strength of materials	24	30	33	39
Totals		60		72

*Institutions should view with concern any curriculum which meets only the minimum shown above. Variations above the minimum are not only expected but desirable.

cause of obsolescence of their technical knowledge, the Committee recommends a rather substantial program in mathematics and physical sciences. The reasons for this are fairly apparent. First, of course, is the fact that all branches of engineering technology are built upon a foundation of mathematics and physical science. Secondly, the specific applications of mathematics and science change quickly with our evolving technology, but the core of principles that underlies these remains more stable. Finally, a broader knowledge of mathematics and science gives the student a better base upon which to advance occupationally. Conversely, a limited mathematics and physical science background is one of the greatest barriers to comprehension of new technical developments and maintenance of technical competence.

Mathematic

Most technical educators and employers of technicians have long recognized that mathematics is one of the more critical determinants of both the level and the quality of an engineering technology curriculum. This is evident in manpower analyses of the Executive Office of the President, Office of Emergency Planning and in the report of the Technical Institute Curricula Task Force of the President's Committee on Scientists and Engineers. 2

In surveys conducted by the Technical Institute Curricula Task Force, the most common criticism by graduates and employers is directed toward the level of mathematical content of engineering technology programs. Top management as well as first-line supervisors expressed a desire for graduates well educated in mathematics. The working engineering technicians themselves expressed a desire for more mathematics and specifically mentioned analytic geometry and calculus.

There is no doubt that the ultimate depth to which the physical science and technical specialties portions of the curriculum can be pursued will be determined greatly by the mathematical preparation of the student. If the curriculum is to provide the greater technical competence needed by tomorrow's engineering technician the math-

2 The President's Committee on Scientists and Engineers, *Report on Techni cal Institute Curricula* (Washington: Office of Civil and Defense Mobiliza- tion, 1959).

ematics courses must be expected to increase in level. Such an increase is also consistent with the anticipated improvement in the level of mathematical preparation of entering students.

The proportion of the curriculum devoted to mathematics will necessarily vary with the admission requirements. The Committee believes that an adequate pro- gram in mathematics can be offered in nine to twelve semester credit hours if topics are carefully selected and the courses are specifically designed for the engineering technology curriculum. The selection of mathematical topics and the best sequence in which to teach them must be determined by coordinated effort of the mathematics and technical faculty members in the light of the aims of their own institution and its curricula.

With these thoughts in mind, the Committee makes the following recommendations concerning mathematics in the curriculum:

(a) *Mathematics taught in the engineering technology curriculum should be of college level.* This refers to the pace at which the course proceeds, the difficulty of the problems solved, the attitude with which the material is approached, and the degree of achievement demanded of the students. While of college level, engineering technology mathematics programs are essentially applied in nature; that is, they emphasize problem solving rather than extensive mathematical proofs. The Committee believes such mathematics courses to be of college level whether or not they are transferable to baccalaureate curricula.

If secondary school-level mathematics is taught to permit students to overcome deficiencies it should not be an integral part of the engineering technology curriculum.

(b) *Mathematics should generally be taught in separate courses from science and technical subjects by qualified mathematics instructors familiar with the engineering technology objective.* This will give the student flexibility in applying mathematics to a greater variety of problems rather than restricting him to applications presently used in his technical courses. It will also tend to be more adaptable to any further mathematics education which the student may wish to pursue either formally or informally. This provision, of course, does not relieve instructors in technical courses of their responsibility for giving supplementary instruction and insight into applications of mathematics.

(c) *Mathematics programs should include carefully selected topics from such areas as analytic geometry, differential calculus, integral calculus, differential equations, probability and statistics, vector algebra, and Boolean algebra.* The selection of topics will depend on the branch of technology and on the functions the curricula are designed to perform. The Committee feels constrained, however, to make special note of the part that calculus plays in technical literature and in almost every technical field today. It recommends that enough calculus be taught to guarantee that the students are professionally literate and to permit the use of this mathematical tool in the technical specialties.

(d) *The curriculum should be so arranged that principles are taught in the mathematics courses prior to the time they are needed in the technical courses.* This requirement does not necessarily demand that all mathematics courses be completed before the student undertakes his technical courses. It does demand sufficient integration to assure that if the student is taking mathematics and technical courses concurrently a given mathematics topic will be covered in the mathematics course before its application is required in the technical courses. This may well necessitate rearrangement of topics within the mathematics courses in such a way as to differ from the traditional sequence.

Physical Sciences

If the mathematical sciences underlie all the technical courses of the curriculum, similarly the physical sciences give them unity. Thus it is to the physical sciences that the engineering technician must look for the fundamental concepts which tie together all the technical areas. Because of this integrative function, it is apparent that most of the observations about the role of mathematics in the engineering technology curriculum apply equally to the physical sciences. There are, however, particular aspects of a satisfactory physical science sequence within

the curriculum which merit additional clarification. Therefore, the Committee makes the following recommendations:

(a) *The physical sciences should be taught in separate courses from the technical specialties.* The Committee makes this recommendation in keeping with its previously expressed conviction of the need for a broader foundation of knowledge for engineering technicians. It believes that certain physical science fundamentals may be required by the engineering technician which are not likely to be included in his specialized technical courses. For example, a mechanical engineering technician working in machine design may need some knowledge of the principles of optics and light. Separate courses are preferable since, where physical science is integrated into technical courses, the coverage will tend to be limited.

(b) *An engineering technology curriculum should contain at least a one-year sequence (six semester credits) in the physical sciences at the college level.* The problem of condensing the desirable theoretical background in the applicable sciences into this few hours is itself considerable. Many curricula may have to exceed this minimum requirement to meet their objectives.

The function of the physical science courses is to interrelate the technical subjects and provide the student with a foundation of scientific principles. Toward this end the courses should emphasize the understanding, measurement, and quantitative expression of the phenomena involved. This points up the importance of the student's having had some science in high school. It also is the basis for the previous statement that this high school science training should, if at all possible, be in physics or chemistry.

(c) *Physical science courses should be accompanied by appropriate laboratories.* Experiments should be chosen to reinforce comprehension of the principles and to aid in developing methods of observation. Careful work, precise observation, and accurate measurement and recording should be emphasized.

NON-TECHNICAL COURSES

The engineering technician requires more than technical knowledge. He must be able to use his native language both during and after working hours. He must live with other people both on and off the job. He is a citizen as well as an employee and must participate with other citizens in the making of democratic decisions. Consequently, the Committee recommends that as part of both his occupational and cultural development an engineering technician's education should include instruction in linguistic communication, the humanistic- social studies, and other appropriate non-technical studies. A minimum of 15 semester hours should be devoted to these non-technical subjects. The Committee recommends that six of these credit hours be devoted to communication, six to humanistic-social studies, and the remaining three either to additional humanistic-social studies or to other non-technical studies such as industrial organization, human relations, or supervision.

Communications

There is no aspect of modern education which has been singled out for criticism more than the area of communications. This is especially true of written communications. Technical education is no exception to this general criticism. Much has been written in the technical press regarding the inability of technical personnel to communicate their ideas cogently and. concisely. Schools working in close cooperation with employers have frequently heard criticism of the communications ability of their graduates. In answering the questionnaire of the President's Committee on Scientists and Engineers, technicians expressed the need for better preparation in English and in report writing.

In fact, the occupational futures of the graduates probably depend on their ability to communicate as much as on their technical ability .The first line supervisor is not judged by how well he can do the job from which he was promoted. He is judged on how well he can communicate with others and be communicated with. The importance of this facet of his education should be reflected in the curriculum.

The Committee, therefore, recommends a minimum of two semesters of study (six semester credit hours) in

written and oral communication. Basic would be such courses as English composition, technical report writing, and speech. The Committee further recommends strong- ly that institutions offering engineering technology curricula insure that faculty members in *all* departments promote the use of good English in all course-related writing and speaking, including classroom recitation. Nothing influences the technical student in his assessment of the importance of good English so much as his instructors' valuation of its proper and effective use.

Humanistic-Social Studies

Engineering technology curricula must accept with other collegiate programs responsibility for educating students hot only for immediate employment after graduation but also for subsequent development as citizens and responsible human beings. It is the obligation of engineering technology education to acquaint the student with the resources of humanistic-social studies at least sufficiently to whet his interest in personal development in these areas after graduation.

Here, as in other curriculum areas, courses specifically designed for engineering technology students can prove especially effective. Much has been done recently in some engineering colleges toward the development of integrated courses and sequences in humanistic-social studies and it would seem that engineering technology education could benefit from a similar approach.[3] The "selected topics" approach described under mathematics above is worthy of investigation by engineering technology faculties constructing humanistic-social sequences.

The effectiveness of courses in the humanistic-social studies depends to a great extent upon the instructors. They must be genuinely interested in and enthusiastic toward the humanities, but at the same time they must be familiar with and sympathetic toward the goals of the engineering technology curriculum. They must plan their courses with the interests and the needs of the engineering technology student in mind.

The Committee recommends a minimum of six semester hour credits in humanistic-social studies, which might include such subjects as psychology, sociology, economics, political science, history, and literature.

3 *General Education in Engineering* -A Report of the Humanislic-Social Research Project (Urbana, Ill.: American Society for Engineering Education, 1956), pp. 68-106.

TECHNICAL COURSES

The technical courses consist of all subjects that directly and immediately pertain to the specialized occupational education of the engineering technician. For purposes of this report the Committee has separated these courses into two groups, the technical skills and the technical specialties.

The technical skills group comprises those courses which are intended to familiarize the student with techniques and practices associated with his occupation and to develop some facility in their application. The technical skills include such subjects as drafting, breadboard construction, welding, building construction practices, and manufacturing processes. The technical specialties group is made up of courses in the student's major field and others designed to supply the core of engineering knowledge he needs in his chosen occupation. This group would include such courses as strength of materials, machine design, semiconductors, highway de- sign, and soil mechanics.

The division of technical courses into two groups is not intended as a division between laboratory courses and lecture courses. It is presumed that both the tech- nical skills and the technical specialties would include some classroom and some laboratory instruction.

Technical Skills

The ASEE *Report on the Evaluation of Engineering Education* (1955) indicated that future engineering curricula would probably show a decrease in the proportion of time devoted to technical skills such as drafting and manufacturing processes. The engineering technician has been expected to move upward to fill this gap. While development of a high degree of manual skill is not the principal objective of the engineering technology curriculum, it is apparent that the engineering technician's education must include at least an introduction to the art and practice of engineering.

It would be impossible to list all the technical skill areas associated with specific branches of engineering technology. However, the Committee would like to emphasize the importance of two technical skill areas common to all branches of engineering technology.

(a) Every engineering technician should know the rudiments of making and reading drawings.

Without this skill he may find that he is partially illiterate in his field, for graphic expression is as much a part of technical language as is mathematics. Every curriculum should include at least one course (three semester hours) in engineering graphics. The emphasis and specific content would, of course, vary with the field of specialization. In many cases additional graphics instruction can be anticipated in design courses which are included in the technical specialties.

(b) Every engineering technician should have a first-hand knowledge of the general capabilities, limitations, and economics of the conventional manufacturing or construction techniques used in the industry in which he works. He does not, of course, need the high degree of skill and proficiency demanded of the craftsman whose primary function is the application of these techniques. Yet, he can scarcely function in his field if he is ignorant of the methods by which things are made. For example, the engineering technician who works as a designer should be able to evaluate the manufacturing feasibility of his designs.

At least one course (three semester hours) should be given in the manufacturing processes, construction techniques, or chemical unit operations associated with the technical specialties portion of the curriculum. Such a course would normally be accompanied by a laboratory. Supervised work experience of a com- parable nature can accomplish entirely or in part the objectives of this course.

Technical Specialties

The technical specialties portion of the curriculum includes the area which the student will find most immediately applicable on the job after graduation. For example, if the student is majoring in electronic engineering technology, the technical specialties would consist of his electrical and electronics courses and appropriate supporting technical courses. The technical specialties are always in transition. What today is an innovation in professional engineering design or methodology, tomorrow becomes the established engineering practice

33

falling within the province of the engineering technician. For this reason it is impossible to establish permanent course content for the technical specialties in any branch of engineering technology. The subject matter of the technical specialties must be reviewed and revised at regular intervals.

Since an engineering technology curriculum is inherently specialized, a substantial portion of the curriculum should be devoted to the technical specialties. It is the Committee's opinion that 30% to 50% of the total credits (comprising not less than 24 semester credits) should be devoted to courses in the technical specialties.

It is obviously impossible in a report of this type to describe in detail the specific courses which would comprise the technical specialties in each of the many branches of engineering technology. There are, however, certain general points concerning the technical specialties courses which deserve particular comment:

(a) *Course Emphasis:* Since engineering technology curricula are oriented toward mathematics and science, and since technicians will work within the engineering field, technical specialties courses should include considerable attention to problem identification and solution. They should also emphasize the quantitative, analytic approach rather than be limited to the descriptive.

Textbooks in the technical specialties courses should also utilize the quantitative approach and should be at a mathematical level compatible with that of the program.

It is undesirable to use texts in the technical specialties which are at a substantially lower mathematical level than the mathematics in the program. In like manner it is undesirable to utilize textbooks which require a mathematical maturity beyond that which the student would normally obtain from the mathematics courses in the curriculum.

(b) *Integrative Project:* All too often students view their curriculum as a sequence of compartmentalized courses and fail to see how the material covered in the various courses is interrelated. Provision should be made somewhere in the curriculum, preferably near the end, for a design project or course in which the student is

34

required to integrate the knowledge obtained throughout the program.

(c) *Laboratories:* Laboratory instruction is an essential part of any engineering technology curriculum. Theory courses in the technical specialties should be accompanied by coordinated laboratory experience. An important feature of this experience is the acquisition of familiarity with techniques and instrumentation used in measuring physical phenomena. The student should also be given the opportunity to learn and practice the collection, analysis, interpretation, and presentation of data. The Committee believes that industrial work experience, in itself, is not an adequate substitute for laboratory experience directly coordinated with the curriculum.

One of the major functions of laboratories is to support closely the lecture and recitation portions of the curriculum to which they are related. Thus, in the engineering technology laboratories, students should have opportunities to verify phenomena described in the theory portion of the course, to familiarize themselves with standard technical equipment, and to develop experi- mental skills. Many engineering technicians are employed in laboratory work and one of their significant responsibilities is the selection and utilization of laboratory instruments. It is thus apparent that administrators must attempt to outfit their laboratories with equipment that is as current as possible in order that their graduates may be reasonably familiar with the types of apparatus that they may encounter in industry.

An adequate laboratory for engineering technology curricula must have sufficient equipment so that all students will have an opportunity for extensive participation in the manipulation and use of laboratory equipment.

LIBRARY

A brief mention of the library is appropriate when discussing the curriculum, although it is not, strictly speaking, part of the curriculum. Use of the library, however, is essential in all forms of higher education. The engin-

35

eering technology student will most certainly require the opportunity to supplement his textbooks. Such use would normally be a requirement in several courses. The student must be urged to discover that a great deal of information exists which is not included in his texts and which cannot be readily obtained by word of mouth. He must be instructed in methods of finding this material in order that he can cope with problems that have not been specifically covered in his courses but which may have been solved elsewhere.

One of the principal ways by which technical persons obtain increased competence and familiarity with new developments in their fields is through the reading of technical periodicals. The library supporting an engineering technology program should be one which will encourage the student to develop the habit of consulting the technical press and professional journals in his field.

The engineering technology student must have ready access to a library V.'hich includes modern technical books, current technical periodicals, and journals in his field. The library should also contain sufficient li- brary materials to support adequately the non-technical portion of the curriculum. The library should be adequately staffed and open to the students during school and study hours.

CONCLUSION

The great diversity of objectives and levels existing among technician curricula presents a particular problem in establishing quality criteria. The Committee has, therefore, limited this report to the education of the engineering technician and has proposed definitions and terminology intended to clarify his position in the spectrum of occupations between the craftsman and the engineer. Failure to distinguish between the level of programs and their quality has created confusion and sensitivity in the past. Distinctions to clarify this area have been made.

Within this basic framework the Committee has at- tempted to present realistic recommendations concerning the three principal variables involved in modern, high- quality engineering technology programs conducted at
the college level -faculty, students, and curriculum. It has made specific recommendations on the minimum number of credit hours that might reasonably be devoted to specific curriculum areas. Serious effort has been made to reconcile the demands of general education and the demands of technical education in engineering technology. Underlying these recommendations is a desire to identify the common core of knowledge essential to technical competence and growth potential among engineering technicians.

Within the context of our present and anticipated levels of engineering and secondary education the Committee believes that its recommendations can be pursued as a present goal and it hopes that standards will be constantly improved as our educational system expands and advances. In closing this report, the Committee urges consideration of these recommendations by in- dividual institutions as a step toward meeting the demands of technical education in supplying the needed engineering technicians.

APPENDIX

Persons Who Reviewed The Draft

H.P. Adams
Director, The Technical Institute
Oklahoma State University
Stillwater, Oklahoma

C. J. Aggeler
Department of Engineering
City College of San Fransisco
San Fransico, California

William Allen, Dean
School of Engineering and
Architecture
The City College
New York, New York

Seymore Alloy
Personnel Generalist
Wright Patterson Air Force Base, Ohio

Lawrence H. Archer, P.E.
Dean, College of Engineering
Ohio Northern University
Ada, Ohio

Sanford Benus
Personnel Generalist
Wright Patterson Air Force Base, Ohio

Harry Bigalow
Employment Manager
Argonne National Laboratories
Argonne, Illinois

R. O. Birkhimer
Junior College Consultant
Office of the Supt. Of Public
Instruction
Springfield, Illinois

W. L. Bolin
Dean of the Div. Of Technical
Education
St. Petersburg Junior College
St. Petersburg, Florida

Harold A. Bolz
College of Engineering
The Ohio State University
Columbus, Ohio

Edward E. Booher
McGraw-Hill Book Company
New York, N. Y.

R. N. Bowman
Asst. General Manager and Chief
Engineer
Willamette Iron and Steel Company
Portland, Oregon

Charles W. Brennan, Associate Dean
College of Engineering Lehigh
University
Bethlehem, Pennsylvania

LeRoy A. Brothers, Dean College of
Engineering
Drexel Institute of Technology
Philadelphia, Pennsylvania

Don Brown, Administrative Assistant
Architecture Pakistan Project
Oklahoma State University Stillwater,
Oklahoma

Paul T. Bryant, Editor
American Society for Engineering Ed.
University of Illinois
Urbana, illinois

Roy W. Burdett
Head, Engineering Technology
Arlington State College Arlington,
Texas

E. W. Carlton, Chairman Dept. of Civil
Engineering University of Missouri
Rolla., Missouri

H. T. Carns
General Electric Company Cincinnati,
Ohio

R. G. Carson, Jr.
Director of Instruction School of
Engineering
North Carolina State College Raleigh,
North Carolina

C. C. Chambers, Vice-President
American Society for Engineering Ed.
University of Pennsylvania
Philadelphia, Pennsylvania

Philip Chandler
Director, Oklahoma State University
Technical Institute
Oklahoma City Branch
Oklahoma City, Oklahoma

Carlton E. Cherry
Div. of Engineering, Science and
Mathematics
College of Marin
Kentfield, California

Lloyd Cherry
Head, Electrical Engineering
Department Lamar State College of
Technology Beaumont, Texas Robert M.
Claflin, Director
Division of Aeronautical Engineering
and Aeronautical Engineering
Technology
Embry-Riddle Aeronautical Institute
Miami, Florida

W. E. Clark
Administrator of Personnel
Hazeltine Technical Development
Center
Indianapolis, Indiana

C. R. Clay
Engineering Technology Department
Arlington State College
Arlington, Texas

W. Leighton Collins, Executive
Secretary

American Society for Engineering
Education

University of Illinois Urbana, Illinois

C. C. Colvert, Professor and Consultant
in Junior College Education
The University of Texas
Austin, Texas

R. J. Combs, Assistant Director
Purdue University Calumet Center
Hammond, Indiana

Floyd Y. Corpus
Federal Aviation Agency
Los Angeles, California

G. L. Crawford
Dean of Technical Institute
Southern Technical Institute
Marietta, Georgia

H. H. Curry
Dept. of Air Conditioning and
Refrigeration
University of Houston
Houston, Texas

Raymond 0. Darling, Staff Assistant
Educational Relations Section
General Motors Corporatiol)
General Motors Technical Center
Warren, Michigan

Benjamin G. Davis
Head, Mechanical Technology Dept.
Mohawk Valley Technical Institute
Utica, New York

J. J. Defore
Head of Dept. of Physics and Chemistry
Southern Technical Institute
Marietta, Georgia

L. G. Dewberry, Jr.
Vice- President
Atlanta Steel Company
Atlanta. Georgia

Donald E. Deyo. Dean
The Montgomery Junior College
Tacoma Park. Maryland

Jerry So Dobrovolny
Head of General Engineering
University of Illinois
Urbana. Illinois

William Duncan
Assistant Department Head
Aviation Technology
Purdue University
West Lafayette. Indiana

Louis J. Dunham. Jr., Director
Franklin Institute of Boston
Boston. Massachusetts

William C. Dwyer. President
Orange County Community College
Middletown. New York

H. F . Eckberg. Dean
College of Engineering
Bucknell University
Lewisburg. Pennsylvania

C. R. Eddins, Director
Area Vocational Education
Texas Education Agency
Austin. Texas

John Elberfeld, Academic Dean
Worcester Junior College
Worcester. Massachusetts

Joseph C. Elgin, Dean
School of Engineering and Applied
Science
Princeton University
Princeton, New Jersey

George Elliott
Head of General Employment
Sandia Corporation
Albuquerque. New Mexico

T. Ho Evans. Dean
College of Engineering
Colorado State University
Fort Collins, Colorado

R. G. Fellers
Dean of Engineering
University of South Carolina Columbia,
South Carolina

Douglas Fellows, Director
Ward School of Electronics
Hillyer College
Hartford, Connecticut

Guy V. Ferrell, Director
Community and Two Year College
Education
State Department of Education
Trenton, New Jersey

Harold Fezer
RCA Institutes
New York, N. Y.

Don A. Fischer, Dean
School of Engineering
Washington University
St. Louis, Missouri

Edward L. Fleckenstein
Director of Technical Institute
Temple University
Philadelphia, Pennsylvania

E. H. Ford
Engineering Technology Department
Arlington State College
Arlington, Texas

C. L. Foster, President
Central Technical Institute
Kansas City, Missouri

F, Leroy Foster, President
Lowell Shool
Massachusetts Institute of Technology
Cambridge, Massachusetts

Carl Frey, Executive Director
Engineering Manpower Commission
New York, N. Y.

Nicholas F. Frigola
Director of the Technical Institute
Trenton, New Jersey
C. N. Gaylord, Assistant Dean
School of Engineering and Technology
University of Virginia
Charlottesville, Virginia

L. Duke Golden
Chairman, Mechanical Technology
University of Dayton
Dayton, Ohio

J. P. Goodwin
Acting Head of Electrical Technology

Southern Institute of Technology
Marietta, Georgia

Harold B. Gotaas, Dean
The Technological Institute
Northwestern University
Evanston, illinois

Otto V. Guenther, President
Hudson Valley Community College
Troy, New York

William H. Hagenbuch Chief Engineer
Hooven & Allison Company
Xenia, Ohio

Newman A. Hall, Executive Director
Commission on Engineering Education
Washington, D. C.

W. R. Halstead, Director
Gaston Technical Institute
Gastonia, North Carolina

Dana B. Hamel, Acting President
Ohio College of Applied Science
Cincinnati, Ohio

Oliver S. Hammer
United Electronics Lab., Inc.
Louisville, Kentucky

George D. Hann
Regional Representative
U.S. Office of Education
Dallas, Texas

Norman C. Harris
Associate Professor for Technical Education
Center for the Study of Higher Education
University of Michigan
Ann Arbor, Michigan

Herbert W. Hartley, President
Northrop Institute of Technology
Inglewood, California

G. A. Hawkins, Vice President
American Society for Engineering Education
Purdue University
Lafayette, Indiana

Harold P. Hayes
Dean of Engineering
California State Polytechnic College
San Luis Obispo, California

Joseph Hazelwood
Personnel Management Advisor
U.S. Civil Service Commission
San Francisco, California

Richard R. Hazen
Chairman. Electrical Technology
University of Dayton
Dayton. Ohio

John Henderson
State University of New York
Agricultural and Technical Institute
Canton, New York

Col. Archie Higdon, Vice President
American Society for Engineering Education
U.S. Air Force Academy, Colorado

W. Scott Hill, Manager
Engineering Recruiting
General Electric Company
New York. N. Y.

Kenneth Holderman. Coordinator
Commonwealth Campuses
Pennsylvania State University
University Park, Pennsylvania

C. T. Holladay
Head of Civil Technology Dept.
Southern Technical Institute
Marietta, Georgia

Joe B. Holmes
Engineering Personnel Service
General Electric Company
San Francisco, California

0. S. Hulley, Consultant
Manufacturing Education
General Electric Company
New York, N. Y.

Donald E. Irwin, Manager
Recruiting Development,
Engineering Recruiting
General Electric Company
Schenectady, New York

Lawrence L. Jarvie
New York City Community College
Brooklyn. New York

Lawrence V. Johnson, Director Engineering
Extension Division Georgia Institute of Technology
Atlanta, Georgia

J. Stuart Johnson. Dean College of Engineering
Wayne State University
Detroit, Michigan

Ray Johnson
College Curriculum Coordinator
Los Angeles City Schools
Los Angeles, California

F. Taylor Jones, Executive Secretary
Commission on Institutions of Higher Education
Middle States Assn. of Colleges and Secondary Schools
New York, N. Y.

Douglass Judd, President
California Society of Professional Engineers
Oakland, California

Frank Juszli, Director
Norwalk State Technical Institute
N orwalk, Connecticut

Jack Kadushin, Training Supervisor
Lockheed Aircraft Corporation
Burbank, California Frederick C. Kintzer
Department of Education
University of California
Los Angeles, California

A. N. Kitchen
Technical Assistant to Director of Engineering- Aircraft
The Bendix Corporation
Bendix Products Division
South Bend, Indiana

A. Ward Knisley
Instructor, Mechanical Technology
University of Dayton
Dayton, Ohio

Edgar A. Kovner, Director
Technical Institute
Old Dominion College
Norfolk, Virginia

Ernest G. Kramer
Bureau of Industrial Education
State Department of Education
Sacramento, California

Truman H. Kuhn, Dean of Faculty
Colorado School of Mines
Golden, Colorado

Charles W. Laffm, President
State University of New York
Agricultural and Technical Institute
Farmingdale, L.I., New York

Dale B. Lake, Dean
Suffolk County Community College
Selden, L.I., New York

Ray K. Linsley
School of Engineering
Stanford University
Stanford, California

E. H. Little
Employment Supervisor
R. J. Reynolds Tobacco Company
Winston-Salem, North Carolina

G. D. Lobingier, Treasurer
American Society for Engineering Education
Westinghouse Electric Corporation
Pittsburg, Pennsylvania

M. R. Lohman, Vice President
American Society for Engineering Education
Oklahoma State University
Stillwater, Oklahoma

William Loughran, Asst. Professor
Chemical Engineering
University of Dayton
Dayton, Ohio

W. J. Luzadder, Professor
Engineering Graphics
Michael Golden Laboratoties
West Layfayetts, Indiana

Donald H. MacKenszie, Dean
Lincoln Institute
Northeastern University
Boston, Massachusetts

R. J. Martin, Vice President
American Society for Engineering Education
University of Illinois
Urbana, Illinois

Robert F. Mauger, Asst. Professor
Electrical Engineering
University of Dayton
Dayton, Ohio

Frederic T. Mavis. Dean
College of Engineering
University of Maryland
College Park, maryland

William Mayo, Dean of Instruction
City College of San Francisco
San F'rancisco, California

H. L. McClure, Director
Southern Technical Institute
Marietta, Georgia

J. E. McCracken
Dean of Technical and Specialized Ed .
Pensacola Junior College
Pensacola, Florida

R. L. McKee, Supervisor
Junior College Technical & Industrial Ed.
Olympia, Washington

W. H. McMahon
Federal Aviation Agency
Ft. Worth, Texas

John S. McNown, Dean
School of Engineering and Architecture
The University of Kansas
Lawrence, Kansas

J. E. McVean, Director
Roanoke Technical Institute
Roanoke, Virginia

Albert E. Meder, Jr., Dean
Rutgers University
New Brunswick, New Jersey

Thomas B. Merson
Asst. Director for Commissions
American Association of Junior Colleges
Washington, D. C.

Donald C. Metz, Director Technical Institute
University of Dayton
Dayton, Ohio

Edward V. Mochel, Supervisor
Engineering Extension
The University of Virginia
Charlottesville, Virginia

D. L. Mordell, Dean of the Faculty of Engineering
McGill University
Montreal, Quebec, Canada

Ralph A. Morgen, President
Engineers' Council for Professional Development
Stevens Institute of Technology
Hoboken, New Jersey

Charles Mueller
Federal Airways Administration
Aeronautical Center
Oklahoma City, Oklahoma

Theodore E. Mulford
Manager of Industrial & Public Relations
Link Division, General Precision
Hillcrest, Binghamton, New York

Glenn Murphy, President American Society for
Engineering Education
Iowa State University Ames, Iowa

B. W. Musgraves
Asst. Commissioner for Junior Colleges
Texas Education Agency
Austin, Texas

Dave Muskat
Electronic Technical Institute
Inglewood, California

Ernest Notar, Dean
Erie County Technical Institute
Buffalo, New York

Donald A. Nutt, Sales Engineer
Industrial Division Minneapolis-
Honeywell Regulator Co.
Dayton, Ohio

Paul B. Orvis, Executive Dean
Institutes and Community Colleges
State University of New York
Albany, New York

Paul L. Ott, Assc. Instructor,
Technical Institute
University of Dayton
Dayton, Ohio

Joseph Parish, Chief Engineer
The Dow Chemical Company
Engineering and Construction Services Division
Houston, Texas

Philip Patrick
Instructor, Technical Institute
University of Dayton
Dayton, Ohio

Joseph A. Patterson, General Foreman,
Rand M Dept.
Transistor Products Division
Texas Instruments, Inc.
Dallas, Texas

John A. Peart
North American Aviation Co.
El Segundo, California

Max S. Peters, Dean
College of Engineering
University of Colorado
Boulder, Colorado

A. E. Peterson, Asst. Professor,
Electrical Technology
University of Dayton
Dayton, Ohio

Larry Pickard
Technician Supervisor
Collins Radio Company
Dallas, Texas

J. H. Porsch, Head
Engineering Graphics
Michael Golden Laboratories
West Lafayette, Indiana

Raymond B. Puckett, Asst. Professor
Industrial Technology
University of Dayton
Dayton, Ohio

W. D. Purvine, President
Oregon Technical Institute
Klamath Falls, Oregon

Thomas V. Raimondi, Director
Hartford State Technical Institute
Hartford, Connecticut

George Richards, Head
Department of General Education
Milwaukee School of Engineering
Milwaukee, Wisconsin

E. H. Rietzke, President
Capitol Radio Engineering Institute
Washington, D. C.

Albert Romeo
Transportation Engineering Center
The Ohio State University
Columbus, Ohio

M. W. Roney, Director,
Technical Teacher Education
Oklahoma State University
Silllwater, Oklahoma
(Consultant, U.S. Office of Education, Title VIII, NDEA)

A. M. Roseman
General Employment Representative
Bell Telephone Laboratories
Winston-Salem, N. C.

H. C. Rountree, Head
Engineering Technology
Purdue University
West Lafayette, Indiana

44

Robert S. Rowe, Dean
School of Engineering
Vanderbilt, University
Nashville, Tennesee

Robert H. Roy, Vice President
American Society for Engineering Education
Johns Hopkins Universty
Baltimore, Maryland

Issak J. Russum, Head
Electrical Technology
Arlington State College
Arlington, Texas

J. D. Ryder. Dean
College of Engineering
Michigan State Univerisity
East Lansing, Michigan

Raymond E. Schultz
Department of Higher Education
Florida State, University

Walter J. Seeley, Dean
College of Engineering
Duke University
Durham, North Carolina

Jimmy W. Seyler, Assistant Secretary
Ameircan Society for Engineering
Education
University of Illinois
Urbana, Illinois

Harry Simrall, P.E.
Dean, School of Engineering
Mississippi State University
State College, Mississippi

Ray Sims, Dean
College of Technology
University of Houston
Houston, Texas

G. E. Smith,
Assistant Dean of Engineering
Arlington State College
Arlington, Texas

J. M. Smith
Regional Representative
US Office of Education
Atlanta, Georgia

Marion L. Smith Associate Dean
College of Engineering
The Ohio State University
Columbus, Ohio

R. C. Smith
Assistant Personnel Director
Allison Division
General Motors Corporation
Indianapolis, Indiana

C. J. Statt, Manager
Schenectady Tube Plant
General Electric Company
Schenectady, New York

Albert E. Staub, Asst. Director
Technical Institute University of Dayton
Dayton, Ohio

Raymond J. Stith, Asst. Dean,
School of Engineering
University of Dayton
Dayton, Ohio

Jerry D. Strange
Mathematics Instructor
Technical Institute
University of Dayton
Dayton, Ohio

Fred W. Swan, Dean
Collegiate Technical Division
Ferris Institute
Big Rapids, Michigan

B. R. Teare, Jr., Dean
College of Engineering and Science
Carnegie Institute of Technology
Pittsburgh, Pennsylvania

0. I. Thompson Vice- President
DeVry Technical Institute
Chicago, illinois

Fred Thomton
Consultant in Technical Education
Division of Community Junior Colleges
State Dept. of Education
Tallahassee, Florida

Emil 0. Toews
Division of Higher Education
State Department of Education
Sacramento,
California

John W. Trego
Advanced Studies and Education
Hughes Aircraft Company
Fullerton, California

Myron Tribus, Dean
Thayer School of Engineering
Dartmouth College
Hanover, New Hampshire

Richard J. Ungrodt
Dean of Engineering
Milwaukee School of Engineering
Milwaukee, Wisconsin

Edward Van Dusen
Director of Evening Studies
Lowell Technological Institute
Lowell, Massachusetts

Robert W. Van Houten, President
Newark College of Engineering
Newark, New Jersey

Frank Verbrugge, Associate Dean
Institute of Technology
University of Minnesota
Minneapolis, Minnesota

Esther Walden, Standards Specialist
Personnel Classification
Wright-Patterson Air Force Base, Ohio

Pascal M. Walker, Chief
Classification and Wage Division
Directorate of Civilian Personnel
Wright-Patterson Air Force Base, Ohio

Cornelius Wandmacher
Dean of Engineering
University of Cincinnati
Cincinnati, Ohio

William J. Warren
Shell Development Corp.
Emeryville, California

Vernon C. Watson, Dean

Engineering Technology

Sinclair College Dayton, Ohio

Paul K. Weatherly
Director of Technical Education
State Commission of South Carolina
Columbia,
South Carolina

K. 0. Werwath, Vice President
American Society for Engineering Education
Milwaukee School of Engineering
Milwaukee, Wisconsin

Harold E. Wessman, Dean
College of Engineering
University of Washington
Seattle, Washington

T. A. Weyher, Dean
School of Engineering University of Miami
Coral Gables, Florida

R. D. Whipple
Employment Coordinator
Texas Electric Service Company Ft. Worth, Texas

Walter G. Whipple, Jr.
Professional Employment Education Department
Westinghouse Electric Corporation East Pittsburgh, Pennsylvania

George Whitney, Chairman,

Industrial Division

State University of New York

Agricultural and Technical Institute

Alfred, New York

B. J. Whitworth, Asst. Manager,

Design & Drafting Dept.

Hughes Tool Company

Houston, Texas

Everett L. Williams, Dean
Del Mar Technical Institute
Corpus Christi, Texas

Curtis L. Wilson, Vice-President

American Society for Engineering Education

Missouri School of Mines

Rolla, Missouri

Edward Wray
Dean of Administration
Ohio College of Applied Science
Cincinnati, Ohio

Scanned by L. J. Wolf
January 7, 2006

Engineering Schools and Depts. of Colleges and Universties

Arkansas, University of
Bucknell University
California State Polytechnic College
Carnegie Institute of Technology
Cincinnati, University of
Colorado School of Mines
Colorado State University
Colorado, University of
Dartmouth College
Dayton, University of
Drexel Institute of Technology
Duke University
Embry-Riddle Aeronautical Institute
Georgia Institute of Technology
Houston, University of
Illinois, University of
Iowa State University
Johns Hopkins Universty
Kansas, The University of
Kentucky, University of
Lamar State College of Technology
Lehigh University
Maryland, University of
Massachusetts Institute of Technology
McGill University
Miami, University of
Michigan State Univerisity
Michigan, University of
Minnesota, University of
Mississippi State University
Missouri, Rolla, University of
New York, City College of
New York, State University of
North Carolina State
Northeastern University
Northwestern University
Ohio Northern University
Ohio State University
Oklahoma State Univsersity
Pennsylvania State University
Princeton University
Purdue University
Purdue University Calumet
Rutgers University
San Fransisco, City College of
South Carolina, University of
Stanford University
Stevens Institute of Technology
Temple University
Texas, University of

Engr. Schools Continued

U.S. Air Force Academy
Univ. of California at Los Angeles
Vanderbilt University
Virginia, University of
Washington University in St. Louis
Washington, University of
Wayne State University

Technical Institutes and Community Colleges

Academy of Aeronautics
Agricultural and Technical Institute, SUNY
Arlington State College
Broome Technical Community College
Capitol Radio Engineering Institute
Central Technical Institute
Chicago City Junior College
City College of San Francisco
Cogswell Polytechnical College
College of Marin County
College of Technology, University of Houston
Del Mar Technical Institute
DeVry Technical Institute
Electronic Technical Institute, Inglewood
Erie County Technical Institute
Ferris Institute, Big Rapids, Michigan
Franklin Institute of Boston
Gaston Technical Institute
Hartford State Technical Institute
Hudson Valley Community College
Institute of Technology, University of Minnesota
Lincoln Institute, Northeastern University
Los Angeles City Schools
Lowell School, MIT
Lowell Technological Institute
Milwaukee School of Engineering
Milwaukee School of Engineering
Mohawk Valley Technical Institute
Montgomery Junior College
New York City Community College
Newark College of Engineering
Northrop Institute of Technology
Norwalk State Technical Institute
Ohio College of Applied Science
Orange County Community College
Oregon Technical Institute
Pensacola Junior College
RCA Institutes
Roanoke Technical Institute
Ryerson Institute of Technology
Southern Technical Institute
St. Petersburg Junior College

Technical Schools Continued

Suffolk County Community College
Technical Institute, Old Dominion College
Technical Institute, Trenton
Technical Institute, University of Dayton
Ward School of Electronics
Wentworth Institute
Worcester Junior College

Technical Employers

Aeronautical Center
Argonne National Laboratories
Atlanta Steel Company
Bell Telephone Laboratories
Engineering Manpower Commission
Federal Airways Administration
Federal Aviation Agency
General Electric Company
General Motors Technical Center
Hazeltine Technical Development Center
Hughes Tool Company
Link Division, General Precision
Lockheed Aircraft Corporation
McDonnell Aircraft Corporation
Minneapolis-Honeywell Regulator
North American Aviation Co.
R. J. Reynolds Tobacco Company
Shell Development Corp.
Texas Electric Service Company
Texas Instruments, Inc.
The Bendix Corporation
The Dow Chemical Company
Transportation Engineering Center
U.S. Civil Service Commission
United Electronics Lab., Inc.
Willamette Iron and Steel Company
Wright-Patterson Air Force Base, Ohio

Government and Educ. Agencies

Am. Assoc of Jr. Col.
California State Dept of Ed.
Commission on Engineering Ed.
Florida State Dept of Ed.
Middle States Association
New Jersey Department of Ed.
Office of Emergency Planning
Texas Eduction Agency
U. S. Office of Education
Washington State Dept of Ed.

Engineering Societies

California Soc. Pes
ASEE
ECPD