

DEPARTMENT OF THE INTERIOR  
BUREAU OF EDUCATION

BULLETIN, 1924, No. 16

OBJECTIVES IN  
COMMERCIAL ENGINEERING

REPORT OF THE SECOND CONFERENCE ON BUSINESS  
TRAINING FOR ENGINEERS AND ENGINEERING  
TRAINING FOR STUDENTS OF BUSINESS

PITTSBURGH, PENNSYLVANIA  
MAY 1 AND 2, 1922

Prepared by

GLEN LEVIN SWIGGETT

SPECIALIST IN COMMERCIAL EDUCATION, BUREAU OF  
EDUCATION, AND CHAIRMAN OF THE COMMITTEE ON  
COMMERCIAL ENGINEERING



WASHINGTON  
GOVERNMENT PRINTING OFFICE

1924

ADDITIONAL COPIES  
OF THIS PUBLICATION MAY BE PROCURED FROM  
THE SUPERINTENDENT OF DOCUMENTS  
GOVERNMENT PRINTING OFFICE  
WASHINGTON, D. C.  
AT  
10 CENTS PER COPY

## CONTENTS

	Page
Introduction.....	1
First public conference on commercial engineering.....	1
Second public conference.....	2
Program of conference.....	3
First general session.....	5
Introductory remarks by—	
Arthur A. Hamerschlag.....	5
Walter F. Rittman.....	5
Address by chairman of the committee on commercial engineering.....	5
Current practices in colleges and universities relating to business training for engineers and engineering training for business.....	7
P. F. Walker.....	7
R. L. Sackett.....	11
D. C. Jackson.....	13
G. L. Swiggett.....	15
Discussion (E. H. Schell and J. G. Callan).....	22
Committee on resolutions.....	26
Second general session.....	27
Coordination of college training with the industrial demand.....	27
Joint paper by W. E. Mott and W. V. Bingham.....	27
C. R. Dooley.....	32
Discussion (F. B. Jewett, D. C. Jackson, E. P. Walker, Col. Keppeler Hall, F. Paul Anderson, E. M. Herr, C. R. Mann, Hugo Diemer, and A. J. Hughes).....	34
Evening session.....	43
Address—By the president of the Carnegie Institute of Technology.....	43
Third general session.....	45
Civic and social training of the engineer and business man.....	45
C. F. Scott.....	45
C. R. Mann.....	45
Discussion (G. W. Dowrie, K. G. Matheson, F. M. Feiker, C. S. Howe, I. N. Hollis, T. T. Read, L. W. Wallace, and S. E. Doane).....	47
Report of committee on resolutions.....	52
Final session—Group conferences.....	54
Group No. 1.....	54
Groups Nos. 3 and 4.....	59
Appendix—Committee on commercial engineering.....	65

# OBJECTIVES IN COMMERCIAL ENGINEERING

---

## REPORT OF THE SECOND CONFERENCE ON BUSINESS TRAINING FOR ENGINEERS AND ENGINEERING TRAINING FOR STUDENTS OF BUSINESS

---

### INTRODUCTION.

---

*The first conference.*—The first conference,<sup>1</sup> held in Washington June 23 and 24, 1919, was called by the United States Commissioner of Education on behalf of a conference committee consisting of business men and university deans of commerce and engineering.

The following tentative curricula suggestions were submitted for consideration by the committee: First, that a minimum number of hours in business training, to be determined by the committee, be required in all engineering courses; second, that a curriculum providing for a minimum of 15 to 30 units in business economics be incorporated in all engineering courses and offered on an elective basis; third, that a curriculum in commercial or industrial engineering subjects be offered in schools of commerce with degree to be given in that school; fourth, that a five-year combined engineering and commercial course be prepared. The committee further recommended that from 12 to 18 semester hours be required in all engineering courses in the following subjects: General economics, cost accounting, business organization, and business law; that electives be encouraged in connection with all engineering courses in the following subjects: Labor and employment problems, statistics, corporation management and finance, political science, marketing, including advertising and salesmanship; psychology, scientific management, and transportation. It was further recommended that economic phases of engineering subjects be emphasized wherever possible in engineering instruction.

The four curricula suggestions submitted by the committee were approved by the first public conference. It was recommended that no action be then taken in regard to the third and fourth curricula

---

<sup>1</sup> A report of this conference was printed as Bureau of Education Bulletin, 1919, No. 58, copies of which may be secured from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 20 cents a copy.

suggestions. The conference, however, recommended that the following engineering subjects be approved for students of commerce, the selection of all of which, exclusive of freshman mathematics, would give a total of 30 semester hours: Shopwork, 3 hours for one semester; properties and strength of materials, 3 hours for one semester; drawing and machinery analysis, 3 hours for one year; applied mechanics including hydraulics, 3 hours for one year; and a 2-hour course for the year in each of the following: Mechanical engineering, civil engineering, and electrical engineering (may be better called mechanical, civil, and electrical applications). It is assumed that commerce students enter upon this work with high-school algebra through quadratics and plane geometry, freshman mathematics, and preliminary training in physics and chemistry.

*The second conference.*—The primary purpose of this conference held in Washington May 1 and 2, 1922, was to promote through training better coordination of the major operations in industry and commerce. There was an attendance of 215, comprising largely business executives, engineers, and professors of business and engineering. The topics of discussion related to the coordination of college training with the industrial demand, to civic and social training of the engineer and business, and to the training of the engineer for management of overseas engineering projects. The committee<sup>2</sup> hoped that the discussion of these topics might help solve the new problems that have recently arisen in modern industries, the solution of which demands a more scientific approach to include job analysis and personnel specifications and a translation of these into a new and teachable content for use in our engineering and commerce schools; might assist the engineer to a better understanding of problems relating to community development and aid in the training of the engineer for management of overseas engineering projects.

---

<sup>2</sup> The names of the members of the committee on commercial engineering are printed in the Appendix.

## PROGRAM.

FIRST SESSION: May 1, 10 a. m.

Presiding officer: Joseph W. Roe, professor of industrial engineering, College of Engineering, New York University.

Word of welcome to the delegates:

A. A. Hamerschlag, president Carnegie Institute of Technology.

W. F. Rittman, professor of commercial engineering, Carnegie Institute of Technology.

Address by G. L. Swiggett, chairman of the committee on commercial engineering.

MAJOR TOPIC: Current practices in colleges and universities relating to business training for engineers and engineering training for business.

Speakers:

P. F. Walker, dean of engineering, University of Kansas, Lawrence, Kans.

R. L. Sackett, dean of engineering, Pennsylvania State College, State College, Pa.

D. C. Jackson, professor of electrical engineering, Massachusetts Institute of Technology, Cambridge, Mass.

H. R. Hatfield,<sup>1</sup> dean of the faculties, University of California, Berkeley, Calif.

SECOND SESSION: May 1, 2.30 p. m.

Presiding officer: F. B. Jewett, vice president Western Electric Co., New York City.

MAJOR TOPIC: Coordination of college training with the industrial demand.

Speakers:

W. E. Mott, director, College of Engineering, Carnegie Institute of Technology.

C. R. Dooley, director, personnel and training, Standard Oil Co., New York City.

THIRD SESSION: May 2, 10 a. m.

Presiding officer: C. F. Scott, professor of electrical engineering, Sheffield Scientific School, Yale University

MAJOR TOPIC: Civic and social training of the engineer and business man.

Speakers:

C. R. Mann, chairman of operations and training division, General Staff, War Department, Washington.

Arthur Morgan,<sup>2</sup> president Antioch College, Yellow Springs, Ohio.

<sup>1</sup> Owing to the unavoidable absence of Dean Hatfield the report upon current practices in colleges and universities relating to business training for engineers has been prepared since the conference by the chairman of the commercial engineering committee and is printed on pp. 15-22.

<sup>2</sup> Owing to relief work in connection with the Pueblo (Colo.) flood, President Morgan was prevented from attending the conference.

## FINAL SESSION—Group conferences, 2 p. m.

Group No. 1. Presiding officer: George W. Dowrie, dean, School of Business, University of Minnesota. Discussion of topic, first session.

Group No. 2. Presiding officer: F. M. Feiker, vice president, McGraw-Hill Co. (Inc.), New York City. Discussion of topic, second session.

Group No. 3. Presiding officer: L. W. Wallace, executive secretary, Federated Engineering Societies, Washington, D. C. Discussion of topic, third session.

Group No. 4.<sup>2</sup>

TOPIC: Training of the engineer for management of overseas engineering projects.

---

<sup>2</sup>Group 4 met in conjunction with Group 3.

## PROCEEDINGS OF THE CONFERENCE.

---

### FIRST SESSION.

*Presiding Officer: Joseph W. Roe, Professor of Engineering, College of Engineering, New York University.*

---

Dr. A. Hamerschlag, in a brief address of welcome to the delegates, stated that young men and women are vitally interested in the effort to coordinate business and science, since it will create business opportunities for technically trained men.

Dr. W. F. Rittman expressed the belief that the conference would greatly aid in determining content and methods in their course in commercial engineering, a description of which had been prepared and issued in a special bulletin for distribution at the conference.

GLEN LEVIN SWIGGETT, general chairman of the conference. The training or work of a commercial or management engineer, or of the civilian engineer of a century ago, is not that of the engineer specialist of to-day with his purely engineering training. According to the charter of the Institution of Civil Engineers, 1820, for example, the civil engineers of London thought of themselves as directing the "great sources of power in nature for the use and convenience of man, as the means of production and traffic in States, both for external and internal trade, etc."

Refinement of technique and specialization, while essential in economic progress, has deprived industry and commerce in recent years of a much-needed type of service. The problems which the need presents will only find solution in the coordination of all factors that have seemed to function separately within the major divisions of production and distribution. The efficient and scientific conduct of business demands an adequate supply of college-trained men and women whose training represents a combination of essentials of engineering and the fundamentals of business practice.

Between the new engineer and the civil engineer of 1820 lies a succession of design engineers—engineers trained by the best methods known to the physical and mathematical sciences of their time to plan and create within the field of engineering construction. The latter are, however, design and research engineers who have had but



little concern in the past with the commercial or even community use of their design or construction. The steady drift away from the narrow specialization of the technical engineer in the direction of the commercial engineer is giving to industry and commerce men capable of applying the principles of engineering to the progressive needs of business and a changing economic society; men capable of regionally grouping the economic resources of the world so that they can be at all times recovered and assembled in proper places for manufacture and use by the most direct routes in the most effective and least costly manner. The commercial engineer is not the engineer become a business man. He must be prepared for his work by a course of study so framed as to afford the technique, the principles, and knowledge required in industry and commerce, by a newer and better combination of physical and mathematical science with the subjects of business and commerce. The tendency of business is more and more to direct selling, even direct financing in certain types. Knowledge of production processes and methods is becoming necessary as supplementary or even basic knowledge in marketing and finance. Schools of commerce of university grade have attempted to meet this situation by developing courses in accountancy, organization, and management. Their courses can be strengthened in the preparation for management, however, by some emphasis upon subjects dealing with the materials and means or agencies of commerce from the engineering point of view.

The problems of community or city management are such as a commercial engineer can best solve. He should be able to coordinate efficiently all broadly economic factors of the modern city, in itself a gigantic engineering project, a colossal industrial enterprise. The commercial engineer has an even greater opportunity which potentially presents itself in every county throughout the United States. The scientific conduct of the Nation's business is impossible without full knowledge of the sources of materials, manufacturing centers, and consuming markets, the relations of these to labor, credit supply, and transportation facilities. To secure and make that information understandingly available for our business men, we must begin with our smallest economic unit, the county. Rural communities must be changed scientifically into industrial units; industrial units must be similarly guided on their way to a more rapid return to truck or farming communities. Economic community guidance is imperative in view of world-trade competition. Many communities to-day are supporting industries that are by their location a liability to the community and a greater one to the Nation. Counsel and guidance of commercially trained engineers in every county will aid these counties to solve their problems relating to unwise employment and care of labor, seasonal and rotary; wrong standards of living,

therefore, uneconomic; improper transportation outlets; standards and kinds of production; marketing opportunities; available credits; and above all to solve problems relating to housing and health, to the proper balance between the individual's duties to society and his own economic rights.

**Major Topic of the First Session: Current Practices in Colleges and Universities relating to Business Training for Engineers and Engineering Training for Business Men**

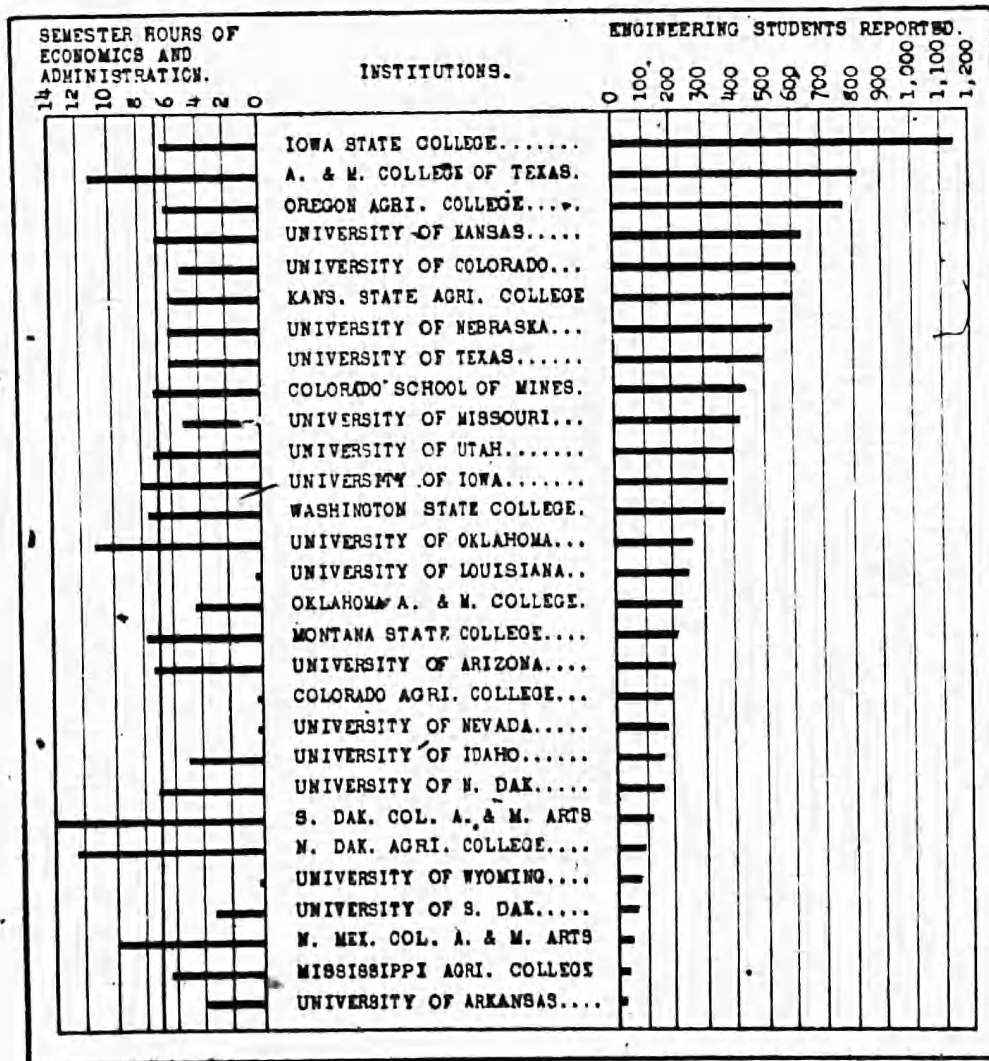
The three speakers based their remarks upon data secured in advance of the meeting by the chairman of the committee on commercial engineering. Deans of engineering were asked to supply the following information for the engineering divisions, mechanical, civil, electrical, mining, chemical and industrial, or commercial: Number of semester hours offered and required in business law, business organization, corporation management and finance, cost accounting, general economics, labor and employment problems, marketing—including advertising and salesmanship, political science, psychology, scientific management, statistics, and transportation. Deans of commerce were asked to state, if offered, the number of semester hours, elective or required, of business students in shopwork, properties and strength of materials, drawing and machinery analysis, applied mechanics—including hydraulics, general course in mechanical engineering, civil engineering, or in electrical engineering. Dean Walker discussed practices in State institutions to the west of the Mississippi River and Dean Sackett those to the east. Professor Jackson discussed practices in non-State higher institutions. A statement on current practices in colleges and universities relating to business training for engineers has been prepared since the conference by the chairman of the committee and is printed as part of this report, pages 15-22.

P. F. WALKER, dean of engineering, University of Kansas. Since the 1919 conference, changes in a considerable number of institutions have been brought about. The causes which have led to those changes have probably been many, the major one being the trend in industry toward a recognition of the need for men who have learned to think in broad terms of production on a nation-wide scale. The consideration of international problems associated with foreign trade has also led to calls for men fitted to take on the duties of foreign assignments. Several of our institutions recognize the need for work of this character and the benefit that will accrue to individuals and to the Nation through the meeting of such needs.

The recommendations made at the Washington conference of 1919 stimulated the study of business subjects by engineering students. In several of the western institutions it is reported that the inclu-

sion of economics, either as requirements or option, in the curriculum has been brought about since 1919. Some work in economics is required in 25 of the 29 schools which have furnished information on which this report is based. In two of the others economics is optional and quite commonly elected. The second recommendation, however, that would include a considerable amount of optional courses in economics and business, is provided for in only a few instances.

The important part of this report is here given in diagrammatic form.



The part on the right shows the number of students affected by the requirements. These requirements are shown to scale in the heavy lines in the right portion. The institutions represented are arranged in the order of number of students reported on, starting with Iowa State College at Ames, with something over 1,110 students in engineering. The requirements on the left side indicate in each case the average of the hours of work in the standard courses in mechanical,

civil, electrical, chemical, and mining engineering, and architecture.

Where an institution reported on several groups—mechanical engineering, for instance, seven hours; civil engineering, five hours; electrical engineering, five hours—there was no effort made to weight. These requirements represent the simple time average of the reporting groups, whatever that number may have been.

In several of the institutions the requirement in these lines is considerably greater for the mechanical group than for the others. The heavy vertical line shown on the diagram is the weighted average for the entire group of 29 institutions<sup>3</sup>—that is, it is found by taking the number of students, multiplying this by the number of hours required, and dividing the total of the products by the total number of students. This total number of students is 9,897.

For the first four institutions the requirements fall between limits of 5 hours and 11 hours. The requirements at the University of Kansas are almost the average, namely, 6.6 hours. The uniformity shown in the requirements of these 14 institutions, which represent so large a majority of the total number of students considered, indicates that the institutions in the western Mississippi and Missouri Valleys are bringing their requirements together on a very satisfactory basis. The smaller institutions show a greater tendency to fluctuate in their requirements.

The subjects within the group of courses involved in this general study which have been required in the greatest number of institutions are: General economics, usually a three-hour course; business law, in amount varying from one to three hours; business organization, frequently united with business law for about the same amount of attention; corporation finance, in the same manner but in somewhat less degree; scientific management, in seven institutions, for two or three hours. Business law, business organization, and corporation finance seem to be grouped in a number of institutions into a single course, which may be required or optional for engineering students. It is, of course, a hasty course and can only give the out-

<sup>3</sup> Data sheets were not received from the University of California, the University of Washington, and others.

The following excerpt is from a letter of the vice chairman of the faculty of engineering of the University of California received subsequent to the conference by the chairman of the committee on commercial engineering: Prescribed subjects practically include nothing like business law, business organization, etc. Students are encouraged to use their electives for such subjects as economics, law of contracts, etc. Within the engineering departments courses on marketing, labor and employment problems, scientific management, etc., are not offered, except in so far as these subjects are dealt with in announced subjects in the curriculum. The following statement, also received since the conference, relates to business training for engineers at the University of New Mexico: Six semester hours each in general economics and cost accounting have been offered since 1920 in civil, electrical, mining, and chemical engineering. The engineering students are required to take either 4 semesters' work in economics and accounting, or in some foreign language.

line of contract principles and the principles underlying the organization of the corporation.

Cost accounting, political science, and psychology appear as required subjects twice each, although political science is an optional subject in a considerably larger number. It is only an occasional institution which goes outside of the above-mentioned branches for students in the standard engineering courses. The catalogue of the University of Washington shows an average graduation requirement of two semester hours in business law. The University of California and Leland Stanford University have their requirements for graduation indicated on a plan showing a large number of elective hours, but very little actually required. For these institutions it is undoubtedly true that students in large numbers include subjects of this general character in their work schedule, but it is difficult to determine with accuracy from the catalogues.

The tendency to permit students to select optional subjects to a considerable extent makes it difficult to arrive at positive conclusions. The general resultant is slightly toward an increase in the time given to business subjects, but the tendency is not especially marked, and it is probable that the limit will be reached very soon.

Only three institutions west of the Mississippi make specific provision for carrying out the second recommendation of the conference committee.

Two of these schools, the Universities of Kansas and of Utah, have established courses under the name of industrial engineering. These are for the regular four-year course and call for the completion of a considerable amount of work in economics. At the University of Kansas 21 hours in general economics and accounting are required, with 10 additional hours in scientific management, transportation, and business law. At the University of Utah a general requirement of 25 hours in this group of topics is required. These courses, in industrial engineering correspond in a general way with those offered at the Massachusetts Institute of Technology, Pennsylvania State College, Sheffield Scientific School, Columbia University, New York University, and several others. It is essentially a course in mechanical engineering with the business courses substituted for a corresponding amount of the more highly specialized work. At the University of Kansas the general degree of bachelor of science is given, while the degree of bachelor of science in engineering is given on completion of the standard courses.

The University of Nebraska has adopted a plan whereby students may remain for a fifth year, to be given over largely to work in the school of economics and business, following which another degree of the baccalaureate grade is awarded.

The University of Kansas also makes provision for students to take five years in the university for the completion of the engineering requirements. This is based primarily on the plan of the student devoting the first year of the period to general work in the college of liberal arts, but during which time he would make a start in mathematics. With 30 semester hours to his credit he then enters the school of engineering, where he completes the schedule as required of regular four-year students, but with a considerable number of optional hours which he may devote to business subjects. Of the comparatively small number of students who have followed this plan, a considerable portion actually take several additional hours in economics and sociology.

The average number of semester hours required for graduation in the 29 reported institutions is 142.5. The average for the first 14 is 137.4 hours. These figures should be given some weight in judging as to the significance of the semester hour.

The western institution is gradually coming to the idea that the engineer needs to have at least an introduction to economics and business principles. Many of the smaller schools are unable to carry through the program on an effective scale. For the bulk of students trained in this section of the country, however, there are afforded abundant opportunities to secure the work recommended by the first national conference on commercial engineering, held in Washington, June, 1919.

R. L. SACKETT, dean of engineering, Pennsylvania State College. This report is based upon data from 27 institutions, having a total enrollment of 15,536 technical students. All except 2 offer economics for engineers, and all but 6 require it or some related subject. The average number of credits required by those specifying economic subjects is 7.5 semester credits, or almost 5 per cent of the total. There are numerous variations in the same institution in the requirements in different courses. In such case, the representative course was included. In practically all institutions listed, economics, political science, and related subjects are offered, and probably elections are more numerous than the table shows.

Economics and related subjects are valuable to the engineer; so are psychology, logic, social science, law, medicine, and theology, but manifestly only a limited amount of them can be included in our engineering curricula. We may in the future discard some of the engineering subjects. Some are decreasing the amount of modern language or other cultural subjects, but on the whole the change is very slight.

A previous speaker has referred to the usual course in industrial engineering as being practically the same as that in mechanical

engineering. My interpretation would be slightly different. In the institutions east of the Mississippi which have such a course, it is not a course in mechanical engineering, with certain subjects omitted, and certain business subjects, such as those mentioned, included. It is rather a more distinctive course, in which, while mechanical engineering is included, and electrical engineering also, there is a backbone which has for its emphasis production, management, organization, routing, and those fundamental factors in American economic industrial production.

We can give in a four-year course the fundamental training in engineering and also in economics or even in business practice—a superficial form of economics. Four-year curricula in engineering in American institutions have a fairly well-defined purpose. The same is true of those in economics, business administration, commerce, and finance. Five and six year engineering curricula are already here and in a few years will probably be more numerous. These contain and will contain more of the cultural subjects and will permit limited instruction in economics or business methods. But at present there is a very definite and logical course for the student of engineering in a four-year curriculum who desires to further fit himself for business or executive work, and that is by taking a postgraduate course in an institution specializing in that particular subject.

The conferences held on this subject by the committee on commercial engineering have been valuable because they have emphasized the commercial side of engineering, but the commercial is not the most important of high-grade undergraduate training in engineering. The table shows that engineering college administrations appreciate the value of economics and related subjects and have given them some part in their curriculum. Engineering is more broadly interpreted to-day than ever before, and service to humanity is the goal. Engineering curricula are overcrowded, and the difficult problem is what to omit and how to broaden engineering subjects so that new emphasis may be placed on economy in design and operation of engineering enterprises and to so develop the instincts of management and responsibility to the public that the engineer and the profession shall perform a more positive public service.

Students enrolled in certain institutions—Credits and hours required.

Institution.	Number of students.	Average number semester credits required to graduate.	Average number semester hours of business required.	Average number semester hours elective.
Georgia School of Technology	1, 226	167	5	
Michigan College of Mines	325	1 200	112	
University of Delaware	125	153	6	
University of Tennessee	200	132	9	
University of West Virginia	384	1 88 or 176	10	
Rhode Island State College	187	160	6	
Purdue University	1, 849	159	6	
University of Alabama	292	150	6	
University of Mississippi				
Pennsylvania State College				
University of Kansas	1, 273	164	14	
Clemson College, North Carolina	587	139	16	
University of Vermont	457	158	4	
North Carolina State College	197	162		4
University of Wisconsin	638	170	8	
Ohio State University	1, 250	152	7	4
University of Illinois	1, 221	151	E E 6	
University of Florida	1, 473	142		6
Alabama Polytechnic Institute	150	150	4	
University of Kentucky	543	164		18
University of Virginia	330	180	3	
University of North Carolina	200	1 104	13	
University of Maine	132	154	12	
Michigan Agricultural College	529	150	7	
University of Michigan	490	160	17	
New Hampshire College	1, 278	140		11
	291			16
Total	15, 536			

- 1 Uncertain.
- 2 Above does not include commercial or industrial engineering courses.
- 3 Freshmen not included.

DUGALD C. JACKSON, professor of electrical engineering, Massachusetts Institute of Technology. This report is based upon data from 56 engineering schools other than State universities. The institutions range from schools of special character like the Lowell (Mass.) Textile School, Drexel Institute (Philadelphia), and certain smaller municipal universities of the Central West to long-established large engineering schools like Rensselaer Polytechnic Institute, Massachusetts Institute of Technology, and the engineering schools at Cornell and Columbia Universities. The territorial range is from our Atlantic seaboard to the Pacific slope and from the Gulf States to our northern border. The 56 institutions are located in 22 States and the District of Columbia. Pennsylvania stands first in number of these institutions, with 10 of the 56 within its borders. New York State runs a close second. Massachusetts and California stand third and fourth. The range in character of institutions is fairly illustrated by the 10 in Pennsylvania: Bucknell University, Carnegie Institute of Technology, Drexel Institute, Lafayette College, Lehigh University, Pennsylvania College (Gettysburg), Swarthmore College, University of Pennsylvania, University of Pittsburgh, Villanova College. In this list of 10, the scope of



engineering instruction differs widely. The number of engineering students goes from less than 70 in one institution to nearly 800 in another.

The questionnaire relates to instruction in subjects which are associated with the business aspects of engineering practice and are collateral to the economic applications of the sciences underlying engineering.<sup>4</sup>

Many of the answers do not distinguish between some of the subjects. Several observations of definite character and service, however, are to be drawn from the answers. In the 56 institutions the subject of general economics is omitted from the instruction of only 7, and these are mostly institutions giving what may be called introductory or partial engineering courses, e. g., the University of Toledo, which gives only the first two years of the engineering courses and expects those students who wish to finish in engineering to complete their courses at the Ohio State University or elsewhere. Two well-established institutions with comprehensive engineering courses are among those that omit general economics, however. Moreover, the variety of time allotted to this subject in the various institutions shows that no consensus of policy has been reached regarding the methods of teaching it or the scope needed.

Business law is a required study in a large majority of the institutions, and most of those omitting it as a direct subject include some business subjects in the curriculum of which legal illustrations must be a part, so that the curricula of very few contain no content partaking of the nature of business law.

The variety of treatment or the avoidance given to the other subjects named in the questionnaire shows that the presence of any one in a curriculum is the result of some individual opinion or some local condition. The results indicate that there is no unit of thought on their relative importance respecting each other or respecting other subjects. As the answers do not show the experimental changes that have been tried in the curricula here, there, and elsewhere, the questionnaire gives no indication of tendencies in opinions regarding these subjects. Perhaps trial has not gone far enough to say that any real tendencies exist in this matter.

Finally, the status of one subject, psychology, deserves thought. In 9 of the institutions psychology is a required subject in one or more of the engineering courses. In 7 more it is optional in one or more of the engineering courses. The questionnaire thus shows that 16 out of the 56 institutions recognize psychology as an appropriate subject in the engineering curricula. As its introduction by these has in most cases been recent, it may be fairly assumed that the subject is

<sup>4</sup> For lists of subjects, see p. 15.

under test, that other institutions will also try the effect of its introduction, and after a few years psychology will have proved its worthiness or unworthiness for a permanent place.

Generalizations from the questionnaire are impracticable, but the data seem to support the writer's opinion that the engineering-school faculties generally are giving some thoughtful study to the best content of engineering curricula, that they are doing some experimenting with changes on their own initiative, and also are utilizing opinions and suggestions reaching them from outside their own organizations. Too great readiness to change would be unfortunate, as it might result in much confusion in educational processes. Experiment must progress cautiously and in an orderly manner, but more definite reflection and experiment on educational processes and the content of curricula are necessary to bring the engineering courses into their most serviceable place as feeders for the professional engineering groups serving the industries and other engineering branches. If these conferences of the committee on commercial engineering should stimulate to deeper reflection and more thorough experimenting of the nature referred to, they will perform a great service to the cause of engineering education.

G. L. SWIGGETT, United States Bureau of Education. The following report on current practices relating to engineering courses for students of business in colleges and universities is based upon data furnished by deans or head professors of business or economics in colleges or universities in which engineering is taught. The questionnaire dated January 3, 1922, sought this information—number of semester hours, elective or required, for students in business in the following engineering subjects<sup>a</sup>: (a) Shopwork; (b) properties and strength of materials; (c) drawing and machinery analysis; (d) applied mechanics, including hydraulics; (e) general course in mechanical engineering; (f) general course in civil engineering; (g) general course in electrical engineering.

#### ENGINEERING SUBJECTS AND BUSINESS STUDENTS

##### ALABAMA.

University of Alabama. The problem of combining engineering and commercial work is satisfactorily solved in this university by the industrial management course, of four years, in the college of engineering, leading to the degree of bachelor of science in industrial management. In the first two years the work is straight engineering, with the exception of the course in American economy. In the third and fourth years other commercial subjects are introduced, constituting in all approximately one-fourth of the four-year curriculum.

<sup>a</sup> Reference to these subjects in the body of this statement will be according to letters in the assigned order; for example, shopwork, (a); general course in mechanical engineering, (e); etc.

**ARIZONA.**

University of Arizona. Every student registered for the bachelor of Science degree in commerce is allowed 20 free electives. These may be taken in engineering subjects which he is qualified to enter.

**ARKANSAS.**

University of Arkansas. Twenty-seven term hours may be selected from the courses offered in the college of engineering.

**CALIFORNIA.**

California Institute of Technology. Semester hours required of business students: *a*, 4; *b*, 7; *c*, 10; *d*, 14; *e*, *f*, and *g*, 34; alternative, chemistry, 9; physics, 12; mathematics, 7. The subjects listed form part of course in engineering economics and are compulsory for all students who enter for the degree in E and E. Business and economic subjects may be elected by students in other departments, however. A complete redraft of the whole scheme is now in process.

University of California. No students in business take the listed courses, although students in business might take them if they were willing to take the necessary prerequisites.

University of Santa Clara. Not permitted to take any engineering subjects.

University of Southern California. A very limited number of courses may be taken by commerce students and count as electives, but there is as yet no definite cooperation between the department of engineering and college of commerce.

**COLORADO.**

Colorado Agricultural College. Business subjects not offered.

Colorado College. At present no credit is given in the business department for these listed subjects.

Colorado School of Mines. A business curriculum is not offered. Engineering students are offered some business subjects.

University of Colorado. No credit given in these subjects.

**CONNECTICUT.**

Yale University. Course in business administration, a graduate course, formerly given in Sheffield Scientific School, now discontinued. Engineering students required to take course in economics, business, finance, and accounting.

**DELAWARE.**

University of Delaware. Accepted on transfer a maximum of 12 semester hour credits in such engineering subjects as constitute definite studies.

No credit allowed for strictly laboratory work.

**DISTRICT OF COLUMBIA.**

Howard University. Students in business course may elect subjects in engineering provided they have the prerequisites. Students in engineering are required to pursue courses in business and commercial law, economics, and business organization.

**GEORGIA.**

Georgia School of Technology. Students may take the first two years in electrical, mechanical, civil, chemical, or textile engineering, or architecture, and then take commerce during the last two years; or they may elect to take the straight four years in commerce. In the latter case should their future objective indicate the necessity of knowledge in some engineering subject, they may elect appropriate engineering subjects approved by the heads of the departments concerned during the last two years.

University of Georgia. No credit for engineering subjects.

## IDAHO.

University of Idaho. Plans, not yet approved, will permit business students to take several subjects in technical departments that bear directly on the special field in which they are interested.

## ILLINOIS.

Northwestern University. Course in commerce is a two-year senior college course. Not practicable to allow much range in the listed subjects as electives. Such combinations as hydraulics, or electricity, or machinery analysis, and accounting, or salesmanship, or advertising, would be treated as individual exceptions to the general curriculum.

University of Illinois. Shopwork, properties and strength of materials, and general courses in civil and electrical engineering are offered in the junior year, and general course in mechanical engineering in the senior year. The following number of semester hours are required of all students in industrial administration in the following subjects: a, 4; b, 3; c, f, and g, 4 each.

## INDIANA.

Purdue University. Has no school of commerce.

## IOWA.

State University of Iowa. Subjects are not taken.

## KANSAS.

University of Kansas. Subjects are not allowed.

## KENTUCKY.

University of Kentucky. So far there has been no tendency for business students to take engineering subjects. A possibility of the plan will be suggested in next year's catalogue. A total of 30 hours of work in engineering may be taken. None required.

## LOUISIANA.

Louisiana State University. Has no curriculum in business administration.

Tulane University. No joint course in engineering and commerce.

## MAINE.

University of Maine. No provision for students in business to take these courses; might be allowed when classes are not overcrowded.

## MARYLAND.

Johns Hopkins University. Students in the college of arts and sciences specializing in political economy may elect subjects in engineering if they so desire. So far, however, there have been no such cases. All our undergraduate students in engineering take a full year of political economy.

University of Maryland. Although no specific arrangements have been made to permit commerce students to apply technical engineering subjects such as these toward satisfying requirements for the commerce degree (bachelor of sciences in economics), we will be willing to do so to a limited extent.

## MASSACHUSETTS.

Harvard University (Graduate School of Business Administration). Engineering synopsis is offered in the second half of the first year in the industrial management study group on engineering. The purpose of this course is to impart a sympathetic understanding of general problems of engineering in industrial management, with a view to helping the manager to reach proper decisions in matters involving technical considerations as a major element. The course deals with the scope and limitations of the engineering staff and the weight their technical

## MASSACHUSETTS—Continued.

point of view should be given in reaching business decisions. Provision will be made for laboratory shopwork and instruction necessary to a clear understanding of simple mechanical engineering problems. The principal subjects taken up are: Buildings and construction; factory tools; internal transportation; power; research and technical development, and patents.

Massachusetts Institute of Technology. Semester hours required of business students: *a*, 55; *b*, 90; *c*, 280; *d*, 505; *e*, 260; *f*, 75; *g*, 220.

Northeastern University. Schools of engineering and commerce have no connection at present.

Tufts College. Owing to intensive specialization of these subjects in engineering schools, it is not possible at present for students preparing for business to take them.

## MICHIGAN.

Michigan Agricultural College. Has no business students.

University of Detroit. Commerce and finance department has no working arrangement with the engineering department. Each department is separate and independent.

## MINNESOTA.

University of Minnesota. Subjects not offered to business students.

## MISSOURI.

University of Missouri. Semester hours elective for business students: *a*, 4; *b*, 3; *c*, 5. Two years of college work required for admission to the school of business and public administration. Students who desire shopwork and drawing elect these subjects while they are in the college of arts and sciences. Students will not be permitted to elect for credit properties and strength of materials until after they have entered the school of business and public administration. General courses in engineering are not offered in the school of engineering. Students in the school of business and public administration are permitted to elect other subjects in engineering for which they are prepared, subject to the approval of the dean of this school.

## MONTANA.

Montana College of Agriculture and Mechanical Arts. Students not permitted to take these subjects.

## NEBRASKA.

University of Nebraska. The students in the college of business administration may take 30 semester hours in engineering subjects, but very few, if any, have as yet availed themselves of this privilege. The college of engineering, on the other hand, offers a fifth year, during which their graduates may take chiefly business subjects, after which they receive from the college of engineering the degree of bachelor of science in commercial engineering.

## NEVADA.

University of Nevada. Has no school of commerce. All business subjects offered are free electives and may be taken by any student in the university.

## NEW HAMPSHIRE.

Dartmouth College, Amos Tuck School of Administration and Finance. Semester hours elective for business students: *c* to *g*, inclusive, 3; structures, 3; heat and power, 3. Permission to elect these subjects granted to business students in 1920-21. A one-semester engineering course called engineering in business is given by the Thayer School of En-

**NEW HAMPSHIRE—Continued.**

gineering to second-year students who elect the course. The general policy has been to try to select from the whole two-year course offered by the engineering school those phases of it which would be most essential for business students who plan to enter the field of production.

**NEW JERSEY.**

Rutgers College. Has no business course.

**NEW MEXICO.**

College of Agriculture and Mechanical Arts. No credit allowed for these subjects in business training course.

State University of New Mexico. Students in business rarely take any engineering subjects; possible as electives.

**NEW YORK.**

Columbia University. Students in the school of business may take the following engineering elective: Manufacturing processes and management.

Cornell University. Has no school of business or group of subjects in this field.

New York University. The two following courses, to which Managements 1 and 2 are prerequisite, are offered in 1922-23: Mechanics of management (4 points), the object of which course is to acquaint the student with the use of various labor-saving equipment used in the industrial field. It includes the use of various devices, such as planning boards, power meters, cost recording machines, weighing and counting devices, communicating systems, duplicating devices, calculating machines, etc., and machinery and factory equipment analysis (probably 4 points), the object of which course is to give the student a working knowledge of the mechanical equipment, machinery, tools, etc., used in various types of industrial plants so that he, as a manager, or as an employee, will be acquainted with the mechanical end of the business and can think and talk intelligently along this line with other men in the industrial organization. It includes drafting-room methods and interpretation of working drawings, describes the pattern shop, foundry, foundry equipment, practice and metals used, forge shop and methods, tool room and its equipment, cutting tools, machine tools and their uses, wood-working machinery, textile machinery, etc.

Syracuse University. Semester hours elective for business students: *a*, 14; *b*, 6; *c*, 6; *d*, 9; *e*, 6; *f*, 2; *g*, 10; shop management, 2. Permission granted business students in 1921 to elect these subjects.

The College of the City of New York. Subjects listed are open as electives to the students who are specializing in business. Other subjects in the engineering field are also allowed to students of business as electives, provided they take them in proper sequence and meet the usual college requirements in the matter of prerequisites. Degree of management of business administration is granted on the completion of the five-year course, of which two years are from the fundamental college course leading to one of the liberal degrees. The student then specializes in business and has also a range of election which can embrace engineering as well as other subjects.

**NORTH CAROLINA.**

North Carolina State College. Number of semester hours elective for business students: *a*, 3; *b*, 3; *c*, 4; *d*, 6; *e*, *f*, and *g*, not given, but would allow to elect as much as 10 hours if wanted. Semester hours required of business students: *a*, 3, in one curriculum. Twenty semester hours of

## NORTH CAROLINA—Continued.

free electives allowed in junior and senior years in general business course. The student can take them all in the engineering department. In the shop management course students must choose one of these groups. Would prefer to follow the suggestions contained in the last paragraph of your circular letter.\*

University of North Carolina. Semester hours elective for business students: *a*, *b*, *c*, and *d*, 3 each; *e*, *f*, and *g*, 6 each.

## NORTH DAKOTA.

University of North Dakota. Commerce students may elect these subjects. No special provision is made, however.

## OHIO.

Ohio State University. Working out relationships with the college of engineering.

Municipal University of Akron. Semester hours elective for business students: *a*, 4; *b*, 6; *c*, 6½; *d*, 6; *e*, *f*, and *g*, 12½.

University of Cincinnati. Semester hours required of business students: *b*, 5; *c*, 5; *d*, 6. Subjects *a*, *b*, *c*, and *d* have been required of business students since 1919. The shopwork is obtained by the student in work performed for remuneration in manufacturing plants. This work obtained under direction of the university coordination department, as in the case of engineering students. The cooperative part, involving shopwork, covers the first two years' time of the student. The essentials of engineering in the various branches mentioned are given in several courses during the first two years of work. The students pursue the regularly prescribed courses in these subjects for all engineering students during the years prior to entrance into the strictly commercial or business subjects.

## OKLAHOMA.

Oklahoma Agricultural and Mechanical College. Students are permitted to take any engineering subject they desire. Drawing is required of all students in the first half of the freshman year. Other subjects may also be elected by the student who wants this type of work. Seniors are urged to take works management as an elective.

## OREGON.

Oregon Agricultural College. All students have a general option of 45 credits out of 207 which may be taken in the listed subjects. In addition a minor in commercial engineering is offered.

## PENNSYLVANIA.

Carnegie Institute of Technology. The course in commercial engineering extends over a period of four years and leads to the degree of bachelor of science in commercial engineering. The course is especially designed for men who would enter those fields of work where the problems to be solved have to do in the main with production, finance, and distribution, rather than with engineering research, design, and construction. The subjects of instruction group themselves naturally under three heads—fundamental, engineering, and commercial. Fundamental subjects are: Mathematics; descriptive geometry; physics; chemistry; English; psychology; and economics. Engineering subjects are: Engineering; drawing and sketching; practice in pattern shop, machine shop, and forge and foundry; materials; applied mechanics; machine design; and theory.

\* Refers to recommendation of the 1919 conference relating to third and fourth curricula suggestions (Cf. p. 1 of this bulletin).

## PENNSYLVANIA—Continued.

and application in civil engineering, mechanical engineering, and electrical engineering. Commercial subjects are: Industrial history; statistics; economic production; industrial management; personnel; safety and welfare; letters and reports; accounting; commercial law; banking and credit; corporation finance; advertising and selling; domestic and foreign trade; and transportation.

Gettysburg College. The listed subjects are not open to students in business administration or to those majoring in economics.

Lafayette College. Semester hours elective for business students: *c*, 3; *d*, 3.

Pennsylvania State College. Semester hours elective for business students: Industrial accounts, 3; scientific management, 3; industrial organization, 3. Semester hours required of business students: Industrial management, 3. In the industrial engineering course students receive the same instruction in fundamental engineering and general subjects as is given to all of the engineering students of the other courses. The specialized industrial engineering subjects in the industrial engineering curriculum are: Organization; administration; time and motion study; safety engineering; industrial relations; personnel—including employment, industrial costs, factory planning, shop economics, manufacturing methods, purchasing, receiving and storing, routing and scheduling, production control, and scientific management.

University of Pennsylvania. Mechanical drawing, 3 hours. First offered as an elective in 1921-22.

University of Pittsburgh. Semester hours elective for business students: *a*, 6; *b*, 8; *c*, 8; *d*, 4; design, 4; power plants, 4; and automotive engineering, 8.

## RHODE ISLAND.

Brown University. Semester hours elective for business students: *b*, 3; *c*, 3; *d*, 12; *e*, 6; *g*, 6; and industrial plants, 3. Applied mechanics, including hydraulics, not readily elective by students in business; may be taken, however.

Rhode Island State College. Has no business students.

## SOUTH DAKOTA.

University of South Dakota. Semester hours elective for business students: *a*, 12; *b*, 6; drawing, 8; machinery analysis, 6; and *d*, 6. Total not to exceed 24 semester hours.

## TENNESSEE.

University of Tennessee. Semester hours required of students taking course in factory management: *a*, 6; *b*, 3; *c*, 6; and *e* (steam engineering), 3. These subjects were required in 1922.

## TEXAS.

University of Texas. Very few business students take engineering subjects. Such subjects are not required. A student may, if he desires, use his elective credits on any engineering subject for which he has the prerequisites.

## UTAH.

University of Utah. Semester hours elective for business students: *a*, 10-18; *c*, 9; *d*, 18; *e*, 6; *f*, 9; *g*, 8.

## VERMONT.

University of Vermont. No provision for election of subjects in college of engineering.



## VIRGINIA.

University of Virginia. Elective for business students: One semester hour in cost accounting as applied to engineering, and two semester hours in business administration for engineers. In addition 12 session hours taken at any time, of subjects *a* to *g*, inclusive, may be credited toward a bachelor of science degree in commerce.

Virginia Polytechnic Institute. Has no business course. Course in commercial engineering embraces a number of subjects in various branches of engineering curricula.

Washington and Lee University. No definite coordination of engineering and commerce work and no course in commercial engineering. Students in commerce required to take one course at least in physical science, and permitted to take 18 semester hours electives. Engineering subjects are available as electives. Hopes to be able to offer next year a regular curriculum course in commercial engineering.

## WASHINGTON.

State College of Washington. Semester hours elective for business students: *a*, 9; *b*, 4; *c*, 8; *d*, 14; *e*, 12-30; *f*, 18-32; *g*, 28-32.

## WEST VIRGINIA.

West Virginia University. No formal curriculum, special school or department for commerce. The department of economics has most of the business subjects. Students in this department are not expected to take the listed subjects, but for special cases such work might be permitted to count.

## WISCONSIN.

Marquette University. Students do not take any of these subjects.

University of Wisconsin. Electives in the college of engineering to the extent of 20 credits permitted to juniors and seniors in the course in commerce. The only limitations on such electives is that the students must have had the prerequisite for any subject elected.

## WYOMING.

University of Wyoming. About three hours in each year's work allowed as electives in these subjects.

## DISCUSSION.

ERWIN H. SCHELL, Department of Economics, Massachusetts Institute of Technology. Our work in the field of business does not deter us from the prime activity of training engineers. We hope to develop administrative engineers in the course in engineering administration. Nineteen professional courses are offered by our institution. The work required during the first year is essentially the same for all courses and comprises the following subjects put in their order of time requirement: Chemistry, mathematics, physics, English and history, descriptive geometry, military science, elementary machine drawing, physical training, and mechanical drawing. At the close of the first year the student chooses his course, and if he elects engineering administration he has three options—civil, mechanical and electrical, and chemical engineering, and most of his time in the next three years will be spent upon these engineering subjects.

We thoroughly believe in instilling in these men the principles and practice of the scientific method, and we believe we can do it through the engineering courses far better than we can through the nonengineering courses. The subjects not strictly technical engineering which are included in the course in engineering administration are: Second year, accounting, English history, political economy, military science; third year, banking, English, industrial organization, industrial relations, report writing, securities and investments, and statistics; fourth year, business law, business management, cost accounting (thesis).

The following illustrations indicate course content of a purely engineering course and that in engineering administration. In both courses the nonengineering subjects are in the minority.

The following subjects are available in general option courses for purely engineering students: Marketing methods, production methods, investment finance, banking and finance, economics of corporations, business and patent law, English (contemporary literature), English (contemporary drama), informal public speaking, Lincoln and the period of the Civil War, political and social problems, the human factor in business, the engineering field, engineering publicity, appreciation of music, and international law and American foreign policy.

The subjects presented in mechanical engineering which are not presented to engineering administration students are: General studies, industrial plants, mechanics of engineering, mechanism of machines, dynamics of machines, forging, pattern making, and power-plant design.

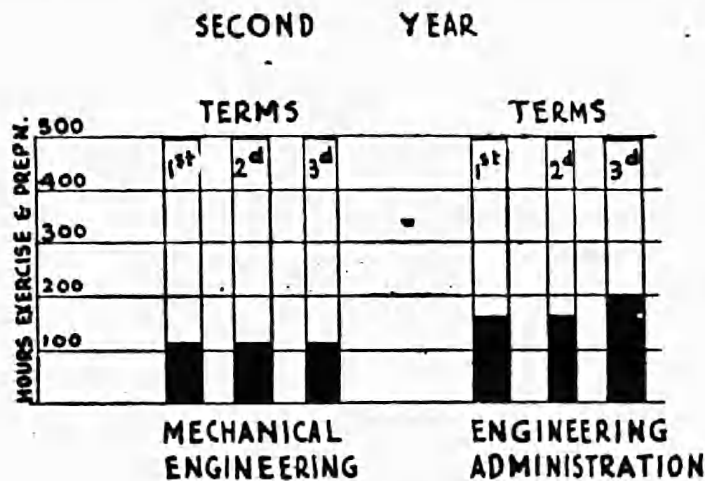
The subjects which receive greater emphasis in mechanical engineering than in engineering administration are: Heat engineering, engineering laboratory; foundry, machine, and bench practice; political economy, machine design, mechanical engineering drawing, engineering electives, materials of engineering, and testing materials laboratory.

The subjects which receive equal emphasis are: Applied mechanics, physics, mechanism, elements of electrical engineering, machine drawing, hydraulics, hydraulic engineering, electrical engineering laboratory, and general engineering lectures.

The subjects receiving greater emphasis in engineering administration are: Thesis, surveying, electrical distribution and transmission of power, central stations, English, and report writing.

The subjects presented in engineering administration which are not presented in mechanical engineering are, with number of assigned hours: Accounting, 90; cost accounting, 110; banking, 80; securities and investments, 70; statistics, 50; industrial organization, 180; business law, 180; business management, 300; industrial relations, 80.

The following statistics were collected from graduates of this course of engineering administration. Members of the first group, graduating in 1917, are engaged in the following occupations: Administrative (president, vice president, treasurer, etc.), 4; executive (superintendents, managers, etc.), 8; functional (purchasing agents, inspectors, etc.), 3;

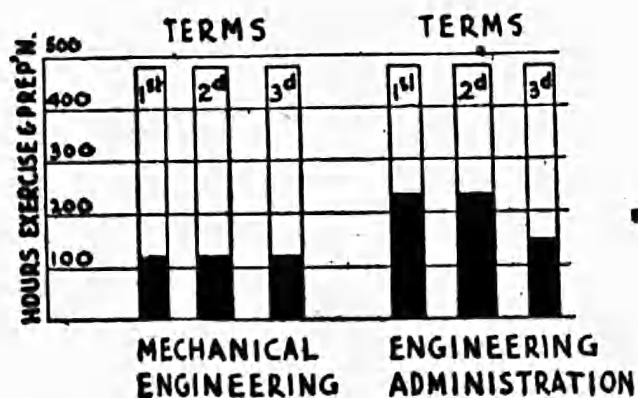


technical staff work, 7; management staff work (which has to do with nonengineering problems), 4; clerical work (none are operatives or apprentices), 1; merchants, wholesale and retail, 1; sales, advertising,

and publicity management, 2; salesmen, agents, and representatives, 2; teachers, 4; and one in the United States Army.

Statistics from 306 students from all classes show the following occupational divisions: Administrative, 14; executive, 24; functional, 9; technical staff work, including research, 84; management staff work, including research, 53; clerical, 14; operatives and apprentices, 28; merchants, wholesale and retail, 4; sales, advertising, and publicity management, 16; salesmen, agents, and representatives, 46; and teachers, 14.

**COMPARISON OF COURSES II AND XV  
THIRD YEAR**



J. G. CALLAN, professor of industrial management, Harvard University. In teaching business to engineers and engineering to business students the question is one of results. Engineers may manage, and often do.

Business students practically never do their own engineering. There is a distinct relation between engineering and certain types of management, while that between business activities and engineering is of a totally different character. Wise teachers of engineering and of business alike realize that the world is full of millions of facts, and that the teaching of facts as facts is

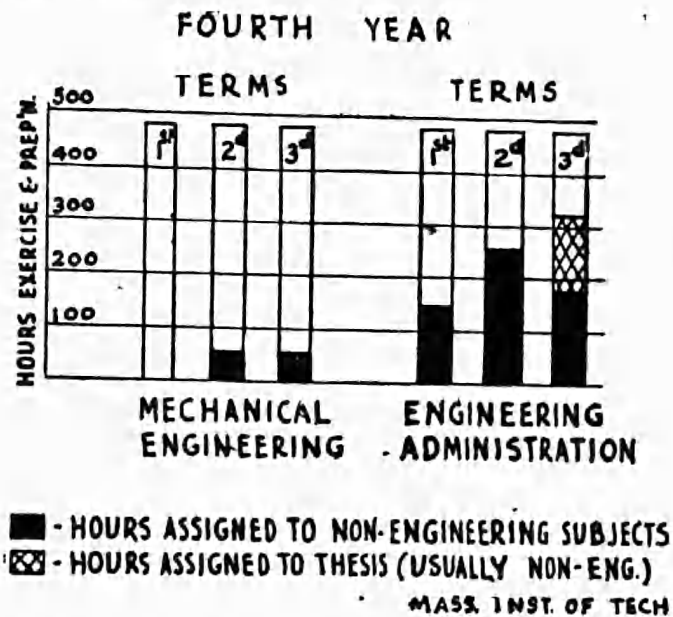
hopeless. It is necessary to present methods, to show typical facts in their typical relations. Related facts in either engineering or business are carefully selected to convey a certain developed aptitude and a certain broad attitude of mind, materially different in the two fields.

The spirit and content of engineering teaching is necessarily that which arises from a picture of the world as a place ruled by laws, relatively precise, and which follow exactly natural relations. Business training is that in which the outstanding foreground consists of man-made relations, underlain it is true by laws, such as economic laws, but rather remotely obeyed. When we deal with man-made relations, that is usually true; and the degree to which the laws are followed varies with different countries at different times.

Prominent in everybody's mind now is the business cycle. It may vary from 3 or 4 years to 10 or 12 years, and may be followed with some degree of precision and be therefore predictable, or it may not. A slowly building picture, or rather a dramatization of life, is being built up on the one hand in the mind of the engineer

and on the other in the mind of the business student. For the one, the engineer, a picture in which there are precise relations controlled, rather absolute conditions, and a somewhat hard and fast organization, not merely of the instrumentalities of production, but of men behind these instrumentalities; and in the mind of the business man, customs, and those human relations which can be swayed by eloquence, by approach, by all of the intangible and fourth-dimension things that make a business man successful. Therefore when we are supplementing the picture from an educational point of view rather than a pragmatic one, we should supply the wanting element.

The relations in business are relations of mind to mind. They contain much more of error and are dealing in a way with a harder problem. The engineering approach is, on the contrary, one kind of dealing of mind with matter. It has for the business student a particularly educational effect and value, in that the analogies and



parallels of dealing with matter and dealing with mind are important and illuminating. For the purely engineering student there is a danger in dealing with people in that it involves more variables and equations. The solution is never determined, and the results vary with the most intangible and difficult elements in the swaying of the minds of individuals and masses.

There are times when the engineer knows the value of time perhaps as well as any man in practice; but there are also many occasions when the lack of alertness and adroitness and astuteness, those things that involve the sense of time and a quick perception of relations and effectiveness, is apparent. The structure of the business world and business instrumentalities are not quite the same when presented as a matter of information in education. Any business course for the engineer, however, should be so presented as to carry as much as possible of this intangible picture and dramatization of real men working together. The content varies, naturally, with the different courses. We do have admirable courses in accounting, absolutely essential, and business law that offers a substantial amount of the general picture of the structure of business relations.

A different situation presents itself in teaching engineering to business students. Frequently they have to be told why they should know anything about engineering. They think they can control engineering, not realizing that the type of engineer being turned out from the modern course with the business content has a 50-50 opportunity to control them. Control is essentially an engineering approach to business. Precision and sincerity are also things that the business man in embryo has to learn. They are not essentially engineering attributes, but are so conspicuously.

Engineering achievement is a dignified and important phase of activity. Business men should be able to follow the major details of it, to sit down with engineers and sympathetically understand their point of view, their problems, and the method of attack, the only one which will successfully solve these problems.

#### COMMITTEE ON RESOLUTIONS.

The following persons were appointed by the chairman of the conference to constitute a committee on resolutions:

P. F. Walker, dean of engineering, University of Kansas, chairman; George W. Dowrie, dean, school of business, University of Minnesota; C. R. Mann, chairman of operations and training division, General Staff, War Department; Joseph W. Roe, professor of industrial engineering, New York University; C. F. Scott, professor of electrical engineering, Sheffield Scientific School, Yale University; and W. E. Wickenden, assistant vice president, American Telephone & Telegraph Co.

## SECOND SESSION.

*Presiding Officer: F. B. Jewett, Vice President, Western Electric Co., Inc., New York City.*

### COORDINATION OF COLLEGE TRAINING WITH THE INDUSTRIAL DEMAND.

Joint paper by *W. E. Mott*, director, college of engineering, and *W. V. Bingham*, director of the division of cooperative research, Carnegie Institute of Technology. (Read by Doctor Bingham.)

Coordination between college training and industrial demand is easily accomplished when the two interests involved have a common viewpoint. But educational institutions are too often unresponsive to outside educative influences, and industry often does not appreciate how the colleges may be of service by providing trained men and women. The World War, however, demonstrated how much help scientific and technical institutions can render our producing and manufacturing interests, and it likewise opened the eyes of those responsible for educational methods to sources of inspiration and guidance of which they had never before been aware or at least had ignored. One may now turn to almost any line of business or industry and find at once alert minds, active, energetic executives who are more than ready to cooperate with our colleges and universities.

The highest ideals in education can not be served solely by the aid of even the fullest measure of cooperation with the industrial interests; and students must not be led to think that earning power, efficiency, high production, etc., are the fundamental considerations even in a technical engineering course. Some educators are disposed to emphasize the immediate ends of educational work. Many agree with the statement of Helmholtz, that whoever in the pursuit of science seeks after immediate practical utility may generally rest assured that he will not seek in vain.

The college tries to accomplish a double purpose, usually in four years—to train for citizenship and for earning power; to develop an understanding of the ideals of the past as well as a knowledge of our fellow workers of to-day; to impart a love for the higher things of life and a spirit of fairness and self-sacrifice in our everyday relationships. Technological institutions accomplish these ends more frequently than do the "old line" colleges. But engineering courses have a way of becoming dangerously narrow.

From the earliest days our best teachers in technical colleges have been teaching about men, but they have dwelt mainly upon the ethical questions of business and engineering.

Recent events have emphasized the necessity of training engineering students so that they will appreciate the business phases of their technical employment. There is now available a fund of knowledge with which all graduates of technical institutions should be familiar; material dealing with economic, psychological, and sociological questions, with men and their relationships one with another.

The industrial demand for curricula modifications is becoming insistent. To what extent should colleges and universities meet the demand and still do justice to the students, in the larger educative sense, and in what measure are the institutions able to satisfy this demand? In other words, how can college training be coordinated with specifications laid down by industry?

The Carnegie Institute of Technology has had, since its inception, a policy of coordination constantly in view. This may be easily seen in our educational experiments in commercial engineering, coal mining, industrial management, salesmanship, and cooperative business and industrial research.

The course in commercial engineering was begun in 1909. In this course we are interested in problems of management and finance as related to engineering work fully as much as in the elements of design and construction. Commercial engineering is that branch of engineering which deals with the problems of production, finance, and distribution in which the elements of management and personnel are of importance. Analysis of the positions held by the graduates of engineering colleges shows, according to "Industrial Management," that only 15 to 18 per cent remain in technical work. The major portion enter widely different pursuits, although many seek positions of executive or managerial responsibility. This situation, and the need of industry for trained intelligence to direct and operate its complex activities, has caused a number of engineering schools to establish new courses to educate executives, based on a background of mathematics, physics, chemistry, mechanics, economics, and psychology. Commercial engineers are interested in the use and application of engineering tools, while the older type engineer is interested primarily in design and construction.

One of the oldest and most conservative of our local industries is coal mining. In this industry changes in methods of development and operation have come slowly. Workings have extended both laterally and vertically to such an extent that new or modified engineering methods have become imperative. Coal-mining engineering has never attracted many graduates of engineering schools.

This situation has been recognized for some years by thoughtful men in the coal-mining industry, as well as by those responsible for training mining engineers in the technical institutions.

On the advisory board are men representing nearly every important coal-mining interest in the Pittsburgh district. The board advises relative to the curricula for four-year mining students, two-year coal-mining men, and graduates. The companies represented open their mines for inspection and instructional work, send engineers and others who lecture on practical phases of the work and cooperate on research conducted by the officials of the Bureau of Mines and our graduate students. Manufacturers of mining machinery—not less than 35 companies—have either donated or loaned us the equipment for our laboratories. This intimate contact with the industry makes the students feel that they are a part of the business. They are practically assured of summer work and a job when they complete their studies. The companies have sent their promising young men to the school, even financing them in whole or in part. The Carnegie Institute of Technology is so convinced of the soundness of this plan of coordination that we hope to organize similar advisory boards in connection with each of our professional courses.<sup>7</sup>

The financial index and the salary scale indicate that industry to-day needs engineering graduates who have, or who can develop, executive ability as managers of production, as salesmen, and business managers quite as much as it needs men competent in engineering design.

Another way to measure industrial demand is to note the lines of employment in which technical graduates tend to find their level in industry. When the Carnegie Institute of Technology was founded in 1905, one of its four main departments was called the School of Apprentices and Journeymen. This department aimed to meet the needs of the workers of the Pittsburgh district for a vocational training supplementary to what they could get on the job. Eventually, this school developed a three-year curriculum with a backbone of courses in English, science, mathematics, and drawing, as well as a rich variety of shop practice in the elements of the trades germane to the student's chosen specialty. As the years went on, the graduates of these courses came more and more to be sought by industry, not for jobs demanding manual expertness but for minor executive, managerial, or supervisory positions. In 1919 the course expanded into a full-fledged four-year curriculum for the training of future executives in building construction, machine production, and in printing.

---

<sup>7</sup> Prepared from this point on by Doctor Bingham.



One way of building curricula is to make a more or less arbitrary selection from among the branches of study available, add one or two new ones of an intensive sort with specialized title, arrange these courses in a judicious sequence, and call the whole program a curriculum. The attempt is seldom made to find out whether the topics are really essential, or whether the essential topics are adequately covered. One prime reason why the evaluation of the content of instruction is but seldom attempted is that we do not know with sufficient definiteness and detail just what we hope to accomplish in these several courses.

We knew that we wanted to develop and improve three curricula. But what is an executive? Just what does a manager in each of these three fields do? What are the differences between a successful and an unsuccessful manager? What must the successful executive know? What abilities must he have which this school through its instruction and training can help him acquire? Basic questions of this sort are ordinarily answered by a consensus of opinion.

But the time has come when higher technical education is asking for detailed itemized facts as to what is actually expected by industry of its executives. Our problem was to make a job analysis of the manager in industry.

The technique of making duty analyses and personnel specifications has notably advanced since Frederick W. Taylor published *Shop Management* in 1911. We undertook in pioneer fashion to use this technique in getting first-hand information from industry as an aid in coming to a decision regarding the content of the new four-year industries curricula. The men spent the entire summer of 1920 in selected typical industries of Pittsburgh and other cities, securing descriptions of duties and personnel specifications of all the executives from the foreman to the president. Whenever a manager was not able to give an entirely adequate account of his own responsibilities, his immediate subordinates and superiors were interviewed; and then, having written out as complete and definite an inventory as possible, the latter was finally checked once more by the executive himself.

These descriptions of executives' duties, or job specifications, were studied and reclassified according to subject matter for the purpose of improving the new curricula. While certain facts only strengthened opinions already reached, others pointed toward large gaps in the program of training. The only function found to be common to all executives, for example, is that of managing men, a function for which the typical curriculum of the past provides no overt training whatever and which many contend can not be taught. We are not certain. We now have courses in management, in personnel administration, and in psychology, which aim to ac-

quaint the students with some of the principles of success in dealing with the human factor in production. Experiments now contemplated or in progress, based upon the study of what executives actually have to do in industry, have made our faculty keenly aware of the value of anything the colleges can do to prepare their students for effectiveness in personal relations.

A similar statement holds regarding the need for familiarity with cost accounting and estimating; credits and banking; labor and capital; for skill in preparing lucid, concise reports; and for many other items of training which are sometimes overlooked or insufficiently emphasized.

While it is not contended that this inductive approach to problems of curriculum construction is the only approach, or that its findings can forthwith be accepted as decisive, it is, however, a valuable aid and sheds a new and unique light on the demands which industry is making of the colleges. The outcome of thoroughgoing research of this type will be invaluable to American industry. Perhaps it is up to industry to find the necessary funds and to invest them in cooperative educational research of this remunerative sort.

The introduction of courses of salesmanship is another example of readiness to meet the demands of business and industry. These courses were based, too, upon comprehensive research in cooperation with business and industrial concerns which maintain selling organizations of national scope. Thirty such concerns established here in 1916 the Bureau of Salesmanship Research, for the purpose of studying the best methods of selecting, developing, and supervising salesmen. A group of Pittsburgh department stores, wishing to have their special problems of personnel selection and training studied in greater detail, established in 1918 the Research Bureau for Retail Training and have maintained it at an annual cost of \$32,000. This amount is equal to \$2 for each store employee.

Another attempt to coordinate life-insurance instruction with business demand has resulted in a curriculum adopted in six other States. The life-insurance companies besought us to undertake the training of their salesmen. An intensive three-months course of instruction was prepared through the research cooperation of distinguished educators and practical sales executives. The school was opened three years ago. Already it has graduated 500 men.

Through the division of cooperative research this institution is better able to respond to the demands of industry for cooperation in the application of scientific method to the solution of outstanding problems. During the present year this division has been of direct aid to the steel industry, the automobile industry, the soap industry, and the ceramic industry. The research problems submitted have

varied all the way from metallurgy and organic chemistry to personnel management and sales organization. These industries have in turn been of help to us, for we believe that the teaching in our classroom is more vital if our instructors have opportunity to be actively in touch with research.

C. R. DOOLEY, director of personnel and training, Standard Oil Co., New York City. Engineering has a commercial side. Anything that is designed must have a market. There is, therefore, the sales aspect in engineering training. There is a great demand for trained men. The telephone interests want 700 men this year. The two large electrical manufacturing concerns want about 600 men. Together they create a demand for about 1,500 engineers, probably one-third of the total available. How are we now going to find students who are best fitted to take training? We need men for research, designing, manufacturing, commercial men, financiers, etc.

There are certain fundamental types of native ability. For example, there is the inventive or constructive type of people, who when they find a lot of loose ends immediately see them combined as a working unit. Another is the research type, interested in taking things apart to find out what is inside. Men who have achieved marked success seem to have had these characteristic qualities even when they were children.

The commercial type may be divided into the commercial individualist and the commercial organization man. The former makes a fine salesman, but often can not keep accounts straight or follow orders. He can not play the rules. Yet that fellow is a wonderful salesman. I would call him an individualist. Many of these men have had this tendency all their lives. On the other hand, commercial organization men do not like to take full responsibility. They work best as committee men or in groups. They will whet their wits on other men's wits, and out of a committee meeting will come the best sales policy.

We must make some effort to find out the native characteristics in men and women while they are still in school and build on that which nature has already provided—not try to make salesmen or engineers out of the rank and file of students indiscriminately.

This meeting to-day has a marked significance. I believe that industry is suggesting ways for helping the schools in this matter.

Most young college men lack a serious motive. They do not know why they are in college. A man sends his son to college, and the boy doesn't know what it is all about. He is perfectly at sea, and the professors seem to be too busy with classes to be bothered with him. Dealing with the individual student takes a lot of individual time. Many employees come to the personnel manager with their problems, big problems to them. We sit down and talk to each one and see

what is the matter with him and whether we can help him and put him on the right track. The school must also focus attention on the individual rather than the group. Its first objective in dealing with individuals is character; the building of a good cooperator, of one who is interested in the team, who will do more than he has to, the fellow who has vision, who is looking ahead. The next objective is a knowledge of fundamentals of the work the young man is to do. As employers we are interested in the man who knows what he wants to do and has been trained to some extent to do it. We want specialization only to the point of being thoroughly grounded in the fundamentals of his work, so that a man can soon apply them to varying conditions with good judgment and accurate performance.

The best way to get these two objectives, namely, character and fundamentals, is to base instruction on two things—a knowledge of man, and of the fundamentals required in the various industries, particularly in the industry that the individual student wants to get into. You are not going to make narrow specialists by training men so that they can get a point of contact with industry at approximately 100 per cent. The very best way to develop breadth of view is to start with a specific situation and go through clean with it. Incidentally that's the very best way to develop character.

The process of education would be greatly helped if industry would lay down even a general statement of job analyses in its various branches and subdivisions. This would be a guide to the student in determining his course and to the professor in advising the student. With a job analysis on one hand and a clear view of the background of the student on the other hand, a sound beginning in that student's education can be made. When such a young man graduates and comes to us we can use him. He will do simple tasks correctly; will make a point of contact and begin to grow. To prepare a young man to follow a specific line of engineering by grounding him in the fundamental principles involved, and by giving these a twist in accordance with his native ability, will make him immediately employable and will give the best background and the best impetus for development both technically and personally.

One of our department heads in the selling organization is very insistent that the young men of his department should run the typewriter and take shorthand notes; and he is right. They learn in this way what the manager is thinking about, and also the policies of the business, as well as the peculiarities of a business department which is not standardized. The young men of your schools should learn to run the typewriter. We send a young man down to Central America as assistant to the manager of the office. He may have a dozen men to look after, but he has also the clerical

work to do. In his college work he has learned a great deal about capital and labor problems, etc. However, on the job he has to send in weekly reports which must be neatly typed and tabulated. The trouble is that he can not run a typewriter. We lose sight of the fundamentals—such as to be able to express oneself clearly and to do the routine work in a logical way.

The big problem in education is to find some way of giving individual attention in class work. Otherwise you turn out machine-made products “all wrapped up and delivered and never touched by human hands.” That’s the way a good many men come to industry.

The commercial manager, an engineer of one of the big corporations in New York, who has to do with the financing and promoting of subsidiary companies, has made this comment:

In guiding young men who have an interest in commercial work, you will find men who have all the qualifications except one or two. One may not have the keen financing instinct but may be all right in his technical qualities. Another may get along well with people in buying and selling, but may not know just how to handle the financing so as to make the company prosper. Now if such people can be persuaded to associate themselves with other people who have the qualities they lack, thus supplementing each other, much would be gained. The commercial game is very complex, and men by association can accomplish results that they as individuals could not accomplish. It is important to teach young men this.

A man can not play the game of life all the way by himself. We work together as a team in commercial work. Bridges are designed to-day according to fundamental principles and built by organized cooperation for the service of the entire community. We are rapidly seeing the wisdom of applying the same principles and following the same ideals in the field of commerce. In this field a full measure of success can come only to the man of sterling character who has a clear vision of what he can do, is thoroughly prepared in the basic fundamentals of his work, and has caught the divine spark of inspiration from some teacher who is really interested in human beings. Such a man grows continually, both professionally and culturally, for he understands and loves his fellow men.

#### DISCUSSION.

F. B. JEWETT, vice president, Western Electric Co., New York City. Some of the present tendencies in technical education do not promise well for the future. An appreciation of this point of view, which I hold as a result of past experiences, calls for a picture of the background from which the point of view arises. First there is graduation from an engineering school, with subsequent study for the doctorate in physics, chemistry, and mathematics beyond the needs

of the average engineer. Then after a little experience in teaching comes the building up of a research department in one of the larger industries. This leads finally, as chief engineer, to engineering problems of a technical character; and has led more recently, as executive director, to problems relating to the entire engineering and manufacturing policy. In addition, as director of a company, there are problems relating to financial and business management.

This electrical industry is a highly technical one, founded like many of the other large industries of our country on the fundamental sciences of physics, chemistry, and mathematics. The directors of these industries will, in the future, be drawn more and more from men who have had a thorough grounding in the fundamental sciences on which these industries are based.

The past experiences to which reference has been made were with an association having various types of executives—the executive who was not familiar with technical matters and frankly acknowledged it; one who knew the fundamental scientific principles, the facts and laws with which he was dealing; and the hybrid, with a smattering of this, that, and the other thing. Of the three types I prefer either of the first two as a director of a business rather than the third type which knows a little of science, a little of business, but nothing much of either.

The aim of a college, a university, or a technical school, beyond the main aim of educating good citizens, should be to develop men and women who are as thoroughly trained in some one thing as time will permit. The products of the school should have, further, the ability to express simply, clearly, and forcefully the things which they know. In other words, from the viewpoint of technical industries it should be the aim of our engineering schools to turn out men who can be the future guides of these technical industries, men who know the principles of the fundamental sciences, who know the method of combining these principles with dollars and cents, and who know the English language in a way which will enable them to express clearly their fundamental knowledge in such a manner as to enable others to profit by it.

Many of the subjects suggested for colleges and technical schools, and in some instances attempted, involve ideas which in their very nature can be learned only by living. One of the great requirements for the successful executive, that of ability to deal with human beings, is a matter outside the scope of formal education. It is an art or ability which can be acquired only by actual experience over a long period of life during which one rises from minor executive to higher positions. It has been my observation that from any level at which you start you will find constant promotion of technically

trained men who have a thorough knowledge of the things in which they have been trained and who show an increasing executive ability.

A considerable number of people seem to think that the so-called management course, which has been prominently before the public in recent years, is a high road to executive control in industry without of the necessity of a future executive going through the rub of learning the scientific fundamentals on which the industry is based and learning the business itself from the bottom up. Men who have been taking old-line courses are sometimes beginning to wonder whether they have not chosen wrongly, to wonder if a knowledge of the fundamentals of business is necessary. This attitude of mind, combined with the increasing demands which have been made on our technical school facilities, has tended to weaken rather than strengthen the inherent abilities of the very young men who are going to be the leaders of the future. The danger here to industry would be far greater were it not for the fact that the colleges, as distinct from the technical schools, have begun to supply industry with the material for which we used to look to the technical schools. The colleges and universities are beginning to turn out more men as physicists, chemists, and physical chemists, who are finding their places in industry and ultimately becoming engineers in much the same manner as I did myself. The universities, I believe, through their courses in physics and chemistry are supplying the need just as the technical schools did 35 or 40 years ago.

A picture of our college training and industrial demand as it has developed in the last few decades is somewhat as follows: At one time no engineering schools; then engineering schools following closely the fundamental sciences, gradually spending more time on the applications and details than upon fundamentals. Today, if the engineering schools are going to perform their real function for industry, they must get back closer to the problem of teaching, of really inculcating, the fundamental sciences. Let the matter of trying to make executives go if you will. The men with executive ability will come to the front in the general run of things, provided they have the right human traits and a thorough knowledge of the fundamentals. Industry itself has a large blame in this deficiency of our technical schools. It has not, in general, analyzed its own requirements in a way to make it possible for the colleges, universities, and technical schools to plan satisfactorily their curricula and courses of study. Common problems, which confront industry and the institutions that supply our human material, must be analyzed and specifications written out for the kind of men we want.

D. C. JACKSON, professor of electrical engineering, Massachusetts Institute of Technology. . The cooperation between engineering schools and industries depends upon the industries understanding the

problems of teachers in the engineering schools, just as it depends, to a large degree, upon teachers understanding some of the problems of the industries.

A man's best teaching is done from a textbook that he has written himself. The textbooks must represent his coordination of knowledge that he is going to teach. A man must write books to keep himself mentally alive; he must study the process of teaching or carry on research. A competent engineer and teacher must have one of these outlets. In engineering administration and electrical engineering, the two largest courses in our institution, students study the fundamentals. The industries will find that both courses are going to prove serviceable.

F. P. WALKER, dean, school of engineering, University of Kansas. It is a sound policy for some institutions to provide opportunity for some of their students to take up courses of study which include business subjects, to base that program of work on a solid foundation which is fundamentally engineering. Students who come through these new courses of training are just as well equipped to do engineering work as were the majority of men who graduated from standard engineering courses, say 25 years ago, and who are now, after years of experience, in the leading engineering and executive positions among the industries of the country.

About 15 years ago I made a study of the records of about 1,000 mechanical engineers, graduates of representative technical schools, who had been out of school from 5 to 25 years. Of the number who had been out 10 to 15 years or more, amounting to several hundred, the men were found to be divided almost equally into two groups. The one group had remained in strict engineering work and were filling positions with the titles of engineer, chief engineer, etc., while the other half were men who had become presidents, secretaries, general managers, and superintendents of industrial organizations. It is with these facts in my mind that I formed the opinion that it is most proper for us as we go on in this work of broadening our curricula to meet business conditions, to keep our men thoroughly grounded in the fundamentals of engineering.

In many of the State institutions of the West we are unable to determine entrance requirements, because of the State laws which prescribe conditions of entrance. The standard for preliminary training of students is being lowered. We have a harder struggle each year to meet the situation. The five-year program may be advisable, using the additional time in the form of a preliminary year.

Col. KEPPELE HALL, Joseph and Feiss Co., Cleveland, Ohio. A great responsibility rests on engineers and educators who are preparing young men to become engineers. Without question the commercial engineer, the industrial or management engineer, will assume



more and more the burden of executive control in business. He will have to solve the problems of industry, problems of unemployment, strikes, etc., due to bad management. The technical courses have been thoroughly prepared. The engineer must possess, however, common business sense and the knowledge of how to deal with his fellow man, must think straight and act intelligently. That is a much bigger problem for the educator than the question of how many hours the student shall spend on this or that subject.

In solving our engineering problems per se we have definite rules; our thinking is based on facts. In the other field we do not think as clearly as we should. Then the students must be taught to think and form their own judgments; to do some constructive thinking on matters relating to the conduct of industry, to labor and capital, etc. One more point. There is a certain danger in alliances between educational institutions and big industrial establishments. That must be faithfully guarded against. Our bigger industrial organizations may wish to dominate our educational institutions for their own aggrandizement and profit.

Those problems are to be solved with the cooperation of teachers and of those on the outside in the engineering and business professions who not only know how important the underlying principles are but how important practical experience is. Both must be fortified by sound principles of decency, common sense, and good free high thinking.

F. PAUL ANDERSON, dean of engineering, University of Kentucky. Technical graduates must be made to realize on commencement day that they are in no sense engineers, but that they may some day become engineers if they will enter vigorously into the work of some organization and devote themselves for 10 or 15 years to learning somebody's business. To succeed in an industrial organization they must be able to obey orders.

Colleges must train their students to be men. The technical schools should not attempt to make specialists. Their aim is to train thoroughly in fundamentals. This is true also of the business administration departments of universities. It is impossible to make a banker, a great merchant, or a learned engineer at 19 years of age. And then the technical schools should send their graduates into the world in a humble attitude to learn somebody's business.

Commercial engineering, a term that has appeared only recently, implies an effort to unite human qualities and characteristics with excellent engineering practices. Preparation for careers of dependability and unselfishness in our industries requires two training schools, the college and the industry<sup>2</sup> itself. The graduate from a technical course begins to learn something relative to commercial

engineering by entering a high-grade industry where he must obey orders and can learn some of the important processes and traditions that colleges can not give him at all. The colleges, however, must lay the foundation and give some attention to those personal graces so necessary to the well-balanced individual, so much needed at the present time in all American manufacturing plants.

The engineer, to attain the position of leadership to which his professional service entitles him, must be an English scholar as well as a scientist and technician. No one in all life's relationships has more vital and fascinating observations to relate than the engineer. It is just as essential for the engineer to be able to express his deliberations through written and spoken language as it is for him to be able to convey his technical ideas through the language of mechanical drawing. The banker, the economist, the business executive, the railroad president, and the layman must be addressed in the mother tongue.

It would not be a bad idea to address the engineering graduate thus: Start in the industrial world in a humble attitude to learn somebody's business. Obey orders with a smile. Do not let a single skilled mechanic or executive of the old school know that you have just received your diploma. A college course is a fine tool, but it must be in the hands of a master to be effective.

Engineering is the art of organizing and directing men and, incidentally, controlling the forces of nature for the benefit of the human race. But the principal thing in engineering is the same as in banking or any business. The real work, therefore, of the university should be to give an intellectual basis to the youngster who intends to follow an industrial or engineering career. If this is done, there will be no particular difficulty about the college-trained man being able to cope with the problems and responsibilities of the ever widening and varying world of industry.

E. M. HERR, president Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa. There is no royal road to a place of commanding importance in industry or any other business; nor is it the function of an educational institution to try to teach young men to be captains of industry, or administrators, or occupy very great and important executive positions. That quality in man is not capable of being taught in an educational institution. It's got to be developed in actual contact with human affairs; but it can only be developed well if the man who is engaged in industry is thoroughly grounded in the fundamentals of engineering and science.

If young men are thoroughly grounded in fundamentals, in the basic principles underlying the science of engineering, and are trained in taking and executing administrative orders diligently and faithfully, the talent will develop if it is in them.

C. R. MANN, chairman of operations and training division, General Staff, War Department. A summary of the debate to-day would indicate that we are going to achieve our ideals in engineering and thorough education by training men in fundamentals. But what are fundamentals, for example, of physics or calculus? How are we going to find out what fundamentals of any subject are unless we record the activities in which they find actual expression in the engineering and commercial work of to-day and then analyze the record to find out what the fundamentals are?

HUGO DIEMER, director of industrial management division, La Salle Extension University. In coordinating the work of the engineering school with industry there is a distinct demarcation between industrial engineering and the teaching of business fundamentals to engineers. There are branches in industry, such as planning, laying out the plant, time and motion studies, job analyses and industrial researches of a scientific nature, arranging the equipment, providing the storage of material, the most economic handling of material, scheduling, dispatching, cost accounting, and control, which are distinctly the work of the industrial engineer. There are also laboratory investigations in college which typify fundamental principles for industrial engineering just as much as others do in the old-fashioned experiments for mechanical engineering. For instance, instead of measuring the moisture in steam or calibrating an indicator spring, we can get just as good fundamentals in analyzing the prime elements, the factors which repeat themselves, irrespective of the magnitude of the work, in operating a lathe or a machine tool, or in analyzing all of the conditions relating to production work.

Business men say sometimes that the average industrial engineer does not understand men; nor can he sell his ideas. At a recent convention two speakers attributed this largely to the fact that most industrial engineers have been originally mechanical or civil engineers, picking up their business knowledge by noon-day luncheon talks and through business publications. There is a real opportunity here for the school. The engineer must not be thing-minded; he must become man-minded.

A. J. HUGHES, dean of the Harvard Engineering School, Cambridge, Mass. Educational problems present themselves to some schools in ways that require radically different solutions than in other schools. Harvard is trying to coordinate engineering and business training by offering in the engineering school, with the cooperation of the school of business administration, a group of five-year programs of study combining engineering and business, the engineering courses to be given by the faculty of the engineering

school, and the business courses by the school of business administration. This group of courses is in addition to the four-year courses in engineering in the engineering school and the graduate courses of business in the school of business administration. It was decided as a fundamental requirement of these five-year combined programs of study that they must contain all the engineering, scientific, and general study of the four-year programs, and this is accomplished in the following manner: The first three years of the five-year programs are identical with the first three years of the corresponding four-year programs; and the time of the last two years of the five-year programs is made up 40 per cent of engineering courses and 60 per cent business courses, the engineering being the fourth-year subjects of the engineering programs, and the business courses being the backbone of the two-year graduate course in industrial management offered in the business school.

It is not possible to plan a four-year program to train young men both for engineering and business. The time is inadequate for both. It is a serious question whether five years is sufficient for this double training. It is important, however, above everything to make sure that rigorous training in fundamentals shall not be replaced by courses which, however interesting or informing they may be, do not in themselves offer the best medium for mental training, or are given in a way that does not require vigorous thought.

W. R. RITTMAN, professor of commercial engineering, Carnegie Institute of Technology. Managers or administrators can not be developed by a four or five year course in college, nor can mechanical or civil engineers be developed in that time. The industrial world will have to develop and determine the product. We are not about to lose the fundamentals of life or education just because of an educational experiment which may result in a somewhat different procedure. Fundamentals vary in form and manner of presentation from year to year. There are to-day fundamentals of a greater variety than in the early days of education. Take, for example, the social and economic sciences. They are of a different character and equally important. The man or the engineer who is grounded in the fundamentals of the social and economic sciences, or a foundation of the fundamentals of an exact science, will have a useful and profitable place in the world. It is not intended that he displace the old-line engineer, the designing and constructing civil, mechanical, or electrical engineer. Both types or groups are necessary.

R. L. SACKETT, dean of engineering, Pennsylvania State College. Many years ago one of the technical papers of this country showed, after careful study, that about 50 per cent of the graduating

engineers were in executive positions. The old type of instruction, while different from that at present, offered opportunity for the development of executives. In the development of executives to-day more will have to be done by example. Less importance must be placed upon the subject taught. It is not a question of putting character in, but of drawing character out, of giving the young man an opportunity to develop leadership in surveying, in the laboratory, and in the other places where we have not yet developed it.

EVERETT W. LORD, dean of the college of business administration of Boston University. Schools of business administration can not teach engineering. To teach the things which must be taught young men before they graduate our school has had to lengthen the course to five years, one of which must be spent in actual business. Business training ties up with every kind of professional training. The engineer does not need it any more than does any other professional man who has to sell his services and himself. Practical training courses of the social and economic type are essential to every professional man.

## EVENING SESSION.

*Monday, May 1, 8 o'clock, College of Fine Arts.*

Delegates and visitors were the guests of the institute at a dramatic performance and smoker. The speaker at the latter function was the president of Carnegie Institute of Technology.

ARTHUR A. HAMERSCHLAG. The fine arts have been neglected in American cities and institutions of learning. We have been so accustomed to borrowing and imitating the art of other countries that it seems an anachronism to hope to have an indigenous background created by our own artists. All the arts are inter-related. Breadth of sympathetic coordination, vital to a full comprehensive and intelligent development of the individual, is not possible without access to all the arts that use color, form, structure, letters, and harmony, as foundation mediums. All students who attend this fine arts college are expected to acquire facility in the use of more than one medium, and they have the association of artists in music, painting, architecture, drama, and sculpture, with the beneficial education reactions which only these varied arts can supply.

The plays presented to-night in the Little Theater were given by students who have as their objective careers as playwrights, actors, scene painters, producers, costume designers, etc. In giving their performance they are teaching themselves the art of self-expression, acquiring versatility, ease and poise, diction and carriage. Each of the five major fine arts has one floor of this building exclusively used for its own workshops, drafting rooms, ateliers, and classrooms. The symphony orchestra offers public performances, and the architects enter into the beaux arts competitions in the same spirit as do other students in other laboratories concerned with their own development. All the students who study in this building come immediately into an atmosphere of related arts.

To meet this demand the Carnegie Institute of Technology undertook to offer instruction which departed from the traditional course, the graduates of which have found themselves equipped with a type of knowledge which is passing from the field of practice. To handle the problems of the world's work in 1930 it has been necessary to create a new curriculum, the graduates of which will be equipped to fill acceptably the future specifications for commercial engineering.

This pedagogical experiment needs cooperation elsewhere, so that proven data relating to methods and courses which they have found productive may be exchanged and serve as common experiences to material advantage. Too few colleges in America are willing to venture into educational experiments. We must be aware of the great need which exists for a highly trained and able combination of business man and engineer. We need in our multiplicity of enterprises the individual leadership of men who have the selective mind, understand the fundamental principles of business, are familiar with the existing engineering practice, and who have the vision to comprehend the related activities of finance and commerce, together with their bearing on government economics. It must be an outstanding thought to which we are all committed that commercial engineering education has come to stay, and that the experiments in this field must be made in many places if we are ultimately to meet the growing demand.

The subject of this conference of commercial engineering education is also somewhat novel, having some of the elements of a new doctrine. The time-honored engineering education in the United States has won a definite and sure place because of the very wonderful nature of the performance of the graduates trained under the established curricula. For nearly 50 years our modern life has been influenced and enlarged as a result of the efforts of engineering graduates who have concentrated their whole energy on problems of efficiency and research; until rather recently engineering has been accepted and recognized as a profession with limitations. The fields of distribution, transportation, and sales were quite as distinct from engineering as if production, design, and research were not essentially a part of that profession.

American industrial operations have assumed quite recently such proportions that there has been created a demand for trained men, who are not only familiar with the fundamentals of engineering practice, but have had some training in the business side of the sales merchandising and financing of our large factories and mills. Tested by this requirement, the old-time curriculum is altogether inadequate. It lacks the breadth and vision, and the detailed subjects of instruction which enable intelligent and scientific attack on the problem of merchandising, problems of transportation and distribution, of financing, of personnel, and organization.

### THIRD SESSION.

*Presiding officer: C. F. Scott, professor of electrical engineering, Sheffield Scientific School, Yale University.*

#### CIVIC AND SOCIAL TRAINING OF THE ENGINEER AND BUSINESS MAN.

Doctor SCOTT. Our engineering colleges are giving a certain proportion of their time to the new fields with which engineering is coming into closer and closer relation—not to train men in those fields, but to give them the outlook so that they can see the relation of their work to the broader fields into which, through their engineering careers, they may develop as time goes on. The executive is not made; he is developed. Engineering training is a pretty good beginning from which the executive and the man of large affairs, the director of larger interests, can be developed. It gives the student something of an insight into these relations which he may take up later, so that he will have broad vision as well as immediate proficiency in the work for which he is being trained.

C. R. MANN, chairman of operations and training division, General Staff, War Department, Washington. The Army offers perhaps what is the best educational laboratory in the country. It has all phases of engineering training, a large number of men, and the facility of controlling the conditions of the experiment in a way in which other educational institutions can not. At the outbreak of the war there was an enormous job to do with the military establishment. There was much confusion as to how to organize the manpower of the country to perform that very striking technical job. How were we to find the men who had the particular qualifications for the special jobs required, to train men so that they would fit into the requirements of the military establishment. There were no definitions of the duties of the men in the various parts of the Army; there were no tests that had been developed to measure the experience and abilities of men. Before the war closed there had been developed by cooperation of all civilian agencies and the military authorities the crude outlines of a system of recording the abilities of men, and of classifying men and measuring their qualifications, and of specifying and defining the particular kinds of jobs, so as to make possible a reasonable and rational fitting together of



the men and the work. Since the war that system has been developed and carried out in much greater detail.

The different services in the Army were often confused, the same type of work being called by different names. A standard terminology is being worked out. Instead of 565 titles of various specialized jobs on the Army's occupational index, there will be something like 170, each one accompanied by specifications of the skill, knowledge, and personal qualifications required to do the job properly. Standard terminology and specification are the fundamental basis of any training system which the Army must develop for procuring or producing the specialists needed in the military establishment.

The description of such a standard terminology and such specifications in the industrial work and in the engineering world might be of like use to the training program. There are at the present time over 11,000 different terms used by industry defining various types of specialties. The statistics gathered by the Census Bureau and the Bureau of Labor Statistics are in consequence difficult of classification. We do not know to-day how many machinists there are, nor exactly what a machinist is. We should attempt to get, in civilian life, some sort of a standard terminology with reference to all types of specialist work. One industrial community is interested in this problem. Three of the leading industries of this community are cooperating with three elements of the school system—a university, a mechanics' institute, and the public-school system—to determine what are the types of work required by the industries of that community, what terminology they will use in describing the types of workers, and what the definition of those types of workers shall be. The industries have discovered that they are getting a great deal of benefit from this analysis of their jobs, in regard to their replacement problems, wage scales, and other things within the industry. The schools have also found a new point of view and a new interest in their work.

The second part of the problem is to evolve ways and means of discovering the bent of the men, their natural capacities, their desire to work, their intelligence, and other things of that kind, in order to find out which job the man is best qualified to take. The Army used the means that were developed during the war by the committee on classification of personnel, by the psychological testing division of the Surgeon General's Office. These tests have been studied and developed. Schools are already practicing with these methods and are making progress. With the cooperation of industry, and working along the line of these two fundamental factors, the problem of commercial engineering will be solved more rapidly than by trying to construct curricula before we know exactly what the problem is and

before we understand the specific details of the duties that those men must be trained to perform. They are not to be trained merely to do particular jobs, but trained in the fundamentals to be broad-minded, competent, all-round men.

The most effective way of determining what fundamentals are is to analyze what has to be done, to discover what principles and what basic ideas occur, and how they occur in the world's work. When a student studies physics he has no perspective, because all topics are presented in the same perspective. Texts in physics usually have some five to eight hundred various principles, rules, and laws. According to one analysis of specifications of the world's work there are only 6 fundamental ideas of physics. From my own analysis of the subject there are not more than 25. The same idea applies to other subjects. By recording and analyzing with care what physics does in the world's work, the fundamentals can be discovered, organized, and taught in very much less time. By means of this analysis and application in the Army, the time of training to definite standards of proficiency has been reduced by as much as one-half.

The analysis of what are fundamentals applies to the social, economic, and civic aspects of the problem. If the engineer is merely a master of the technical side of his work, and fails to understand the social, economic, and civic relations, he is out of touch with life, and therefore does not win the professional recognition which should be accorded him. The Army insists also that the soldier be given some of the fundamentals of social and civic relations. Based upon analysis a course of 30 lessons has been developed so that every recruit learns about the organization of the Army, why the Army exists at all, what its relations are to the Government, why the Government exists, what the duties of the soldiers are to one another as men, how this country was organized in the first place, what it stands for, and many other things relating to social and human relations. This material is organized as a series of discussions and episodes in the soldier's life.

When we define our ideals of education in general terms, we have only a very vague and indefinite objective, which is good to look upon but does not get anywhere. This method of definite specifications takes a long time, but every month spent at it gets you somewhere definitely ahead. In fact, if civil communities undertake this program they must expect to continue at it, and change and modify it as time develops.

#### DISCUSSION.

GEORGE W. DOWRIE, dean of the school of business, University of Minnesota. It is expected that the universities in four years' time give to their students the culture that is associated with

the university degree, instill in them the proper professional ideals, make social-minded beings out of them, give them the fundamentals, and help them apply what they have learned in preparation for some specific task. If so, they must have help from the outside. The gulf between school and business can be bridged by having suggestions, inspirational talks from business men on the standards of their profession, which will be later of real practical use, and, most of all, by taking advantage of the laboratory or clinical facilities afforded by business establishments. Business men should study their needs and let the universities know what they are; should help in the collection of case materials. In the use of case material and problems from actual experience one can test the student's power to analyze and can develop qualities which will be of great value to him in meeting the problems of real life.

The University of Minnesota is experimenting with the plan of sending senior students into industrial, financial, and mercantile establishments, where they work as regular employees two days a week. They get the same wages as the less experienced help and are routed according to a systematic plan right through the establishment. Each group of seniors is in charge of a specialist in his major field, who keeps track of what his students are doing in these establishments.

The universities demand that a professor of business subjects have all the erudition and training associated with a doctor of philosophy, and the business man insists that he shall really know what he is talking about. However difficult, these specifications must be met. Instructors must know what they are talking about, and at the same time be not so absorbed in a commercial connection that they neglect their teaching. Business men and practicing engineers can assist with this problem by helping place faculty members, in summer or when on leave of absence, in situations where they can get real, useful, vital contact with business.

K. G. MATHESON, president, Drexel Institute, Philadelphia, Pennsylvania. Business men and manufacturers should adopt this plan of visiting colleges and giving the students the benefits of their practical experience. Engineering education demands that the student have the best preparatory training possible, including and emphasizing cultural studies, in addition to scientific subjects. If the educational impatience of the American student can be overcome, he should graduate from a standard college of the cultural type before specializing in engineering. The graduates of such a course of training not only would be thoroughly versed in their profession, but would be capable and valuable citizens as well. Since college training is not made the basis of specialization, institutions giving engineering courses should inculcate in the curricula the

maximum of cultural training. The most important fundamental in education, as in life, is the building of character; without it, education becomes a menace instead of a benefit.

F. M. FEIKER, vice president, McGraw-Hill Co., Inc., New York City. This conference marks the bringing together of the men whom I call the "makers" of education, the teachers, and the "users" of education, the men in charge of our manufacturing and commercial institutions, who take the product of the technical and engineering schools. In the minds of the latter the former are to-day on the defensive. A large part of the misunderstanding between the two groups comes from lack of clearness in expressing each other's point of view. To set up specifications for jobs is an illuminating attempt to get the users of education to present clearly what they believe to be the requirements for different classes of work and different opportunities in their establishments. To educate men for executive positions in commercial establishments one must know more specifically what are the requirements for these executive positions. There must be set up some broad differences in specific educational requirements between men who are going into technical engineering, design work, and commercial engineering. An opportunity must be found for bringing together through some organized effort the users of education.

The opportunity for the spread of an idea in a meeting of this sort is very small. It is difficult to get ideas started in our great industrial life to-day. The Department of Commerce has been trying during the last nine months or so to get over to industry a new conception of the department. It is the same as getting over a new conception of business or engineering education to business men. The only way to do it is to get the business men themselves interested in what is being done.

To bring educators and business men together there is, furthermore, need of a common language. An industrial engineer is distinctly different from an electrical, chemical, or civil engineer so far as his training is concerned. A commercial engineer is a man with an engineering training who sells the products of an engineering concern by telling the buyer how to use the products. The men who sell motor trucks are successful for a very different reason from that of the men who sell pleasure cars. When you sell a motor truck you have to sell a method of using it. A motor truck to be used efficiently may completely change the method of handling goods in a plant, and the salesman must know enough about processes and the technical handling of the product to fit the motor truck as a unit of transportation into the general plan for the factory. The salesman of a private car makes his sale on the basis of the upholstery, the

painting, and the riding qualities of the car, none of which requires a technical background for successful selling.

CHARLES S. HOWE, president Case School of Applied Science, Cleveland, Ohio. Organizations dealing largely with civic problems during the last 20 years have greatly increased. Chambers of commerce now deal with every civic question. And yet rarely do we find an engineer on the committees which are discussing even the engineering problems before the city. Seldom in advertising clubs, city clubs, rotary clubs, and church clubs are there any engineers taking part in the discussions. One great problem before the cities of to-day is the question of treatment of its philanthropies. In Cleveland there are over 100 such philanthropies under the control of one organization. This organization disburses two or three million dollars to the different charities of the city. All of this work is done through committees, and there are practically no engineers upon any of these committees. It would seem that the engineer is not paying very much attention to some of his civic duties. One reason may be because the engineer is a specialist along narrow lines. It is difficult also for him to get away at noon to attend a civic meeting. The average engineer can not do it. The real reason, however, is because he can not talk.

If the engineering colleges are to train their graduates to take part in civic matters, they must give them a better training in English, more training in speaking. The training in commercial subjects also may be helpful.

IRA N. HOLLIS, president Worcester Polytechnic Institute, Worcester, Massachusetts. So far as engineering is concerned, the application to business of some of the principles taught under engineering is vastly more important than the reverse. That would mean, practically, less business in science and more science in business. The success of a college is more a question of men than it is of studies, of classification, and four-year schedules. That is the chief factor in any kind of education. One of the professors at the Worcester Polytechnic Institute made of mathematics a human subject, alive to every student, and he made of himself a guide to every person who came into contact with him.

The course in engineering is overcrowded. There is no place for a four-year course for accounting or business. The contact with commercial life ought either to come in a fifth year or after graduation.

Engineers do not neglect their civic and social duties. There is no profession superior to the engineer in this regard. Meetings like this indicate that they are endeavoring to do even more than in the past.

The word "engineer" was used hundreds of years ago in exactly the sense in which we use it to-day. It comes from the San-

skrit and meant "father" in that language. With the Greeks and the Romans, and with every modern nation as a rule, it carries the idea "to create or to produce by the power of intellect." It has also in it the idea "generous," a certain nobility of character that would lead the individual to real service of mankind. It is the fourth activity that humanity has developed—the teacher, including the preacher; the lawgiver; the healer or the doctor; and the engineer, that profession which has kept man alive on the earth and will always keep him alive.

T. T. READ, chief of the information section, the United States Bureau of Mines, Washington, D. C. There are three fundamentals—to make men work; to make machines work; and to make processes work. The training in the technical school is largely devoted to making processes work. Less is devoted to making machines work, and still less to making men work. It is not only much easier to teach processes, but man is most likely to start with this. Our training dwells too much on processes and too little on the handling of men. There will be plenty of time for business subjects in engineering education if we do not dwell too much on the less essential matters of the technical school life.

L. W. WALLACE, executive secretary of the Federated American Engineering Societies, Washington, D. C. It would seem that our universities have been teaching too much about how to make money and not enough along the lines of how to spend money; that they are spending too much for buildings and equipment and not enough for competent men to utilize the equipment. It may be that we have too much memorizing and not enough thinking or reasoning; that we have too much curriculum and not enough personality and force in the teaching staff. With improvement along these lines we may be better satisfied with the results of our educational institutions.

S. E. DOANE, chief engineer, National Lamp Works, General Electric Co., Cleveland, Ohio. An educational experiment of the last 10 or 15 years that deals with the selection and training in industry of college-picked men should be of interest. Men with initiative, energy, and ambition were wanted. The engineering schools were selected because the courses were unpopular and hard, and frequently the men worked their way through college. The type of training was purely incidental. In order to get men for the electrical business it made little difference whether they were mechanics or electricians. One of our best men came to us as an M. D. The fundamentals of engineering education are so nearly similar that it does not matter much to us who make specialists of these men or in what field in college they were specializing. Frequently men with engineering training gravitated to the sales department. They had ambition and energy, strong bodies, and clear minds. They

were able to stand up and get through, and when they could choose they naturally drifted to the line of work for which they were particularly adapted. In addition to training the mind, education is a question of selecting men, of keeping their bodies in good shape, of giving them a chance after they get out of college to gravitate to the kind of work for which they are particularly adapted.

#### REPORT OF THE COMMITTEE ON RESOLUTIONS.

Dean P. F. WALKER, of the University of Kansas, chairman of the committee on resolutions, presented the following report:

I. Following the discussion that has been participated in freely by those in attendance at the sessions, the following statement is set forth embodying certain principles which the conference believes to be expressive of proper aims and purposes of educational institutions and industrial organizations here represented:

1. It is believed that the engineering profession will be advanced in honor and dignity and in its capacity to render a maximum of service to humanity if in the schools a substantial effort be made to impart to students an adequate conception of the broad field of action which is theirs in the realms of production, distribution, and finance.

2. It is submitted that the principal means for accomplishing this aim lies in a continuance of the sound and substantial work of the established schools, supplemented and broadened where practicable by instruction in economics and business subjects and in the basic principles of production or industrial engineering; in which, however, no specific curriculum additions are suggested beyond those recommended by the first conference in 1919.

3. It is recommended that established schools of commerce and business take under serious advisement the policy of supplementing standard curricula by the introduction of work in the elements of engineering, in order that more of the business men of the future may have a sympathetic understanding of construction problems that are fundamental to economic progress.

4. It is believed that much may be accomplished through more active researches in industrial and commercial lines to the end that systematic scientific methods may be applied in meeting the problems and needs of industry; this with special reference to the elimination of unnecessary wastes, the conservation of material and human resources, and the lessening of production costs of standard commodities of commerce.

5. The conference recommends that colleges of engineering and of business adopt the following procedure in developing business training of engineers and engineering training of business men:

(a) Secure the cooperation of industry in defining standard terminology and specifications of the requirements of industry.

(b) Analyze the specifications of the requirements of industry to determine what are the fundamentals that must be taught, and organize the instruction accordingly.

(c) Study and experiment with ways and means of discovering native bent and measuring proficiency, that every student may be guided into a career of maximum achievement.

6. We reaffirm the purpose of the committee on commercial engineering of the United States Bureau of Education, and recommend that conferences under the direction of the committee be held at regular intervals.

II. Whereas the Second Conference on Commercial Engineering has enjoyed the hospitality extended through, and very material cooperation of, the Carnegie Institute of Technology: Therefore be it

*Resolved*, by the conference in session assembled at Pittsburgh this 2d day of May, 1922—

1. That the thanks of the conference be extended to the Carnegie Institute and coordinate branches, all of its officers of administration and instruction, for the hospitality and services rendered.

2. That the especial thanks of the conference be extended to Doctor Hamerschlag, president of the Carnegie Institute of Technology, for his inspiring address and other acts of courtesy and cooperation; and

3. That the thanks of the conference be extended to the students of the College of Fine Arts of the institute who so acceptably entertained our members at the theater on Monday evening.

By the committee: G. W. Dowrie, C. R. Mann, J. W. Roe, C. F. Scott, W. E. Wickenden, and P. F. Walker, chairman.

The report of the committee on resolutions was unanimously approved by the conference.



## FINAL SESSION.

*Group Conferences, 2 p. m.*

The report of the group conferences is based upon longhand notes made by members of the conference and later confirmed by the speakers. For program of the group conferences, compare page 4.

### GROUP 1, Dean Dowrie presiding.

Dean DOWRIE stated that there are fundamentals in business training as well as in engineering; that engineers therefore need not less than 25 semester hours in business subjects for engineering. This may mean, he said, a post-senior year for engineering students who expect to go into executive lines.

C. R. JONES, dean, College of Engineering, West Virginia University, Morgantown, W. Va. The engineers and the commercial group, in their endeavor to reach a common meeting point and to establish an effective working base for the solution of the general problem under discussion, must necessarily approach each other from opposite viewpoints. The engineer has a pretty definite idea of the finished product and knows about what an engineering executive must do or ought to be able to do, but he got his business training for the most part in the school of experience and finds it difficult to define exactly the type of courses and the subject matter that should be given to the student to produce the effect wanted.

Teachers in the commercial group have everything that the engineers lack and more, but have only a hazy idea of what the product should be, and consequently they find it extremely difficult to formulate a course for an engineer that shall have, in it the desired basic training in business and still leave enough time for adequate training in the fundamental engineering subjects.

There is a demand for four types of courses with commercial subjects:

1. Some commercial work should be given in all of the standardized engineering courses, such as civil, mechanical, and electrical engineering. Such instruction is, and has been, given at nearly all institutions and is in most cases definitely required. The experience of teachers of engineering and the continued emphasis on the part of the employer class for thorough training in the "fundamentals"

indicate that the schools have gone to the extreme so far as commercial training is concerned in the old-time courses. The engineering schools have made no sacrifice in adding commercial instruction. It is not a good thing for any student to devote all of his time during the last two years of undergraduate work to purely technical and scientific study and investigation. He needs at least two or three hours per week of a different type to broaden his viewpoint and to serve as an antidote against too much specialization. Economic and commercial subjects fill this gap very admirably and have as much purely cultural value as any other general courses that could be chosen.

2. Commercial engineering courses have great possibilities. Time will prove their worth. They afford an opportunity for a student who has the proper natural qualification for a business career to get a fairly thorough, though limited, course in some phase of commercial work, business administration, transportation, etc., and still get those courses in science, mathematics, and engineering common to all courses in engineering, and perhaps some specialization in some one branch. The difficulty is to provide enough engineering training to enable him to take up the engineering side of the job, should later circumstances make it necessary or desirable.

3. Graduate courses in business administration for engineers or five or six year combined engineering and commercial courses can be framed to satisfy both groups to a reasonable degree, but their length and cost are limiting factors.

4. The course in industrial engineering, now considered a standard engineering course, with opportunity for courses in business administration and management.

From the standpoint of the engineer, the list of subjects outlined on the blackboard are all that should be included as required subjects in an industrial commercial course.<sup>8</sup> In addition to these it would be advisable to permit some engineering electives along the line of the industry which the student proposes to enter.

L. M. McDERMOTT, head of department of commerce, College of Engineering and Commerce, Municipal University of Akron, Akron, Ohio. Our course in industrial engineering is a combination of commercial and engineering subjects with such subjects as mathematics, language, and English. The combination is favored by business men and engineers as marking a step forward. The extension courses are filled to capacity with factory employees. The course is hard and utilizes for classroom study the problems that come up in their daily work. Attendance has increased over 200 per cent in two years. Courses in accounting and business administration

<sup>8</sup> Technical subjects for students of business: Freshman year—mathematics, chemistry, and physics; sophomore year—industrial organization, drawing, and mechanics.

are offered to engineering seniors. The regular students in business courses will get much more from them. It is much easier to teach engineers. They will accept statements readily, while business students will always have to be shown the reason for the proposition. A new problem is much more readily attacked by the business student than by the engineer. The training of the former has been of a character to enable him to do this. The engineer, in order to be a successful executive, will have to acquire this habit. The ability to reason is much more marked in students of business than in engineering students. The latter, therefore, should take as many business subjects as possible. Engineers always begin in a factory in a minor capacity, and they will naturally study the work in which they are engaged. Not many study business subjects—new material—at this time. The University of Akron is meeting this condition by requiring engineers to take at least 12 hours of business studies, with the privilege of taking more under special conditions.

J. H. O'HARA, of the department of economics, Carnegie Institute of Technology, emphasized the value of the study of industrial organization to sophomores taking production.

Dean McCAUSTLAND, University of Missouri, advised that as much latitude as possible for business courses be given in engineering and that the same be done for engineering in business courses. He did not think shopwork was necessary for industrial organization.

Professor CALLAN, Harvard University, discussed the course in "Synopsis of Engineering Problems" at Harvard, emphasizing the value of instruction in the technique of drawings, architectural work, etc. Other aspects of engineering, he said, should lead to an appreciation of engineering as a science and an art. All that can be done will be to give to the business student with but little engineering a broad sympathetic understanding of the profession as a whole.

R. A. STEVENSON, professor of accounting, College of Engineering and Commerce, University of Cincinnati. In the fall of 1920 the University of Cincinnati organized a course leading to the degree of commercial engineer. It was organized in response to a demand for men in management positions who have been trained in the fundamentals of engineering and in addition have a knowledge of business administration. Many of the graduates of the engineering courses had been returning to take evening courses in commerce. It is a five-year cooperative course. During the first two years the fundamental sciences underlying all engineering, physics, chemistry, mathematics through calculus, mechanics, and metallurgy

are studied. The outside cooperative work in industry during these years is carried on in the production department of manufacturing establishments. The student then takes a cooperative commerce course in the university. The subject matter is similar to that given in the other commerce courses. Less laboratory work is required. The business firms of the city are enthusiastic about this program as a training for business. The banks which are using the students of the third, fourth, and fifth years find that the rigid scientific training of the first two years, coupled with the production experience in industry, is a valuable foundation for banking practice. The same training should be valuable as a preparation for management positions in general.

Dean BISSELL, of Michigan Agricultural College, suggested industrial history as a desirable requirement for a course designed to give students of commerce a suitable groundwork in engineering subjects and emphasized especially the need of arithmetic.

Mr. DOOLEY, director of personnel and training of the Standard Oil Co. of New York, said that the course of study was not the important thing. A trained mind is the important thing in industry. A man must be able to sense a situation and go to the heart of a problem. Enthusiasm and interest on the part of the student are essentials, and not a specialized knowledge of facts. All courses, including commerce, engineering, and the arts, should be put into one. All fundamentals should be taught so that all students would put their whole hearts into the work they take.

LOUIS MITCHELL, dean L. C. Smith College of Applied Science, Syracuse University, Syracuse, N. Y. Students in engineering may be receiving considerable business training in their technical studies. The study of water supply and sewerage, for example, will include the making of estimates, which involves the questions of labor rates and material costs. It also includes the question of bond issues, sinking funds, depreciation, assessments, taxation, rates, and maintenance. Students of more than average ability should, however, be encouraged to carry nontechnical subjects, business administration subjects, as optional studies.

J. C. PINNEY, dean College of Applied Science and Engineering, Marquette University, Milwaukee, Wis. This conference confirms the increasing experience of educators that representatives of industry who employ the product of schools and colleges want men who are willing to work, who can think along logical lines, and can express their thoughts intelligently.

T. WARREN ALLEN, Chief, Division of Control, Bureau of Public Roads, United States Department of Agriculture. Educational institutions should devise means for keeping in contact with

certain if not all students for a sufficient length of time after they have been graduated to gain some idea as to the coordination of their experience in industry with their college education. Tests made during the time spent in college to determine the range, speed, and precision of mental activity aside from the ordinary examinations might well be continued into the employment period. Postgraduate development may then be studied in comparison with undergraduate work, the deficiencies in undergraduate work indicated, and steps taken to correct them. The same course will not develop all students in the same way, and if thorough tests are made in order to obtain indications of the progress of mental development, such information should be of inestimable value both to the student and to the instructor in determining future procedure.

The value of tests of this character to a thinking student may be likened to the value of cost data to a contractor or a manufacturer. Cost data provide the means of ascertaining whether a particular operation is remunerative or not and how, if possible, a loss may be curtailed or the operation be made more remunerative. If the suggested undergraduate procedure is followed by a record of the character and extent of postgraduate study, in connection with the requirements of the work undertaken, and the mental development under the influences of these as determined by periodic tests, educational authorities should in time secure for guidance in educational work dependable data which would be difficult to secure in any other way.

H. J. HUGHES, dean school of engineering, Harvard University, Cambridge, Mass. Most engineering graduates enter the industries. If they are to serve industry well, their college work must be supplemented by considerable training and experience provided by the industries. The real job of the engineering college is to help students to build a sound foundation of scientific knowledge, to cultivate open-mindedness, and to aid them in developing habits of accuracy, of observation, clear thinking, and those qualities of heart and mind which make them good citizens as well as good engineers and business men. There is constant pressure from within and without the college for new, special, and practical instruction to meet the growing and changing needs of industry. In a conscientious effort to meet these demands the colleges have been attempting much that could better be done by the industries. The results have too often been unsatisfactory to all concerned.

Many industrial executives understand the possibilities and limitations of the engineering colleges; many industrial organizations are cooperating with the colleges in the training of young men for industrial positions. Some companies maintain training courses for

technical graduates; others provide summer training courses for undergraduates; some participate in industrial cooperation on the Cincinnati plan, and a large number employ students during summer vacation. The opportunities for systematic industrial training for graduates, however, are limited to a few fields of industry; in the aggregate there are many such opportunities, but they are relatively few in comparison with the number of graduates entering industry every year. Summer work, which might be made an important part of the students' preparation for industry, is of little real educational value, because it is for the most part neither well planned from an educational standpoint nor properly supervised. Joint local committees of industrial executives and engineering teachers must, by study of this problem, come to a thorough understanding as to what part each group can best perform in training young men for the industries. Such an understanding will inevitably result in economy, efficiency, and better-trained engineers.

#### **GROUPS NOS. 3 AND 4, Secretary Wallace presiding.**

The following excerpt was read from a letter sent by Eugene Meyer, jr., Managing Director of the War Finance Corporation, who was unavoidably prevented from presiding at Group 4:

The training of overseas engineers is entitled to a more prominent place in our educational system. An overseas engineer must, of course, be thoroughly qualified from a technical standpoint. But there are other requisites, particularly, knowledge of language, history, racial and other characteristics, and social points of view of the people with whom he will come in contact. The difference between engineering at home and abroad is, for the most part, the difference in the human element. The engineering technique may be the same the world over, but the problems are different because of the human element involved.

Obviously, a knowledge of languages is vital and fundamental. The superficial knowledge of language that is ordinarily obtained in our schools and colleges is entirely inadequate. Every overseas engineer has to deal with the labor of the country in which he is working. Complete knowledge of the history, characteristics, and thought of these people can only be obtained on the spot and by experience. Training courses can, however, furnish a satisfactory background. An engineer going to South Africa needs a different type of training from one who has to work among the Latin Americans or in the Orient. The ability to adapt one's self to environment, useful even at home, becomes vitally important abroad. Success frequently depends upon it.

G. L. SWIGGETT, chairman of the committee on commercial engineering, reviewed briefly the situation in world development areas, particularly in Latin America and the Far East. He stressed the importance of the engineer in America's program of participation in the economic development of the more backward areas. The engineer has not played the part on the whole in the past that he will play in the future, provided that engineering training in the colleges

is modified to include more of those subjects which give breadth of imagination, keenness of vision, and something of the adventure and courage of commerce. There is need for engineers trained in the practical use of commercial languages and to the visualization of economic resources, commercial products, and engineering designs in the currents and structures of industry and commerce. The engineering executive, with the trained understanding of business details and methods, will be the best qualified man to direct and supervise America's overseas investments and solve the business problems which will necessarily arise from those investments. The knowledge that the world has an ample supply of engineers trained in this manner and to this end will unquestionably overcome our retarded investments in foreign fields, saving our nationals much trouble and cost.

W. W. NICHOLS, Allis-Chalmers Manufacturing Co. (Inc.), New York City. A great executive has truly observed that a man's success, professional and otherwise, depends more on his capacity to learn than on any other faculty, probably on the ground that other necessary faculties would be proportioned to such capacity. His convictions were founded also on an extensive experience in placing graduate engineers. Capacity to learn depends on that exercise which the training we call education gives. Rarely do considerations of curricula or educational methods indicate that such is the aim of our educational institutions. Most teachers overlook the fundamental need for such exercise because they forget the essential character of their aim. Only in comparatively recent years have professional schools made progress in substituting training by demonstration, in the broad sense, for the old method of education by affirmation. More and more is there a realization that an accumulation of technical information is not of itself so important. It is rather the mental development that results from meditation on the merits of such information. Accumulation of facts is not to be deprecated, but accumulation of facts should never be the principal aim of any educational process.

The inability of graduate engineers to express themselves properly may be due to lack of cultural training to which our professional schools are now giving more attention. France is reported recently to have restored the study of classics in the college curriculum because a 20 years' experience had proved a positive loss in culture resulting from the abandonment of these studies. Training in the classics may not be necessary as preliminary to professional engineering success. An enlarged capacity for knowledge, however, with a vision that tends to the progress which the engineer requires, may depend on much more than the limited training of a particular curriculum.

WALTER RITTMAN, professor of commercial engineering, Carnegie Institute of Technology. The engineer connected with overseas oil development is greatly handicapped without an understanding of the new ways of financing, of race differences, and of legal problems. To train engineers for these fields is not easy. A knowledge of the foreign languages is not the main thing. To exchange goods and services successfully one must be acquainted with the spirit and customs of the people with whom one is dealing. The establishment of branch schools in foreign countries, although hardly feasible, offers one solution of the problem.

C. A. NORMAN, professor of machine design, Ohio State University, Columbus, Ohio. Many of the leading schools have felt that engineering students do not acquire through the language training given the ability to read foreign technical literature, much less to express themselves in a foreign tongue. These schools are hard pressed to meet the demands for civic and economic training. With an overcrowded schedule there is a tendency to do away with language training altogether. American engineers should be able to read foreign literature and to deal with foreigners in their own tongue. The need often arises for knowledge of a language never taught in school; for example, Russian, Chinese, and Portuguese, languages undoubtedly of great importance in the future. One can hardly think of teaching them to engineering students generally. We should, however, develop in our students the ability to acquire knowledge in a new field rapidly and without aid when need of such knowledge arises. Foreign schools and our graduate schools develop this ability, the latter, however, at too late an age. By excessive coaching, supervising, and scheduling we kill initiative and enterprise in our undergraduates. American college education develops perhaps the most moral, generous, and decent type of man in the world; and this must not be given up; but we suppress the quality without which we will not hold our own in technical or commercial competition with foreign nations. American engineering students are of high-grade material, but they are now being trained down and fitted to become routine men and job holders at home rather than being stimulated to become energizers and vitalizers on a world scale. They must be given concrete examples of the unusual possibilities in new and undeveloped fields, where higher trained men are scarce; must become imbued with enthusiasm for real individual achievement and for far-reaching work. Business and Government must help in this matter.

**Topic of Group 3. CIVIC AND SOCIAL TRAINING OF THE ENGINEER.**

L. W. WALLACE, executive secretary Federated Engineering Societies, Washington, D. C. It was recently stated that perhaps



the best way the United States could aid in the restoration of the economic equilibrium of the world would be to assist needy European countries in the creation of new capital by sending trained engineers to assist in the development of the great natural resources of those countries. It is also stated with authority that the allied debt is a legal and moral obligation, but that if the debt is paid in manufactured goods the result will be very serious to American industry. It is therefore suggested that the debt, collected on terms most favorable to the Allies, be not used in this country, but very much as the Chinese indemnity was used, namely, spent in behalf of the countries making the payments; that all money received in payment of the allied debt be used to assist the small European countries in building highways and also railways, both electric and steam; in developing hydroelectric power; in developing technical educational facilities and research; in encouraging the use of improved methods of farming and improved farm machinery; and the adoption of better principles and facilities of manufacture, to include better organization, improved personal relations, and higher intelligence in the executive group.

The proposed plan is social, economic, and scientific. It is qualitative, yet its execution would require the best of quantitative thinking; hence the need for the engineering type of mind and experience. A keen student of world affairs has remarked that the engineer of vision, of insight, and of quantitative thinking and experience is the hope of Russia and of the world.

The question now arises whether the engineer has had as a background that training which will enable him to meet his opportunity. On the quantitative side—the purely technical—the answer certainly is, yes. Perhaps, no, on the imaginative, the qualitative side. The engineer is considered a safe operator of a large industry, but not a successful business promoter because he lacks enthusiasm and vision.

By temperament, training, and experience the engineer is an individualist. He leads a quantitative existence. These qualities have brought the world to its present high state of mechanical and scientific development. The world now needs the leadership of the quantitative mind softened by the qualitative touch. It needs the services of men who have mastered the material forces of nature and desire to use them for the benefit of man. Technical and professional business colleges must train men not only in the technical aspects of their vocations but must fill them with a zeal and an enthusiasm that will compel them to render a full measure of social and civic as well as technical service.

Colonel KEPPELE HALL, of the Joseph and Feiss Co., Cleveland, Ohio. There are to-day three or four new groups of engineers. There are many problems to be worked out along engineering lines.

An engineer is a man who can tear apart a problem and by means of mathematics, mechanics, chemistry, etc., put it together to function properly. The problem of bringing together men, machines, money, materials, etc., is essentially a problem of the engineer. He is the man who coordinates. He must have something more than the fundamental engineering subjects; must be interested in psychology, the motives inciting the actions and reactions of people. He must be a real man. Men who have had no engineering experience can fill positions of such demands, but they ought to be engineers. Coal is one of the most poorly managed industries in America. Waste in industry is possible of solution and has been solved to some extent. These are things the engineer can do and must do as part of his public duty to meet his responsibility to all mankind. The seeds must be planted in his mind while he is in school. Banks are dependent on the information of the engineer. Engineers are called upon to survey industries.

Mr. Wallace stated that according to the report of the committee on waste in industry about 50 per cent of the waste could be eliminated by good management, while labor could assist in eliminating 25 per cent. The remainder was due to various causes.

G. L. SWIGGETT, chairman of the Committee on Commercial Engineering. The interest in an educational program combining engineering and commerce has now developed to a point that there is a dependable scientific approach to the problem of curriculum. Much valuable information that will assist in further development is being secured by investigation and survey. We are learning much about the fundamental factors in industry and commerce, of political, economic, and social interrelationships in domestic and foreign commerce. Regional economic developments have a direct bearing upon individual training problems, etc. This is especially true of the training designed for the engineer, since engineering must render such service to the community as road building, housing, sanitation, and the working out of all civic projects. The county is becoming the most important unit in national development, the basic unit. The civic duties of engineers in relation to county problems have not been adequately recognized. Engineers must be trained to become county managers as well as city managers. The engineer must utilize his training in a cooperative manner for the benefit of the community.

The chairman closed the discussion with a few examples to show the growing tendency of engineers to become active in civic and social affairs.

## APPENDIX

### COMMITTEE ON COMMERCIAL ENGINEERING

---

G. L. Swiggett, specialist in commercial education, United States Bureau of Education, Washington, D. C., chairman.

A. C. Bedford, chairman of board of directors, Standard Oil Co. of New York, N. Y.

Spurgeon Bell, dean school of business administration, University of Texas, Austin, Tex.

Frank H. Constant, head of civil engineering department, Princeton University, Princeton, N. J.

G. A. Covell, dean of school of engineering and mechanic arts, Oregon State Agricultural College, Corvallis.

Davis R. Dewey, professor of economics, Massachusetts Institute of Technology, Cambridge.

A. B. Dluwiddie, president Tulane University, New Orleans, La.

Wallace B. Dpnhum, dean of graduate school of business administration, Harvard University, Cambridge, Mass.

George W. Dowrie, dean school of business, University of Minnesota, Minneapolis, Minn.

Coleman du Pont, New York, N. Y.

Charles E. Ferris, dean of engineering, University of Tennessee, Knoxville.

Gen. George W. Goethals, 40 Wall Street, New York, N. Y.

C. E. Grunsky, manager, C. E. Grunsky Co., engineers, Mechanics Institute Building, San Francisco, Calif.

John H. Finley, educational editor, New York Times, New York.

Frederick P. Fish, Fish, Richardson & Neave, Boston, Mass.

W. F. Gephart, vice president, First National Bank, St. Louis, Mo.

Arthur A. Hamerschlag, Pittsburgh, Pa.

John Hays Hammond, mining engineering, Washington, D. C.

Henry Rand Hatfield, dean of faculties, University of California, Berkeley.

Ralph E. Heilman, dean school of commerce, Northwestern University, Evanston and Chicago, Ill.

E. M. Herr, president Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.

E. H. Hooker, president Hooker Electrochemical Co., New York, N. Y.

W. L. Hotchkiss, Industrial Federation of Clothing Manufacturers, Chicago, Ill.

Samuel Insull, president Commonwealth Edison Co., Edison Building, Chicago.

Emory R. Johnson, dean Wharton School of Finance and Commerce, University of Pennsylvania, Philadelphia.

Dexter S. Kimball, dean of the college of engineering, Cornell University, Ithaca, N. Y.

Everett W. Lord, dean college of business administration of Boston University, Boston, Mass.

E. J. McCaustland, dean faculty of engineering, University of Missouri, Columbia, Mo.

C. R. Mann, chairman of operations and training division, War Department General Staff, War Department, Washington, D. C.

Anson Marston, dean division of engineering, Iowa State College, Ames Iowa.

Charles D. Marx, department of civil engineering, Leland Stanford Junior University, California.

E. J. Mehren, editor, Engineering News-Record, McGraw-Hill Co. (Inc.), New York, N. Y.

Stephen I. Miller, jr., director college of business administration, University of Washington, Seattle.

Frank O'Hara, professor of political economy, the Catholic University of America, Washington, D. C.

Charles L. Parmalee, consulting engineer, Woolworth Building, New York, N. Y.

Francis C. Pratt, vice president General Electric Co., Schenectady, N. Y.

Walter Rautenstrauch, vice president The J. G. White Management Corporation, 43 Exchange Place, New York.

C. R. Richardson, president Lehigh University, Bethlehem, Pa.

W. F. Rittman, head of department of commercial engineering, Carnegie Institute of Technology, Pittsburgh.

Joseph W. Roe, professor of industrial engineering, college of engineering, New York University, University Heights, New York, N. Y.

R. L. Sackett, dean school of engineering, the Pennsylvania State College, State College, Pa.

Herman Schneider, dean college of engineering and commerce, University of Cincinnati, Ohio.

C. F. Scott, professor of electrical engineering, Sheffield Scientific School, New Haven, Conn.

A. W. Shaw, president A. W. Shaw Co., Chicago, Ill.

Charles A. Stone, of Stone & Webster, 120 Broadway, New York.

William M. Thornton, dean of department of engineering, University of Virginia, Charlottesville.

J. C. Tracy, professor of civil engineering, Sheffield Scientific School, New Haven, Conn.

F. E. Turneaure, dean of the college of mechanics and engineering, University of Wisconsin, Madison.

P. F. Walker, dean school of engineering, University of Kansas, Lawrence, Kans.

J. M. Watters, dean school of commerce, Georgia School of Technology, Atlanta.

John B. Whitehead, dean of department of engineering, Johns Hopkins University, Baltimore, Md.

W. E. Wickenden, assistant vice president American Telephone & Telegraph Co., New York, N. Y.

