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COMMERCIAL ENGINEERING

Report of a Conference on Business Training for Engineers and Engineering Training for Students of Business

Held in Washington, D. C.
June 23–24, 1919

Prepared by

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SPECIALIST IN COMMERCIAL EDUCATION, BUREAU OF EDUCATION, AND CHAIRMAN OF THE CONFERENCE COMMITTEE

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COMMERCIAL ENGINEERING.

REPORT OF A CONFERENCE ON BUSINESS TRAINING FOR ENGINEERS AND ENGINEERING TRAINING FOR STUDENTS OF BUSINESS.

INTRODUCTION.

PRELIMINARY CONFERENCE, ST. LOUIS, MO., FEBRUARY 22, 1919.

The Commissioner of Education authorized the specialist in charge of commercial education of the Bureau of Education to confer with a small group of administrative professors in engineering and commerce for the purpose of discussing ways and means whereby a larger number of students in engineering and commerce might be prepared better for management positions in industry and commerce, and under date of February 15, the commissioner invited the presidents of higher institutions near St. Louis to send representatives for a conference with Dr. Swiggett, in that city on February 22. The timeliness of the subject of the conference may be judged by the attendance at the conference. Although the conference met in one week from the commissioner's call by letter from Washington, 7 of the 11 institutions were represented as follows:

University of Illinois. C. M. Thompson, associate professor of economics; N. A. Weston, acting dean, College of Commerce and Business Administration; and L. E. Young, of the Union Electric Light & Power Co., St. Louis, Mo.
University of Iowa. N. A. Brisco, director, School of Commerce.
Iowa State College. Anson Marston, dean, Division of Engineering.
University of Kansas. P. F. Walker, dean, School of Engineering.
University of Minnesota. George W. Dowrie, professor of economics.
University of Missouri. Isadore Loeb, dean, School of Business and Public Administration.
Washington University. W. F. Gephart, dean, School of Commerce and Finance; Alexander S. Langsdorf, dean of the Schools of Engineering and Architecture.

The members present at this preliminary conference asked for the immediate appointment by the Commissioner of Education of a committee to consider with Dr. Swiggett, at a second conference in Washington, on or about March 31, the subject of commercial engineering in its various aspects and to prepare one or more curricula

in this field which can be recommended by the Bureau of Education for adoption in our colleges and universities.

It was further recommended that a general conference, national in scope, and fully representative of all interests in character, be held in the immediate future for the purpose of directing attention to the importance of this new type of training and to discuss one or more main topics essential to the preparation of commercial engineers.

The committee to be appointed was further charged to consider the four following tentative curricula suggestions:

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 the School of Commerce with degree to be given in that school;

Fourth, That a five-year combined engineering and commercial course be prepared.

COMMITTEE CONFERENCE, WASHINGTON, D. C., MARCH 31–APRIL 1, 1919.

Pursuant to the wishes of the St. Louis conference, the Commissioner of Education immediately appointed a committee on commercial engineering and called a conference of this committee to meet in Washington, New Willard Hotel, March 31–April 1. Letters of invitation to be represented on this committee were likewise transmitted through their secretaries to the following societies and committees: The American Institute of Mining Engineers; the American Institute of Electrical Engineers; the American Society of Civil Engineers; the American Society of Mechanical Engineers; the Society for the Promotion of Engineering Education; and the Committee of Fifteen on Educational Preparation for Foreign Service.

In the letter of invitation to the engineering societies it was distinctly stated by the chairman of the conference committee that their representation on the committee did not carry with it their endorsement of any course or courses of study which the committee conference of March 31 might prepare for recommendation.

The following members constituted the conference committee of March 31:

A. B. Dinwiddie, president of Tulane University; W. F. Gephart, dean, School of Commerce and Finance, Washington University; Arthur A. Hamerschlag,[1] president, Carnegie Institute of Technology; John Hays Hammond, mining engineer, Washington and New York; Henry Rand Hatfield, dean, College of Com-

[1] Represented by Prof. G. H. Follows, head of the Department of Commercial Engineering, Carnegie Institute of Technology.

merce, University of California; W. E. Hotchkiss, director of business education, University of Minnesota; Everett Lord, dean, School of Business Administration, Boston University; William McClelland, dean, the Wharton School of Finance and Commerce, University of Pennsylvania; C. R. Mann, chairman of the Advisory Board, Committee on Education and Special Training, War Department; Anson Marston, dean, Division of Engineering, Iowa State College; Frank O'Hara, professor of political economy, the Catholic University of America; C. R. Richards, dean, College of Engineering, University of Illinois; Herman Schneider, dean, College of Engineering, University of Cincinnati; Glen Levin Swiggett, specialist in commercial education, Bureau of Education, chairman, and the representatives of the following societies and committee:

Society for the Promotion of Engineering Education, represented by W. E. Mott, dean, School of Applied Science, Carnegie Institute of Technology, Pittsburgh, Pa.

American Society of Civil Engineers, represented by Francis R. Weller, consulting engineer, Washington, D. C.

American Institute of Mining Engineers, represented by H. Foster Bain,[1] assistant director, United States Bureau of Mines, Washington, D. C.

American Society of Mechanical Engineers, represented by R. L. Sackett, dean, School of Engineering, Pennsylvania State College.

American Institute of Electrical Engineers, represented by E. W. Rice, jr., president General Electric Co., Schenectady, N. Y. (alternate Francis C. Pratt,[2] vice president and assistant to the president, General Electric Co.)

Committee of Fifteen on Educational Preparation for Foreign Service, represented by Glen Levin Swiggett, specialist in commercial education, United States Bureau of Education.

The committee conference began its labors at 10 o'clock.[3] All members were present with the exception of Deans Lord, McClelland, Richards, and Schneider.

It was planned to print in full the record of the three sessions of the conference. In view of the fact, however, that a brief preliminary announcement of the main results of the conference, dated April 11, has been prepared by the chairman and sent to the proper officials of educational institutions, engineering societies, business organizations, and to interested individuals, and further because of the fact that the value of the discussions of the committee at that time has been lessened somewhat by the publication, so shortly thereafter, of the proceedings in full of the public conference of June 23–24 there will be printed in this place, as a matter of record, only the approved recommendations of the committee and the remarks, submitted in writing, of Mr. John Hays Hammond. For the guidance of the committee the chairman submitted copies of the engineering courses of study of several of the larger universities, and of a brief statement of present practice and any change contemplated in courses

[1] Represented by A. E. Holbrook, acting chief mining engineering, Bureau of Mines.
[2] Mr. Pratt attended the conference.
[3] The committee met in executive session at the New Willard Hotel the morning and afternoon of March 31 and the morning of April 1. The members were the dinner guests of Mr. Hammond on Monday night, March 31.

of study in engineering and commerce in line with the four curricula suggestions from the St. Louis conference. This statement[1] was based on answers received from university officials in reply to the request of the Commissioner of Education, dated March 4, that administrative professors in engineering and commerce furnish the chairman with this data for the use of the committee conference of March 31.

THE EXTENDED FUNCTION OF THE ENGINEER.

By JOHN HAYS HAMMOND.

This is an era of expansion, and conformably with the change in commercial conditions the function of the engineer has also expanded. From his capacity of an engineer limited to the determination of technical questions, the engineer of to-day has come to assume an economic importance in those branches of industry dependent upon engineering skill for their development. He is, indeed, an engineer of limited usefulness who does not go further professionally than to submit a purely technical report on subjects presented for his consideration.

While he has the same responsibilities as formerly in the solution of the technical problems involved, the engineer is further expected to supplement his report with advice on the financial and commercial aspects of these problems, for the great majority of problems presented to the engineer ultimately involve the determination of the pecuniary relations of the propositions under consideration.

Moreover, when an engineer recommends the investment of capital in an enterprise he incurs a certain moral responsibility for its efficient management, inasmuch as his professional reputation depends upon the realization of his predictions as to the outcome of the investment. For this reason he passes from the rôle of an expert to that of a consulting engineer, bound to supervise both the technical and the business management of the property financed by his clients.

In this extended sphere of professional activity the engineer is destined to play a more important part in the future than in the past. It is with special reference to the expansion of our foreign trade and the services to be rendered by the engineer in this connection that I shall address my brief remarks. In that field he will find his best opportunities and there success will be best rewarded, since exceptionally great responsibility must be imposed in the conduct of operations in distant lands and this calls for men of high professional equipment and men of sound business judgment.

[1] Printed in this report as Appendix A.

In the expansion of our foreign trade we have new problems interjected as the result of conditions created by the World War. For example, as one of the effects of the war, we shall in the future be deprived, in a large measure, of the markets of Europe for our exports; and for that reason we shall have to depend upon the expansion of the markets of the so-called "backward countries" to compensate for the loss of European markets and to provide as well for the products of our ever expanding national industries.

In order to expand the markets of these countries we must first increase their purchasing power. This can be done only by increasing the value of their national securities, through the development of their natural resources. Heretofore, the "backward nations" have relied upon the money centers of Europe for the capital with which to finance the development of their industries, but in the near future they can not depend upon this source of financial assistance. And, if the United States and the rest of the world are to realize the potentiality of these countries as important markets for their industrial products, we must assume the position of the banker of these "backward nations."

In the development of a country's natural resources, the engineer is an indispensable factor as the industries to be created are almost always in the category of engineering enterprises. In the first place, the problem presented is whether or not the enterprise can be made a success from the technical point of view and, secondly, whether or not it can be made a commercial success from a financial point of view. While these problems may seem distinct, they are, nevertheless, closely related and interdependent and can be best solved by engineers having business training and experience.

As the result of my own experience in the development of engineering enterprises in different parts of the world, I am convinced that an engineering education, supplemented by business training and experience, constitutes the best possible qualifications, both for the expert to determine the advisability of the investment of capital, and for the business management of operations in the industries developed. I am also of the opinion that the interests of the investing public are best safe-guarded when the responsibility for the investment of capital and for the management of operations is left to an engineer who has had business training and experience. This is because of the fact that greater honesty and greater ability obtains among the members of the engineering profession than is to be found in the usual class of irresponsible business promoters.

Nothing could do more to add to the dignity, the influence, and the remuneration of the engineering profession than to elevate the engineer from the position of a strictly technical man to one whose

opinion and authority would be supreme in all matters appertaining to industrial development. The engineer has heretofore not been accorded the recognition he has deserved when he has made a success of a great engineering enterprise. He has been regarded merely as a cog in the wheel, rather than as the motive power, for such he really is, and the business man acting as the promoter has, in most cases, monopolized both the credit and the pecuniary profits created by the brain of the engineer.

I have no sympathy, however, with this spirit of self-abnegation and, indeed, often subserviency, on the part of the engineer. He should have the pride of his profession and the moral courage to assert his claim to recognition and for participation in a financial sense in the fruits of his ability and industry. For, after all, it is the engineer who must assume the responsibility for failure if the enterprise goes wrong. He is not privileged to urge extenuating circumstances to the disappointed investor. The engineer may not, like the lawyer, ascribe his failure to win the suit to the stupidity of the judge or the dishonesty of the jury; nor may he ascribe his failure, as does the physician, to the will of God.

This is the age of the engineer, as has been demonstrated by the supreme part he played in the winning of the war, and I believe that, by the adoption of a system of combined commercial and engineering studies in the curricula of the technical schools of our country, the engineer will in the future play no less an important rôle in the pacific field of beneficent industry.

I would venture to express the opinion that engineers who have had the advantage of such a course would within a few years become the directing spirits in engineering projects and in that way be the employers of other engineers whose instruction has been exclusively devoted to technical subjects.

The approved recommendations of the committee in respect to the second resolution and the four curricula suggestions which were referred to this conference by the preliminary conference at St. Louis, February 22, were as follows:

Second resolution, That a general conference, national in scope and fully representative of all interests in character, be held in the immediate future for the purpose of directing attention to the importance of this new and important type of training and to discuss one or more main topics essential to the preparation of commercial engineers. Action in respect to this resolution was taken at the third session, the morning of April 1, as follows: It was moved and seconded that a public conference on business training for engineers and engineering training for students of business should be held at some time in the near future and that the chairman of the conference should proceed to make plans to hold this conference in Washington, Monday and Tuesday, June 23 and 24, immediately preceding the scheduled conference in Baltimore of the Society for

the Promotion of Engineering Education on June 25, 26, 27, and 28; that the chairman should endeavor to secure the cordial cooperation of all interested individuals, educational institutions, and educational and engineering societies; and that the public conference should devote three or four sessions to the discussion of the four following major topics: 1. Business training for the engineer; 2. Engineering training for commercial enterprises; 3. Significance of the war experience for engineering education; 4. Training of the engineer for overseas engineering projects.

CURRICULA SUGGESTIONS.

First. That a minimum number of hours in business training, to be determined by the committee, be required in all engineering courses. In respect to this suggestion it was recommended at the Washington Committee Conference 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.

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. In respect to this suggestion the Washington Committee Conference recommended 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.

Third. That a curriculum in commercial or industrial engineering, permitting full and proper emphasis upon engineering subjects, be offered in the school of commerce with degree to be given in that school.

Fourth. That a five-year combined engineering and commercial course be prepared. It was recommended at the Washington Committee Conference that no action be taken at this time on curricula suggestions third and fourth.

The committee devoted the larger part of the concluding session, the morning of April 1, to the selection of engineering subjects which administrative professors in commerce would like to have their students take in the engineering department. Assuming that the engineering instructors can and will arrange to give certain courses to commerce students, and that these students enter upon the pursuit of these subjects in the engineering school with the two years of required high-school mathematics, namely, algebra through quadratics and plane geometry, in addition to a four-hour course in freshman mathematics, and assuming further that these students have received the necessary preliminary training in physics and chemistry, it was rec-

ommended that the following engineering subjects be approved for students of commerce: Shopwork, three hours for one semester; properties and strength of materials, three hours for one semester; drawing and machinery analysis, three hours for one year; applied mechanics, including hydraulics, three hours for one year. A two-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). The selection of all of these subjects, exclusive of the freshman mathematics, would give a total of 30 semester hours.

PLAN OF THE CONFERENCE, WASHINGTON, D. C., JUNE 23–24, 1919.

Immediately on the adjournment of the committee conference of March 31 and April 1 the chairman asked for the appointment of additional members on the committee. The following members were added: Grant Covell, dean, School of Engineering, Oregon Agricultural College; Davis E. Dewey, professor of economics, Massachusetts Institute of Technology; E. J. McCaustland, dean, School of Engineering, University of Missouri; L. C. Marshall, dean, School of Commerce, University of Chicago; Stephen I. Miller, jr., College of Business Administration, University of Washington; Walter Rautenstrauch, professor of mechanical engineering, Columbia University; J. C. Tracey, professor of civil engineering, Sheffield Scientific School, Yale University; and J. M. Watters, dean, School of Commerce, Georgia School of Technology.

The Commissioner of Education issued May 1, on behalf of the Conference Committee on Commercial Engineering, a call for a public conference to be held at the New Willard Hotel, in Washington, June 23 and 24, on the subject of business training for engineers and engineering training for students of business. Educational institutions with faculties in engineering and economics or commerce were invited to designate representatives to attend the conference.[1] Similar invitations were sent to engineering societies, commercial organizations, and interested Government bureaus.

An alphabetical list of the names of delegates received in advance of the conference and of additional registrations at the time of the conference is printed in this report as Appendix C. The following members of the committee were in attendance and aided the chairman in the conduct of the conference: Messrs. Covell, Follows (representing President Hamerchlag), Hatfield, Hotchkiss, McCaustland, Mann, Marston, Miller, O'Hara, Rautenstrauch, Tracy, Mott, Weller, and Pratt.

[1] A list of universities and colleges, with colleges or schools of engineering is printed in this report as Appendix B.

The program[1] of the four sessions of the conference, with names of topics, chairmen, and speakers, was as follows:

FIRST SESSION, 10 O'CLOCK MONDAY MORNING, JUNE 23.

Address of welcome: P. P. Claxton, United States Commissioner of Education.
Major topic: Business training for the engineer.
Chairman: Frederick C. Munroe,[2] general manager American Red Cross, Washington, D. C.
Speakers: Anson Marston, dean, Division of Engineering, Iowa State College, Ames, Iowa; Spencer Miller, vice president American Society of Mechanical Engineers, and vice president of Lidgerwood Manufacturing Co., New York City.

SECOND SESSION, 2.30 O'CLOCK MONDAY AFTERNOON, JUNE 23.

Major topic: Engineering training for commercial enterprises.
Chairman: Edward N. Hurley,[3] chairman United States Shipping Board, Washington, D. C.
Speakers: Walter Rautenstrauch, professor of mechanical engineering, Columbia University, New York City; E. F. Du Brul, president Pyro Clay Products Co., Cincinnati, Ohio.

THIRD SESSION, 9.30 O'CLOCK TUESDAY MORNING, JUNE 24.

Major topic: Significance of the war experience for engineering education.
Chairman: Maj. Gen. W. M. Black, Chief of Engineers, United States Army.
Speakers: Maj. Gen. John F. O'Ryan,[4] commanding the Twenty-seventh Division, United States Army, New York City; Dr. Charles R. Mann, chairman of the Advisory Board, Committee on Education and Special Training, War Department, Washington, D. C.

FOURTH SESSION, 2 O'CLOCK TUESDAY AFTERNOON, JUNE 24.

Major Topic: Training of the engineer for overseas engineering projects.
Chairman: Angus Wilton McLean, director of the War Finance Corporation, Washington, D. C.
Speakers: Fred Lavis,[5] consulting engineer, American International Corporation, New York City; W. W. Nichols, chairman Committee on Education, American Manufacturers' Export Association and assistant to the president of Allis-Chalmers Manufacturing Co., New York City; Dr. Jeremiah W. Jenks, member Committee of Fifteen on Education Preparation for Foreign Service, and research professor government and public administration, New York University, New York City.

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[1] The chairmen of the four sessions were assisted respectively by the following committee members: Rautenstrauch, Hotchkiss, Tracy, and Miller. Miss Marthena Whipple, of the Bureau of Education, had charge of the registration.
[2] Francis C. Pratt, vice president and assistant to the president, General Electric Co., Schenectady, N. Y., presided in place of Mr. Munroe.
[3] Jeremiah W. Jenks, research professor of government and public administration, New York University, presided in place of Mr. Hurley.
[4] Paper read by the chairman of the conference committee.
[5] Paper read by C. H. Gardner, American International Corporation, New York City.

PROCEEDINGS OF THE CONFERENCE

FIRST SESSION

Francis C. Pratt, presiding

WASHINGTON, D. C.,
June 23, 1919.

The conference was called to order in the New Willard Hotel at 10 o'clock a. m., by Dr. Glen Levin Swiggett, specialist in charge of commercial education, Bureau of Education, and chairman of the conference committee.

Mr. SWIGGETT. Before the conference is formally opened, I am privileged, as the chairman of the conference committee, to make one or two statements in regard to the conference, its conduct, purpose, and character.[1]

This conference was called on behalf of a Conference Committee on Commercial Engineering, appointed by the Commissioner of Education. You will notice, attached to the program of the conference, a mimeographed list of the members of this conference committee. One name by error was omitted, that of Dean L. C. Marshall, of the School of Commerce of the University of Chicago.

On February 22 there was a meeting at the Statler Hotel, in St. Louis, of a small group of administrative professors in engineering and commerce from near-by large institutions. These gentlemen, meeting only for one session, were impressed with the need of formulating some program which might encourage our colleges and universities to train and graduate a larger number of engineers for industry and commerce—engineers who would have, in addition to the fundamental engineering training, a larger amount of supplementary training in business and commerce.

At this meeting they drew up four curricula suggestions, which were later sent by the chairman to colleges and universities with faculties in engineering and economics or commerce. These institutions were likewise asked to send to the chairman a statement in respect to what they were doing or contemplated doing in the future for the training of what we might broadly call the buisness enigneer. That material was assembled and placed before an executive meeting of the conference committee at the New Willard Hotel in Washington, D. C., March 31 and April 1. After full discussion

[1] Names in full, with titles and addresses, of all speakers are printed in Appendix C.

and careful consideration of this material the committee adopted certain curricula recommendations which were submitted for favorable consideration to the proper officials of colleges and universities. The Bureau of Education now has on record correspondence showing that the committee's recommendations have had most gratifying recognition.

The purpose of our conference to-day is to direct public attention at this time to the positive need in our country for an increasing supply of well-trained young engineers to enter upon business careers with promotion in the direction of industrial and commercial management. In large-scale industrial production and commercial enterprise, the man of the future most helpful in eliminating waste of machinery, materials, and men, overcoming the present shocking percentage of loss in these three things, is the man whose training represents a combination of the essentials of engineering and a knowledge of the fundamentals of business practice.

There is some objection to the use of the term commercial engineer for this new type of trained engineer. Our committee has discovered, however, through two preliminary private conferences, that the term is acceptable to many universities and colleges that have already felt the demand from industry and commerce for better trained men and are endeavoring in some way to meet it with the coming school year.

Ladies and gentlemen, this conference is to be very informal. The conference committee of March 31 recommended that there be only four major topics; that we should ask only two speakers to present papers under each of these topics; that there should be very free and frank discussion from the floor. Our conference, therefore, will have largely the character of a symposium, and will serve as a clearing house for the exchange of ideas leading to common thinking and common action in respect to the object and program of the conference.

We desire to have a complete registration. If there are any members here present who have not yet registered, I trust they will do so before leaving the hall this morning.

The major topic of the first session is before us. The gentleman to preside, a commercial engineer of the New England Telegraph & Telephone Co., Mr. Frederick Munroe, general manager of the American Red Cross, informed me by phone a few minutes ago that he had just been called to New York and would have to leave by the first train. Mr. Francis C. Pratt, vice president and assistant to the president of the General Electric Co., of Schenectady, a member of the conference committee, has very kindly consented to preside this morning in lieu of Mr. Munroe. The morning session is now in the hands of Mr. Pratt.

The CHAIRMAN. Gentlemen, Dr. Swiggett has outlined the events which led up to this conference and the purposes of this conference so clearly that I think no further remarks are required by me, and I therefore have the pleasure of presenting, because introduction is really not necessary, the Hon. P. P. Claxton, United States Commissioner of Education, who will give the address of welcome.

ADDRESS OF WELCOME.

By Hon. P. P. CLAXTON,
United States Commissioner of Education.

Mr. Chairman, I shall take only a few minutes of your time to extend a most hearty welcome to this conference, which has so much meaning for a phase of education made necessary by a new era in the industrial and commercial life of the United States. For nearly a hundred and fifty years of our national life we have, from both oceans, turned our faces inland. We had a great task to do, and we have worked at it with an energy, a persistence, and a success probably unequaled in the history of the world. We had a continent to conquer and tame. We have felled our forests, fenced our fields, broken our prairies, built our highways, tunneled our mountains, harnessed our water power, exploited our mines, established our great industrial plants, built our cities. We have produced much, and have sold a very large part of the products of our fields and forests, our mills and mines across the seas. We have bought much from other countries. But we have bought and sold at our own ports. We have developed little international commerce of our own. Little of our exports and imports, and especially in recent years, has been carried in our own ships and under our own flag. The enterprise of exchange has not been under the direction of our merchants nor financed by our banks.

If the great World War had not come we would very soon have begun to change this program. In fact, the change had already begun, however slowly. Our task of conquering the continent and establishing our industries was already largely accomplished. Our accumulation of wealth was making it unnecessary for us to continue to borrow money abroad. We had already begun to buy back our certificates of indebtedness. We had begun to seek for our accumulating capital investments in foreign trade and foreign industrial enterprises. The war has greatly accelerated the new tendency, and has made possible in 5 years what might otherwise have taken 25 years to bring about. A debtor nation in 1914 to the extent of five or six billion dollars, we have bought back these certificates of indebtedness and now own, nationally and individually, approximately fifteen billion dollars of certificates of indebtedness of other

countries. The balance has thus been changed in our favor to the extent of approximately twenty billions of dollars. The creditor nations of 1914 are now pledged to us for large sums.

Throughout all the world the war will be followed by an era of reconstruction and of new construction probably unequaled in the history of the world. The loss of money and men in other industrial countries will make it impossible for them to do their full share of this work, and will leave a very large share of it to us. Therefore, in the immediate future we in the United States will or should be engaged in large enterprises of construction and reconstruction of many kinds in the devastated countries of Europe, and in Russia and China and elsewhere. With the freedom and the consequent growth that will come with the world-wide democracy which is about to take the place of the old repressive autocracies, our industrial development and commerce will flourish as never before. In this new development the people of the United States must do their full part.

As a result of the great increase of our population and the still greater increase in our agriculture and industries, the volume of our exports and imports will be much larger than before the war. Foreign trade will have a new meaning for us. Our large merchant marine will carry, under our own flag, our products to all the ports of the world, and will bring to us the products of all the ends of the earth. Our merchants will direct both enterprises, and both will be financed by our own banks with their branches in all important countries.

All this lays emphasis at this time on the importance of two kinds of education and training:

First, business education for engineers. Men who go abroad to undertake the direction of great engineering enterprises should have knowledge of sound methods of doing business as well as of the technical things of engineering.

Second, engineering education for merchants. And this of two kinds, first, that which results in some degree of technical knowledge of civil, mining, chemical, electrical, hydraulic, and other forms of engineering; second, that which may be called commercial engineering in the large sense, and which relates to building of commercial enterprises on such sound principles as will insure permanent success. Modern international commerce is and must be on too large a scale to trust to methods of blind trial and error.

These phases of education should at once be promoted by the engineering and commercial departments of our colleges and universities, assisted also by the departments of economics, science, language, and literature. The men who are to become the leaders in these great enterprises will need a broad and fine general education

and culture, as well as the more definite training in the specific things of which I have just spoken.

In the lowest levels of industry and commerce and of life generally there is not much division of labor. And for these there is not much need of special training. In the higher levels there is a very narrow division of labor, and therefore greater need for special training than for the broader education. In the very highest levels there is need not only of technical training of the narrower sort, but also of that broad education and the culture which enable one to comprehend the broader problems of management and direction, and to appreciate the values of those skills in which one may have little or no ability. It is dangerous to put at the head of great enterprises men who are narrowly trained in their own particular specialty but who do not have the breadth of vision and of sympathy necessary for coordinating the energies and efforts of large numbers of men of special training.

It is in regard to the training of men for the two higher levels, and especially of the highest, in commerce and engineering that you have met here to take counsel of each other.

Dr. Swiggett and his committee have been very wise in limiting the conference to four topics, and practically to two, as announced in the heading of this program. The first of these two is business training for engineers. This means in reality a higher type of engineering training for engineers that they may be able to direct on the basis of the true principles of engineering the great projects in all of their complexity, as the technical engineer without this training would direct the technical work of each part of mining, building a railroad, harnessing a water power, and constructing an industrial plant. The second is the other side of this program—engineering training for commercial enterprises—which should result in something more than narrow technical knowledge of buying and selling, and give to the merchant the broad outlook of the engineer on his work and his enterprises.

Once more let me welcome you most heartily. It is the function of the Bureau of Education not to impose any policy on the schools of the country or to demand any policy of them, but rather to take the lead in directing their attention to the needs of education as they develop, and to provide the opportunity whereby educators may be better able to work out their problems. It is in this spirit and for these ends that this conference has been called. In serving you in this way at this time the bureau serves the country and the world in a way until now impossible.

I wish for you a most pleasant and most successful conference. I am very sorry that I can not be with you as much as I would like.

Chairman PRATT. I am sure we all are very greatly indebted to Dr. Claxton, and are very much impressed by the inspiring picture which he has drawn of the possibilities of enterprise and commerce opened up before this country at the present time.

I am sure that we all are in sympathy, as we primarily are engineers, in this first subject of the conference; and I need not add that, taking a step forward, we shall be very much interested in the second subject. We know that engineers are trained in seeking the truth, for nothing else but the truth prevails in engineering, and therefore we feel inherently that, if commercial and financial matters are taken hold of by men who have engineering training, nothing but good can come from such procedure.

I have the pleasure now to introduce the first speaker on Topic No. 1. Dean Marston, of the Division of Engineering, Iowa State College.

BUSINESS TRAINING FOR THE ENGINEER.

By ANSON MARSTON,
Dean, Division of Engineering, Iowa State College, Ames, Iowa.

Returning last December to resume charge of an engineering college after an absence of a year and a half in the Army, the writer of this paper found the times and the local conditions opportune for radical improvements in engineering education. Conference with the engineering alumni of the institution showed that they are eager for such improvements but can make comparatively few clear-cut recommendations. On one point, however, they are definite and unanimous—they desire that our engineering students be given some broad training in simple, fundamental business principles, so that they shall not exhibit infantile helplessness in their early efforts to carry engineering enterprises to successful conclusion.

The writer believes that the demand for business training for the engineer is widespread throughout the engineering profession. In part, it is a more or less unconscious revolt against the conception so widespread in the business world that the engineer is merely a very highly skilled mechanic destined by fate and custom to serve only as an employee of some profit seeker. In 1907 one of the first precautionary measures taken by capitalists when the financial storm burst was to drop most of their engineers from the pay rolls. Within a week the character of the letters reaching my desk changed from appeals by corporations for more engineers at any price, however high, to appeals by engineers for employment at any price, however low. Alumni who had just resigned permanent positions held for years to accept enticing new offers found those offers repudiated while they were in transit to their new stations.

Moreover, our railways for a generation before the war met each new legislative restriction on rates by small economies, such as in lead pencils and in engineers.

The new thought is, Why should not the engineer be his own employer in great industrial enterprises of an essentially engineering character? Why should he not be the organizer, the president, the manager of great industrial corporations rather than a mere hired expert?

Another cause for the present demand for business training for the engineer is the widespread dissatisfaction among employers of engineers with the product of our engineering schools. During the last 50 years our engineering courses of study and methods of instruction have become standardized to such an extent that it is almost as great a sacrilege for any engineering college to deviate from the general practice as it was for the ancient Egyptian draftsman to vary a line from the orthodox in representing Pharaoh. Of engineering educators it may be said truly that we have looked upon our work and we find that it is good, but we have no inquisition at our command to put down the numerous later-day heretics who keep on pointing out defects in the results we secure.

The engineer employer needs, above all, men who are qualified for successful executive responsibilities in great industrial undertakings, and he is not satisfied with the product which our engineering colleges are sending out.

Even before the war, then, engineers and engineer employers were demanding business training for the engineer. Since the close of the war comes Uncle Sam, himself, to tell us that the imperative post-war needs of the United States require great engineer leaders with sound business training to develop our great mechanic arts industries for economic and profitable production, transportation, sale and use, at home and abroad. Patriotic duty to the country now furnishes an additional reason for the introduction of business training into every engineering course of study as a fundamental part thereof.

BUSINESS TRAINING FOR THE ENGINEER SHOULD BE SUBORDINATE TO HIS ENGINEERING TRAINING.

The writer would call attention, at this point, to the fact that the subject of this paper is "Business Training for the Engineer," not "Engineering Training for the Business Man." The two topics should not be confused.

The schools of commerce are coming to call upon the colleges of engineering for some informational training of commerce students along engineering lines. This call should be met, but it is not believed that the great mechanic arts and trade needs of the country can be met at all adequately by superficial descriptive engineering training of business men to such extent only as to enable them to

read with fairly intelligent understanding the reports of hired engineer experts. What we need is great engineer leaders like Capt. Eads, Hugh L. Cooper, Thomas A. Edison, Alexander Graham Bell, and John Hays Hammond, men who possess the highest engineering qualifications combined with great business ability, and who can conceive great mechanic arts enterprises, design their engineering details, build their greatest constructions, organize and direct their operations, and who also can interest capital and deliver a fair profit to investors.

I take it that the principal object of all business training (speaking baldly) is financial profit. Public utilities, for example, are successful from the business point of view whenever they make money for their stockholders, although they may poison a city with polluted water, furnish unsatisfactory light and power, cause the traveling public all sorts of inconvenience, or ruin industries by insufficient or inequitable transportation facilities. Toleration of such shortcomings, it is true, might be unwise, but this would be because they might arouse antagonism, cause inaction of legal restrictions, decrease patronage or otherwise operate to decrease profits.

In engineering, on the other hand, profit, though essential, is only one essential to be attained, and achievement in the successful utilization of the principles of the science of mechanics is the great object. The engineer has been trained to give primary attention to the scientific principles of design, to ingenuity in invention, to industrial organization for construction and production on the greatest scale and at the lowest cost. In planning business training for the engineer we should not attempt to lower the great ideals of his profession. We should add business training to the engineer's equipment, not substitute it for engineering qualification. We should qualify the engineer to take into account, with due weights in the solutions of his problems, the great questions of capital, labor, and profits as well as the scientific principles of engineering theory and experience. The engineer's remuneration should no longer be left to be considered as a mere item on the cost side of the books of the enterprise.

WAYS AND MEANS FOR BUSINESS TRAINING FOR THE ENGINEER.

There are those who believe that the problem of how to provide business training for the engineer can be solved best by creating a new branch of engineering to be called "business engineering," providing four-year business engineering courses alongside of the courses in civil, mechanical, and electrical engineering. Some schools of commerce, on the other hand, offer four-year business courses in which a certain amount of engineering training is included alongside of their commerce courses.

Though not denying that they may serve useful purposes at some institutions, the writer does not believe that four-year combined

courses of either type furnish any adequate solution of the general problem of business training for the engineer. Manifestly only a small fraction of the engineering students on the one hand and the commerce students on the other can be expected to enroll in such courses. We have too many special courses in engineering already. The present tendency is toward broader rather than more specialized engineering training.

The only really adequate method for providing the business training now needed by engineers is to put it into the regular four-year courses (civil, mechanical, etc.) as required work to approximately the same extent as chemistry or physics. The writer earnestly believes that this should be done. Many curricula already contain certain work along business lines, such as economic science, business law as applied to contracts and specifications, shop management, and industrial organization courses. Additional room ought to be provided sufficient for at least 10 semester credit hours of required work.

The business subjects should be restricted to simple, fundamental business principles. Economic science, accountancy, business law, corporation finance, industrial organization, and business psychology are examples.

These subjects may be taught wholly in the school of commerce or partly in the college of engineering, according to local conditions. If taught in the school of commerce, turning this instruction over to subordinates should not be tolerated.

In addition to the amount of business training introduced into engineering courses as required work, elective groups of more advanced work might well be introduced into the junior and senior years to provide opportunity for a selected number of students to specialize somewhat along business lines.

BUSINESS SUBJECTS IN THE MECHANICAL ENGINEERING COURSE AT THE IOWA STATE COLLEGE.

An example of a fair start on the plan just recommended is afforded by the curriculum in mechanical engineering at the Iowa State College, Ames, Iowa, for 1919–20, as follows:

Required work.

Subjects.	Year.	Quarter.	Quarter credit hours.
Reports and papers	3	1	1
Specification writing	3	2	1
Business correspondence	3	3	1
Engineering economics	4	1	3
Specifications and contracts	4	2	2
Accounting	4	3	4
Total			12

Elective group work.

Subjects.	Year.	Quarter.	Quarter credit hours.
Industrial engineering	4	1	3
Industrial organization	4	2	3
Industrial history	4	2	3
Time studies	4	2	2
Scientific management	4	3	2
Business psychology	4	3	3
Factory planning	4	3	3
Total			19

The civil and electrical courses at Ames do not yet include so large an amount of business subjects, but we are considering modifying them (and in fact our other engineering courses as well) in conformity with the same general idea.

We are also proposing to enlarge the amount of required work and to enrich the business courses introduced.

Not having a school of commerce, we plan to add an expert engineering economist to our economic science faculty in the near future.

Chairman PRATT. I think we will all agree that Dean Marston has presented an extremely well-planned proposition on this subject, and that it indicates that a definite and practical advance may be made.

At this time it occurs to me that it might be quite in order to remark, although this is an obvious platitude, that the business-trained engineer is not a new product. He has been going on for generations, in fact, since engineering was recognized as an applied science. If we stop to think and look back over history, we will probably find that a large majority of those who loom up as great industrial leaders were men who conformed to that description. My own business experience has been confined very largely to two concerns. In the first, with which I spent some 18 years, my father was distinctly the chief engineer over a long period, and he was the instigator of the enterprise and the administrative head. He, perforce, had to acquire business training, but I do not think that he or anyone else would question for a moment that, if in his early years he had had the advantage of a systematic presentation of the principles which control business as well as engineering, much of his work would have been less laborious than it was. The final results arrived at, perhaps, are not very different, but it certainly is in order to give effectively a young man the broadest possible perspective of the things which he will undertake in the future.

The enterprise with which I have now been associated for some 13 years enjoys the distinction of having as its executive head one who has been its chief engineer for a long term of years, and

whose earlier efforts were devoted primarily to engineering undertakings.

So, from my own experience—of course, our own experiences are always narrow—the engineer seems to be the logical man to enter into administrative work. I am sure that in most industrial undertakings, where that happy circumstance does arise, a very much more consistent and constant progress is made than would otherwise be likely.

My pleasure, now, is to introduce the next speaker on Topic No. 1, Mr. Spencer Miller, vice president, American Society of Mechanical Engineers, and vice president of the Lidgerwood Manufacturing Co., of New York City.

BUSINESS TRAINING FOR AN ENGINEER.

By SPENCER MILLER,
Vice President American Society of Mechanical Engineers, and Chief Engineer of Lidgerwood Manufacturing Co., New York City.

The engineer is assuming an ever larger position in military, commercial, and public life, and in spite of himself he is at the very center of life. The more we realize this great truth the more seriously will we contemplate our growing responsibilities. If at this conference steps may be taken that will enlarge the usefulness of the engineer in the business world, we shall have fulfilled in a measure some of our responsibilities. The spirit of this conference is clearly one of service. We believe that business ethics, business principles, business integrity, and business intelligence will be enhanced by a more determined entrance into the business world of the trained engineer. We also believe that engineers will develop their engineering talents if trained in business management and salesmanship.

The United States of America is about to embark upon an enterprise to distribute all sorts of American-made tools, implements, and processes throughout the world; that the foreigner may obtain from their use the same benefits that are obtained by American purchasers. There can be no higher calling than that of the business man of integrity who in the sale of his products really gives more value than he receives. Thousands of tools, apparatus, and implements invented, developed, and manufactured by American engineers and manufacturers, when put into use intelligently, will return their full cost often in less than a year's time. It is therefore a service that we render to the world by distributing these improved appliances where they may simplify labor and add to the comforts of life.

The natural emissary for the introduction of such American-made machinery and implements to the buyers of the world are engineers,

and those whose engineering training enables them to select the correct implement and the correct size of an implement to best serve the purpose for which it was constructed. It is therefore with a high purpose that this conference is called.

The engineer-business man is with us to-day, the engineer-salesman is a product of the age. We live in an engineering world. Buyers of engineering tools, implements, or processes demand that they negotiate with engineers capable of explaining the apparatus they wish to purchase. Manufacturers of engineering implements employ engineers as designers, superintendents, and foremen, and anxious to meet the demand for engineer-salesmen naturally review their own staff of engineers, selecting those offering the greatest promise for success in obtaining contracts. The general manager or the sales manager, whose function is to obtain contracts for machinery, tools, or other engineering implements, finds himself confined to his office and quite naturally seeks the aid of his own engineers whom he can train to become salesmen. There are various methods by which this training has been accomplished, one of which is somewhat as follows:

The business manager having found an engineer ambitious to become a salesman, selects some particular inquiry at hand. He proceeds to instruct the engineer as to the best method of approach to the prospective buyer. In other words, he gives him a lecture on salesmanship, and sends him forth to find out his own route to success. Whenever the engineer fails, he returns to the business manager, confers with him as to the reason why he failed, and is given further trials. Thus the theory and practice of salesmanship go hand-in-hand. This method has proved successful, possibly because of the quality of the business manager as a teacher in salesmanship. The business manager is presumably a well-trained salesman himself. The instruction is personal; the size of the class is one student. Under these circumstances, is it not evident that this method of business training has proven successful?

Here is another example:

A young engineer in a drafting room of a manufacturer of machinery expressed to the general manager his wish to become a salesman. The manager decided to give him a trial. He gave him only one lesson and sent him forth on an extended trip to learn himself through experience how to make sales. This manager had had extended and successful experience as a traveling salesman. This one lesson in salesmanship touched largely on character. He said:

> A salesman must primarily be honest with himself and honest with his customers. To be successful you must believe in the value of what you are offering for sale. Commercial traveling is a test for the character of any young man, and it will either make him or ruin him. Do not drink. Keep out of saloons; refuse to play cards with drummers in trains, hotels, or any-

where else. Drinking and gambling are usually the ruination of what might otherwise be a successful business career. Go to your customers well dressed, never overdressed. Seek out the president of the company, if possible; otherwise some man high up in authority. When you enter his office be a gentleman always. Carry a card of the company with your own name modestly printed in the corner. You will meet many rebuffs, but do not be discouraged. When a prospective customer tells you he does not contemplate buying machinery that you sell, ask him if you may look through his plant. Tell him that you would be interested in seeing how he is equipped. If this permission is given, you may be able to make a suggestion that should save him some money. Make friends. Never forget to smile. Keep a daily journal. The rest you must learn yourself. If you have the will to be a salesman, are fond of traveling, and avoid the snares and temptations to which traveling men are subjected, you are sure of success. Within three months this engineer succeeded in selling enough to prove profitable to his employer and his salary was raised accordingly.

That young man succeeded both as a salesman, business man, and engineer, but his education as a business man was largely acquired in the Great University of Hard Knocks.

Many large manufacturing concerns of engineering apparatus have training schools for salesmen, and it is confidently predicted, whatever our universities and engineering schools may do in the way of introducing courses for business training, this method of commercial education is likely to continue.

Our engineering schools to-day crowd into a four years' course an amount of study well-nigh calculated to impair the health of the young students, and any attempt to introduce new courses, new things to study in connection with their engineering training, should not be taken up without a full and complete consideration of all the elements of the problem; and that, I understand, is the purpose of this conference. Personally, I favor a broader training of the engineer in fundamentals, applicable to every branch of engineering, seeking to train him to think and study, and eventually to become his own teacher. Among the fundamentals I would include general economics, preferably reserving courses in business training and salesmanship for engineers in a post-graduate course.

Speaking of the engineer's training in fundamentals, an extended study and practice of free hand drawing is most essential. The ability to make a sketch either in the drafting room or in the presence of a prospective customer is of incalculable value. Pictures have the same meaning to men speaking different languages. The salesman who can make a good sketch always wins attention. This ability is a valuable aid to American engineer salesmen dealing with foreigners.

I regard physical training as a fundamental—teaching students how to conserve their health, encouraging among them healthful sports and recreation, giving them lectures on the care of the body,

impressing on their minds that physical strength is at the very foundation of mental activity. I would discourage much of the competition for scholastic honors, which often results in the destruction of the fiber of the young student's body.

I am disposed to regard psychology as a fundamental study in the regular training of engineers.

When we stop to reflect on the training of engineers, business men, or in fact any one, we know that character stands forth as perhaps three-quarters of the whole. Upright character is the very foundation of success. The character of the students can undoubtedly be developed by a well-considered course of study, combined perhaps with student government. Could not this be best brought about in connection with enlarged courses in English, English literature and psychology? For example, could any student in a course in English, studying Emerson's essays on "Self Control," "Self Reliance," "Heroism," and "Friendship," fail to obtain impressions that would not again and again recur to the mind and thus stimulate manly conduct?

A course in English should include the writing of essays, public speaking, preparations of specifications, descriptions of machinery and processes, and even letter writing. All these are essentials in the life work of any engineer.

Many engineers to-day are doing good work known only to themselves and a few that may happen to have been at work with them. Why? Simply because such engineers can not compose a readable report, to announce to others the results of their investigations. Many an engineer has profited through the preparation of a paper on some engineering subject which he has read before one of our national engineering societies.

The engineer-salesman is the natural forerunner of the engineer-manager or engineer-business man, and is to-day a necessity for the intelligent sale of engineering appliances.

A "School of Commerce for Engineers" would indeed be a welcome addition to our numerous educational institutions. A course in commerce for engineers would alike be welcome, and is inevitable, because such will be the logical response to a persistent demand.

There are golden opportunities for graduate engineers well grounded in engineering fundamentals and with well-established characters to enter into the field of business. Engineer salesmanship leads to permanent employment. The engineer-salesman who is successful is more likely to step up to a managerial position than one who restricts himself to pure engineering and design. The engineer-salesman will travel; and through travel the mind is educated and the vision enlarged. Furthermore, the engineer-salesman

is usually found in the very firing line of progress. He is in touch with the latest developments and demands for further improvements, and will therefore be better able to exercise his talent as an engineer in designing or assisting in the design of new tools, implements, and apparatus to meet the ever-increasing demand for more and better machinery.

The engineer-salesman in a few years develops a clientele which becomes a part of his stock-in-trade. Manufacturers hesitate to allow engineer-salesmen to leave because they realize that their resignation is likely to cut the connecting link between the company and a number of important customers.

With such an array of talented educators and engineers present at this conference, it will not fail to be an important factor in the development of schools and courses in commerce for engineers, and manufacturers will welcome their early advent.

Chairman PRATT. Gentlemen, I think we are exceedingly fortunate in having had what seems to be two phases of one subject presented to us with extraordinary breadth and clarity this morning.

We might, perhaps, say that Dean Marston had approached this most interesting subject from the undergraduate's point of view and that Mr. Spencer Miller had presented it from the postgraduate's standpoint. Both are indispensable.

There are but two exceptions which I want to take to Mr. Miller's address. He implied that I had stated that he was not an educator, but it seems to me he is very much of an educator.

The other exception is that he paints such a glowing picture of the possibilities of what we term, for lack of a better name, a commercial engineer, that there is danger of his enticing away from pure designing and research engineering too large a number of men who ought to continue in those lines.

The conference will now be open for the discussion of these papers or any other phases of the subject, and our time is limited.

Dr. Swiggett has made a few suggestions to which I wish to call attention. The first is that a record is being made of the proceedings of this conference, which will be published; the second is that for this reason each speaker is urged to speak slowly and distinctly, giving first his name, then his position or title, and his address; and the third is that those who present papers which have been prepared in advance and printed will confer a favor if they will kindly leave copies of such papers with us here.

I did not intend to call upon anyone in particular to discuss this subject. I want everyone here to feel at liberty to participate in this discussion to the full limit of our time. Obviously, if we are to

get all that there is out of this conference the subjects must be debated. There must be an earnest effort to bring up every side of this question, so that those who are interested in this project may become acquainted with the diversity of views and of experiences of those present, and thereby be helped to rightly form their judgment.

I would, however, like to call upon Prof. Follows, of the Carnegie Institute, for a discussion of this subject. I think, perhaps, that the Carnegie Institute is the one educational institution in the land which has established a course in commercial engineering, or, at least, that it has gone farther than any other in this direction. This course has been the result of a great deal of study on the part of Prof. Follows, and I believe he has very definite ideas on the question of what can and should be done.

We should be very happy, Prof. Follows, to hear from you.

Mr. FOLLOWS. Mr. Chairman, Ladies, and Gentlemen, Mr. Pratt says we should be as definite as possible in our suggestions. I am afraid you will think me too definite. I am inclined to be revolutionary. I have become revolutionary during the past eight years in an effort to develop a course, a definite course, in commercial engineering in what we call "Carnegie Tech." (The Carnegie Institute of Technology is too much of a tongue twister; so I shall say "Tech.") In 1908, we were giving a course in what we called "production engineering," and during the past 10 years we have been developing. This year, at the present time, we have 72 students who will graduate as time goes on in what we call, definitely, commercial engineering. We do not say "commercial engineering so-called." We do not make any apologies for calling it "commercial engineering" because we believe we have just as much right to the word "engineering" in connection with great commercial projects, as Commissioner Claxton suggested, as any mechanical, civil, or electrical engineer. We are revolutionary in this way, perhaps, that we do believe that it is better to educate and train a real commercial engineer than it is to educate and train, first of all, a mechanical engineer, and then make him into something different—make him later into a commercial-mechanical or commercial-civil or commercial-electrical engineer, or anything else. We experimented for several years with what the students called the "hyphenated engineer," and, perhaps, like the hyphenated American, it is not the best type, the best possible type. We think we ought to go the whole distance and come out flat-footed and say we train men to manage men, to manage and engineer great projects, to take up the problems of "commercial engineering" as in engineering management, production, accounting, salesmanship, and foreign trade.

The idea that a man can be made into a good salesman by a conversation, however delightful or inspiring it may be, and then put

on the road; the idea that that is the best way to make a salesman is, I think, just as far from the truth as the idea that you may take a man and give him a talk about machine design and then say, "Now, go into the drafting room, and during the next 10 years your experience will make you into a successful machine designer."

There are fundamentals of salesmanship; there are fundamentals of selling and of advertising, just as there are fundamentals of scientific management and employment, safety engineering and economic production, accounting, auditing, and factory costing. These and kindred subjects occupy four years of the student's life fully. We have adopted our present plan after several years of testing; we have sent out a goodly number of what we might call "test" commercials, "trial" commercials, men who have gone out with part of our training, not all of it, because we have only been giving all of it during the past 2 years. But we make this claim, that to be a good engineer, that is, a good commercial engineer, these men must have a technical background; and we call the technical background subjects "engineering practice." In a sort of way we give them technical training. We give informational courses, descriptional courses. But they are fundamental, not superficial. They are so fundamental that if a man should choose he may take up any one of those lines and, in time, be a success.

Only last year we graduated a young fellow in commercial engineering who went immediately into war service in radio work. I have a letter from him in my pocket, which I will not bother to read to you, but he became what they call a master signal electrician in the radio department. I heard only yesterday from the head of one of the bureaus here, that he was one of the most brilliant radio men in Washington—and his training was in commercial engineering. He came to see me about six weeks ago and said, "Prof. Follows, if you really have the fundamentals you can easily make good; I knew the fundamentals of electrical work."

Only last week we had calls from representatives of the Standard Oil Co., the National Supply Co., Doherty & Co., and other engineering project people, who are ready to take all the commercial engineers that we can possibly graduate. The National Supply man said, "You are five years ahead of the times. You are doing what we have been hoping would be done; you are cutting out design work and research work and training men to be real commercial engineers."

During the past 8 or 10 years our "commercials" have been going into large plants involving large projects, and making good in the management of men, in welfare work, safety work, employment management, advertising, and salesmanship; also in shop accounting. Some of these men have been successful in a very big way. One came to visit Tech only last Christmas, and said: "I only

graduated from Tech in 1910, and my salary to-day is $18,000. I am the head of the biggest organization of its kind in the country, and I know that my success is the direct result of my training at Tech in the science of management and production."

I had a talk with the general manager of one of the big steel plants in Pittsburgh only two years ago; he looked over the commercial course, the chart of which is on the easel there.[1] [Indicating.] I went through the whole course with him. He said, "You are on the right track, absolutely." He himself was trained as

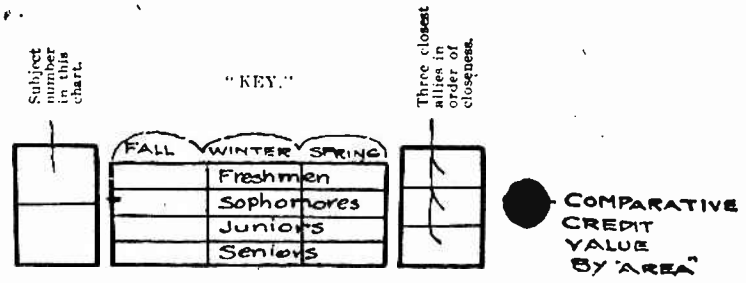

DIAGRAM 1.

OCCUPATIONS.

In the field of organization, as in—
- Employment management.
- Office management.
- Safety.
- Welfare.
- Works management.

In the field of production, as in—
- Work planning.
- Efficiency.
- Shop planning.
- Storekeeping.
- Work and time studying.

In the field of commerce, as in—
- Advertising.
- Catalogue work.
- Manufacturers' agencies.
- Publicity.
- Purchasing.
- Salesmanship.
- Sales managing.
- Technical writing.
- Transportation.

mechanical engineer and is now general manager of one of the large steel plants. He said:

> My training in mechanical engineering made it very difficult for me to become a real manager of men. Once train a man in design and research work and you have made it impossible, almost, for him to become a great organizer or manager, because he knows too much about the material details; his point of view is not that of a true manager and executive; he is in touch with materials rather than with men.

But we at Tech are drawing a definite line. On one side of that line we give courses in the material technical work. On the other side we give courses in the more human technical work, which deals with management, salesmanship, safety, and so on, and we feel that we are on the right track. So we are revolutionary, because no other

[1] Diagrams 1 to 5 reproduced from the speaker's chart map.

FUNDAMENTALS

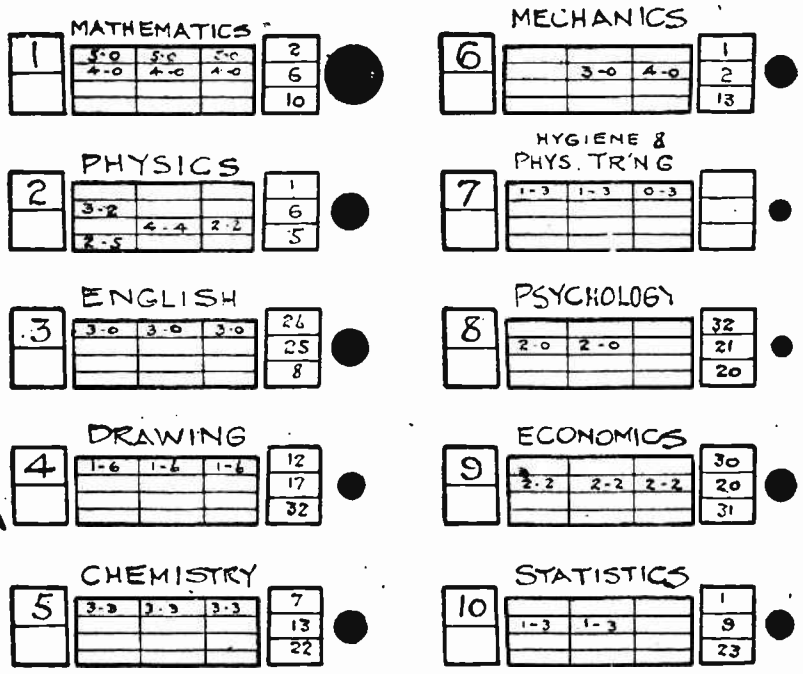

DIAGRAM 2.

Concise Contents.

1. Mathematics: Algebra review; trigonometry; spherical trigonometry; theory of equations, vectors; analytical geometry; calculus.
2. Physics: Mechanics, etc.; electricity and magnetism; heat; light.
3. English: Themes and public speaking, based on the current-issues course.
4. Drawing: As a "language" with alphabet, vocabulary, modified words, and compositions, in both perspective and orthographic—all by the problem method. As the "vehicle" in the "illustrated specification."
5. Chemistry: Historical development; fundamental laws and conceptions; nonmetallic elements; electrolytic dissociation and chemical equilibrium; batteries; important industrial processes.
6. Mechanics: Statics of particle and of rigid body; stresses in frames; center of gravity; moment of inertia; friction; dynamics; work; energy; impact; stresses in beams, etc. Problems using handbooks.
7. Hygiene and physical training: Lectures and exercise.
8. Psychology: Nervous system; sensation; perception; memory; imagination; judgment; reasoning; emotion; will, etc.
9. Economics: By problem method. Production; distribution; consumption value; survey of money, credit, banking; economic significance in governmental administration in industry and business.
10. Statistics: Tabulation; plotting frequency surfaces; central tendency; median; mode; mean; scatter diagrams; empirical equations; regression equation; correlation coefficient; multiple correlation, etc.; coefficient; graphical representation; probability.

school is doing this, so far as we know. No other school is at the present time, I believe, giving a degree of bachelor of science in commercial engineering.

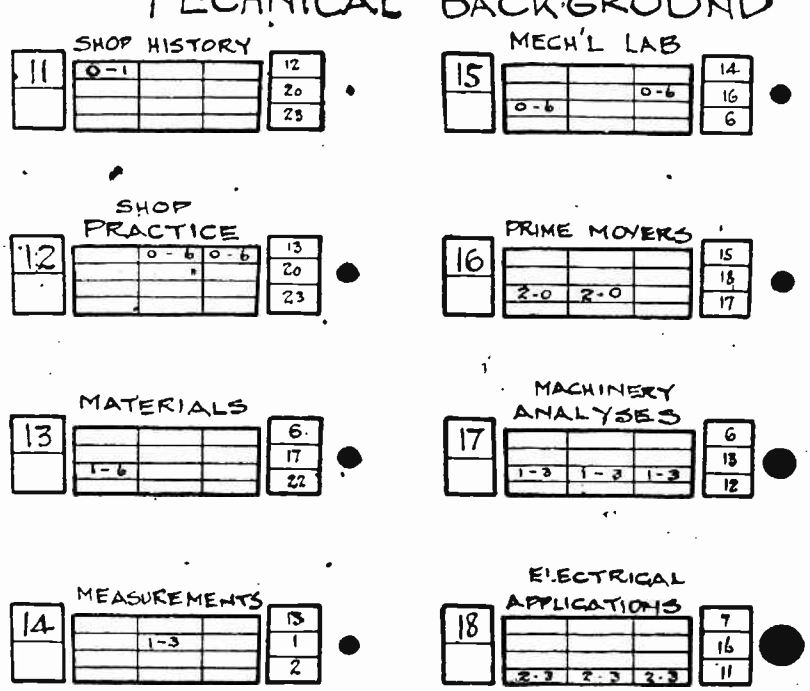

DIAGRAM 3.

Concise Contents.

11. Shop history: Engineering trades; shop-practice outline; organization and management of shops; standardization; materials; work and tools.
12. Shop practice: Pattern shop; foundry; forge; machine shop.
13. Materials: Methods of testing; properties and uses of materials—steel, cast-iron, cement, cement mortars, concrete, timber, etc.
14. Measurements: Thermodynamic and hydraulic; elastic and inelastic flow.
15. Mechanical laboratory: Calibration of scales, anemometers, tachometers; indicator springs, pressure gauges, water meters, planimeters; efficiencies.
16. Prime movers: Thermodynamics of heat engines; boilers, engines, turbines, power-plant equipment. Whole treatment essentially practical.
17. Machinery elements: History, design, construction, and application of the more important elements of machines, as fasteners, bearings, shafting, belting, gearing, cams, and automatic devices.
18. Electrical applications: Power plant and substation equipment; power distribution; industrial applications; comparative costs.

If I may step down from the platform just a moment, I will speak about this chart. I hope some of you will come and look at it afterwards, because it is a very interesting and instructive chart, the result of experience and hard knocks and a great deal of resistance.

I know that many of you are connected with educational establishments, and if there is anything more difficult to fight than the opposition of an orthodox faculty I have yet to find it. The orthodox faculty is conservative—opposed to changes. If there is a course in

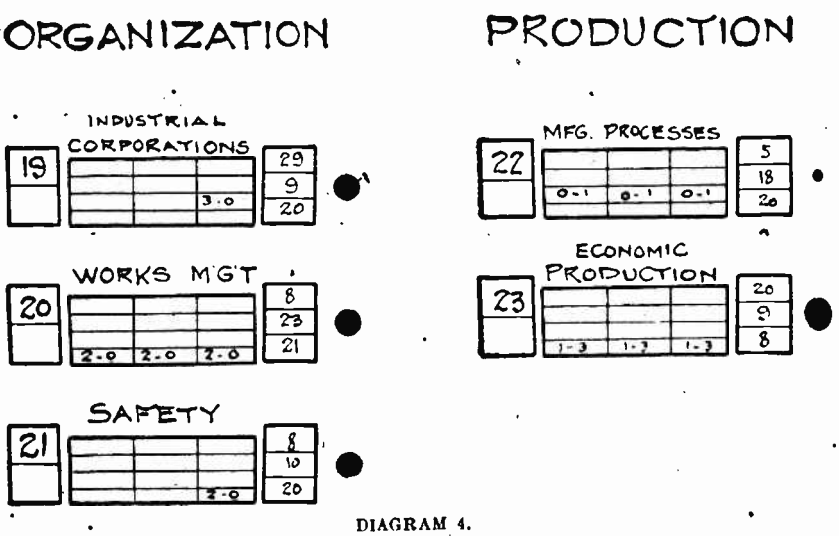

DIAGRAM 4.

Concise Contents.

19. Industrial corporations: Formation and powers of corporations; special acts *re* manufacturing corporations; stockholder rights and liabilities; mergers; consolidations; stocks and bonds; taxes; labor and employer liabilities.

20. Works management: Cooperation; administration; tree-plant chart; charting in general; elementary formalities; routine apparatus; five essentials; incentives; expense classification and distribution; depreciation, appreciation, maintenance, repair; costs; work and time studies; bonus plans; handling men; organization for personal efficiency; personnel and employment bureau work.

21. Safety engineering: History, growth, and scope; organization for accident prevention; habits; mechanical safeguarding; hygiene; betterments; occupational diseases, etc.

22. Manufacturing processes: *Chemical:* Industrial chemistry, patents, and tariff; history of industries; dyestuffs, synthetic drugs, rubber, varnish, artificial plastics, etc. *Metallurgical:* Relation of mining to general industry; occurrence of ores; types of mining processes; extraction; iron and steel manufacturing; working of metals; alloys. *Mechanical:* Evolution of typical machines used for direct production.

23. Economic production: Management, equipment, personnel, and production studies in from 8 to 12 Pittsburgh plants * * * from the receiving of the order to the shipping of the product.

mathematics, that is the course in mathematics; it should not be changed. It is according to the laws of the Medes and Persians. But if it never changes, it will never improve; and we ought, I think, to work always toward improvement, and to the development of special courses of instruction for special needs.

We have what we call "fundamentals." Mr. Miller has said that the main fundamentals for the commercial engineer are hygiene

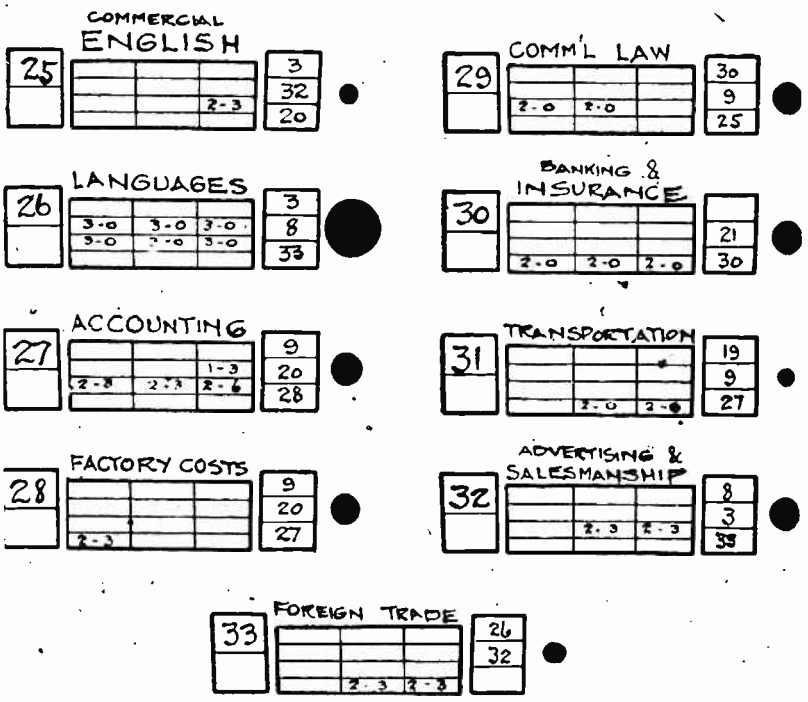

DIAGRAM 5.

Concise Contents.

25. Commercial English: The exact method in the preparation of written specifications; correspondence forms; letter writing, etc.
26. Languages: *French:* Beginner's course; reading of technical journals. *Spanish:* Beginner's course, with emphasis on commercial forms.
27. Accounting: Bookkeeping, debits and credits, opening and closing entries, statements, income and balance sheets; proprietorship accounts, interest, depreciation; amortization, balance sheets, audits.
28. Factory costs: Production factors in relation to costs; apportioning in direct expense; control accounts; relation of costs to financial books.
29. Commercial law: Contracts and negotiable instruments, bailments, bankruptcy, franchises, partnerships, corporations, conveyancing, sales and insurance; legal forms; workmen's compensation act—all applied, where possible, to engineering problems.
30. Banking and insurance.
31. Transportation: Railroad industry historically; organization and management; competetive agreements; inter-railway relations; freight handling and routing; theory of rates and fares; rate making in practice; accounts and statistics; private versus Government control.
32. Advertising and salesmanship: Psychology applied to; analysis and classification; statistics of; plans of campaign, etc.; salesmanship; the "art" of selling; marketing methods.
33. Foreign trade.

and physical training. Well, we give all students 5 hours a week of hygiene and physical training.

The fundamentals of commercial engineering proper are psychology, economics (9 hours a week), and statistics—based, of course, on mathematics. There are the usual educational chemistry and drawing, which latter, by the way, is largely free hand, taught distinctly as a shape language. We teach these young men to make good perspective sketches by absolutely fundamental methods. They are taught to compose in lines, to express themselves by means of the pencil. Some of them are skillful, some are clumsy, but, at any rate, they can all make themselves understood; and, as Mr. Miller has suggested, it does not matter whether the man you are "sketching to" is a Chinaman, a Dutchman, or an Irishman. It makes no difference, the perspective sketch can be read.

Then we have what we call our engineering practice—a sort of technical clinic, or technical background—shop history, shop practice, machine shop and foundry, a knowledge of measurements, testing of materials, mechanical laboratory, a strong course in power plants and prime movers, machinery analysis—a sort of machinery clinic—passing through the history of machinery, the development of machines and a very detailed treatment of the essentials of machine design, so that the salesman or the purchasing agent will know what machinery is and what makes it more or less efficient, and more or less expensive.

Then electrical applications. This course has been developed during the past four years, and our electrical engineer, Prof. Work, tells me that the development of this course has given him a new lease on life. Instead of the old orthodox course in electrical engineering he has developed a course which puts the student in touch with the functioning and applying of electrical apparatus. This is distinctly a descriptional and problem course, with laboratory experience.

Then we come to the really distinctive part of the commercial engineer's training, which covers industrial corporations—employment management and personnel—and safety engineering. We now have a real course in safety engineering and welfare work, thanks largely to the help received from the National Safety Council, from the Workmen's Compensation Service Bureau, and from "many prominent safety men," such as Mr. De Blois, of the Du Pont Powder Co.; Mr. S. J. Williams, chief engineer of the National Safety Council; and Mr. Robert W. Campbell, of the United States Steel Corporation.

Throughout one year lectures are given on manufacturing processes by men who are masters in their line. We do not believe that

information of this kind can be given from books by school-training instructors.

Then a course in economic production, which means a study, an observational study, of the methods of production in a great variety of plants in and around Pittsburgh. This extends through the senior year.

Then we go into what we call the commercial or marketing subjects, and there we begin with commercial English, a special course in the writing of business letters, and also oral English, and the proper use of the speaking voice. I only wish I had had training of that kind in the use of my voice. I do not know how to use it.

Under languages, French and Spanish. Then there is a full course—nearly two years—in accounting, auditing, and factory costs. A course in commercial law, two-thirds of the year; banking and insurance, two-thirds of the year; a strong course in transportation which deals with transportation from the moving of material inside the plant to the delivery of the material at the plant abroad, hoisting and conveying, shop trucking, auto trucking by railroad, on board ship, across the ocean, to the foreign port, and then on to the factory abroad.

Advertising and salesmanship: This includes applied psychology. Psychologists agree that there is no richer field for applying the fundamental principles of psychology than in advertising and salesmanship.

Finally, we have a course in foreign trade. This is being given by a specialist who is doing very good service at the University of Pittsburgh and is sharing his time just now with us at Tech.

So we have a program which is now a standard program. Let me add this: This year, of the 220 freshmen at Tech who have elected engineering courses, 35 have elected commercial engineering, as large a number as elected either mechanical, electrical, or civil engineering. The commercial course is becoming very popular, certainly not because it is an easy course, but because of the great opportunities it offers to the graduate. We are assured by many of the big corporations, not only around Pittsburgh, but elsewhere, of their need of these men. Some have told us that they are ready every year to take all the men we graduate and distribute them through their various interests either in this country or abroad.

I thank you very much.

Mr. TAYLOR. Mr. Chairman, it seems to me that this phase of the subject belongs more to the afternoon's topic, but since it has come up, I want to ask whether the commercial course at Carnegie Tech is an essential part of the course in mechanical engineering?

Mr. FOLLOWS. Do you mean how much commercial engineering the mechanicals get?

Mr. TAYLOR. Yes; in business training.

Mr. FOLLOWS. We give the "mechanicals" a commercial background. We feel that the commercial background is just as necessary for the mechanical or electrical or other technical engineer as the technical background is for the commercial engineer. So it is only a matter of giving that commercial background, which we do through economics, political science and safety and welfare, works management and economic production. They are in some cases lighter courses than those given to the commercials, but they are being included in practically all the technical courses now. They are all given a part of the commercial work as a background.

Mr. TAYLOR. Can you reduce the amount to semester hours?

Mr. FOLLOWS. We have just adopted a new unit of one clock hour of work, whether it is laboratory work, recitation, lecture work, or home work, but I can not give you the actual number of hours. It is approximately as recommended by Dr. Swiggett and the Commercial Engineering Conference of the 1st of April last.

Mr. TAYLOR. In other words, you are using the clock hour. the actual clock hour?

Mr. FOLLOWS. Yes, sir.

Mr. BEE. Mr. Chairman, it is evident that there is a great field for the kind of education that the Carnegie Institute is teaching, but I think we must agree that if a large majority of our technical schools give that kind of an education, the progress in real engineering along scientific lines would be handicapped. It is true that a great many engineers try to become commercial engineers, parts of the commercial organization, and eventually reach high positions; but we must hope, and I believe it is necessarily true, that a great many engineers love engineering sufficiently so that they will not be tempted off the main road. I am sure that it is desirable to have a great deal of economics and like subjects in an engineering course, and was shocked to find that 50 per cent of the technical colleges did not even give an elementary course in economics. That is certainly wrong and can not be justified. I think, however, that it would be decidedly unfortunate if we convey the impression here that it is possible and desirable that every institution give a course in economics involving, say, 12 to 15 hours. Some institutions could advantageously do it, but the majority of institutions have not the teachers nor the justification to do it.

I am familiar with the conditions at Union College and shall, therefore, refer to that.

In the engineering courses of Union College we have a three semester-hour course in economics and a three semester-hour course in business law. In addition we have—I don't remember the exact number—four or five elective courses along lines of economics open

to men who have taken these elementary courses. As it turns out, the majority of students enjoy these courses in economics very much indeed, but only about half the class elect to take economics in the senior year, because we happen to be fortunate enough at Union College to have one real character builder, a man that every student feels he must have studied under—Dean Ripton—professor of history. His elective courses in history divert the students from electives in economics.

To conclude, we all agree about the importance of economics. There is no question about it—it is extremely important, and we should do all we can to introduce it extensively in our engineering curriculum. But the important thing, after all, is to make the best use of our men, our faculty. If our best man is a professor of history, the student should take and takes many courses in history. Similarly, if we have a strong man in economics, our students will elect not three or four but 12 hours of economics.

Mr. HUGHES. I am here to-day more for the sake of obtaining information than for anything that I can impart to this assemblage.

The Harvard engineering school is being reorganized. Five years ago we made an agreement with the Massachusetts Institute of Technology and we moved our civil, mechanical, electrical, and sanitary engineering and our mining and metallurgical staff and all our equipment to the institute. Then, in 1917, the supreme judicial court of Massachusetts decided we could not stay there, and we are now moving back, which gives us a chance to reorganize.

We find the process difficult, chiefly because we do not know what subjects to leave out of our programs. Four academic years and one full summer's work are required of all students for the bachelor's degree. In addition to the school shopwork of the sophomore year, in the case of mechanical and electrical engineers, we plan to put them for 11 weeks during the second or third summer into industrial plants. One of our great problems is how to manage this summer's work. We do not want to put them into a shop and turn them loose all summer long on a lathe or planer in just one place, and we are trying to find out from people who have experience how to handle this instruction in order that the students may get a knowledge of men and of business organization as well as technical training. The civil, mining, and sanitary engineers will have an equivalent amount of work in surveying and in mines or in suitable industries.

We have planned for the seniors that a fifth of the students' time be devoted to accounting and business law and management. Those courses will be given to our students by professors in the Harvard Graduate School of Business Administration. We do not think it is enough, but so far it seems to be about all we can give. We feel that the engineering students must have, first of all, a thorough course in

engineering. This work, with the summer work, will take about one-tenth of the students' four years. There is little specialization during the four years, but the fifth year may be wholly devoted to some special field.

We hope that such of our students as wish to combine engineering and business administration will go to our school of business administration after they have completed the engineering course. It is a wonderful organization. In addition to its large and skilled staff of permanent men, a large group of successful men come in from business and give instruction in their own life work. Such a combination will take time, but if one is to have both he must give sufficient time.

I have followed closely the courses in engineering administration given in some places, and I do not approve of the courses as they are generally given, because four years is not long enough, in my opinion, to cover the combined work. They are not courses in business such as Prof. Follows has explained, but they are a sort of a makeshift, a smattering of engineering and business.

I would like to raise a definite question before I close and that is, how to make a connection between the schools and the shops which will give students the training which is required. We do not see our way clear to adopt two weeks in and two weeks out, but we do want to make a first-class summer's work.

May I also indorse what one of the previous speakers expressed? I do not think that the English as it is taught in the best schools is as good as we ought to have for our engineering students. We ought to have all sorts of training in expression. We should not turn over our students to dilettantes whose interest is chiefly literary and who criticize chiefly from the standpoint of elegance. What we need for our students is live teachers of English who will stay with them day in and day out, throughout their college career. Every article that is written should be scrutinized by teachers who are expert in this matter of English. Occasionally the older teachers of engineering may be depended upon to do this; but in general everything a student produces, written or spoken, throughout his four-year course ought to be criticized from the standpoint of expression by some one whose business it is to do so. I do not believe a student can be taught to write English in three hours a week for one or two years, or even three years of his course. Teach him all the time.

Chairman PRATT. I would like, if Dean Turneaure, of the College of Engineering of the University of Wisconsin, is present to have him give us a few words.

Mr. TURNEAURE. Mr. Chairman, Ladies, and Gentlemen, our faculty is approaching this subject from a standpoint about as follows:

As every one knows, who is a teacher, there is a vast number of things that can be taught in college, not alone in engineering, but in business, law, and almost every other branch. The problem is, what does it pay to teach in college for a period of about four years? We know we can not turn out finished engineers. We can turn out men who, presumably, at the end of four years, are capable of becoming engineers. We can give them the fundamentals. We can give them some of the A B C's of engineering so that they will not feel perfectly green when they go into a particular branch of work.

It seems to me we can do the same sort of thing along the line of business and commerce. Each year a larger proportion of graduates is going into business closely related to engineering, and the demand is upon us to fit those young men in such a way that when they go out into practice they can fill a subordinate position in those lines more effectively than they can at the present time.

In many cases young engineers would find excellent openings in the business side of engineering, but, being almost wholly ignorant of the A B C's of business, they hesitate to tackle that phase of the profession.

It is our idea that engineering students should be given at least the A B C's of business practice in the same sense that they are taught the A B C's of civil, mechanical, and electrical engineering. Our alumni, many of whom are in business practice closely related to engineering, have urged upon us the desirability of introducing into the courses a comparatively small amount of business practice. I think most of us will agree that fundamental courses in economics are essential to engineers; but I believe that some applied work in business practice should also be introduced to a limited extent, primarily for the purpose of opening the door wider for engineering graduates in the field of business engineering. Beyond this point we have not gone very far. Perhaps we will not go very far. We look upon this general subject about as we look upon such a branch as telephone engineering. We do not think it would be worth while or economical to teach a large amount of telephone engineering in four years. Business practice is a specialized branch, and a large amount of time can not be afforded such specialized branches in four years.

Chairman PRATT. Will Mr. Howard B. Shaw, in charge of the Doherty Training Schools, give us a few words? I am sure his viewpoint on this topic should be of interest.

Mr. SHAW. I have not prepared any definite discussion. I came rather for information, because I have been out of touch for six years and have not kept up with what the engineering schools have

been doing except as to come in touch with them by getting graduates from them.

I have charge of the Doherty Training Schools. We have in the last 14 years employed about 400 engineering graduates and attempted to work them into the utility business. We find, generally, that their training in engineering, strictly technical work, is sufficient wherever we get them, with the possible exception that chemistry is not welded into engineering courses the way physics is. Chemistry, generally, except in chemical engineering courses, is given as one subject in the freshman year, and the remainder of the course the students proceed to forget about it. Some of our work depends largely on chemistry, such as gas engineering; and in recent years we have gotten into the oil business, and chemistry is necessary in some phases of the oil business or for engineering connected with the oil business.

In general, we have found the students knew little of organization work. In general we find difficulty in interesting graduates in the oil business when we get them from the schools. After they have been with us two or three months, it is hard for us to keep them from going into the oil business, whether they have been trained as electrical, mining, mechanical, or civil engineers.

Recently we made a study of a few engineering schools where we could determine classification of graduates as to employment, and we found that approximately 75 per cent of engineering graduates were employed with organizations; a larger proportion with organizations which were operating as compared with manufacturing—that is, organizations like utilities, railroads, etc.

We think that some attention ought to be given by engineering schools and engineering educators to the question of where their graduates go after they get through with them and what they will be called on to do.

I venture to say that over 90 per cent of the engineering graduates would be benefited if they had some of the principles of business as well as economics while they are in school. Most of our work consists in teaching them or giving them, rather, the opportunity to learn the means and methods of organization.

Mr. MARSHALL. I hope it may be pertinent if I refer for just a few minutes to something that I have done in North Carolina in the last three years along educational lines connected with business in the school there.

Our work, so to speak, was in a local field. After getting underground sewerage, filtered water, and proper sanitary conditions, we built a public school. They had nothing like it in the State. We tried to mark a new line in the method of training children there to take the full courses. We tried to train the body so as to make

the mind better. We taught domestic science and manual training. We would call in the chemists and engineers for an hour or so. We would also invite a fellow engineer, engaged in some practical business, and who lived there, to talk to the whole class. The chemists and engineers were not a permanent part of the faculty, but they gave the students something that made them more practical when they graduated. It will be granted, I think, that they will make better engineers or chemists or whatever they intend to be from the introduction of this practical work into the public school system, and it is worth going far to see the actual results accomplished.

Chairman PRATT. That is an exceedingly interesting illustration that has just been called to our notice.

There are, however, four sessions to this conference, and I want to bring the discussion of this first session back as closely to the topic as I can. The topic is "Business training for the engineer," whether or not the engineer as an engineer should receive a greater degree of business training than has been the custom in the past. It is not that we are going to make business men out of engineers primarily, but it is that the engineer, in prosecuting engineering science and practice in the broadest possible manner, should be in position to deal with business problems as they arise and to direct them.

I should like very much to hear from Prof. Jenks, of the New York University, if he is present this morning.

Mr. JENKS. I had not thought of speaking at all this morning. I have only a word to say along the lines suggested by the chairman at this moment.

I had supposed that the purpose of the conference was not to train business men who do certain engineering work, but was to see how engineers might get some capacity and experience and ability by handling business problems that come to them incidentally in their work as engineers.

I have only a suggestion or two to make, because I understand that we are discussing this question from the point of view of teaching in an institution, and that suggestion is regarding the teacher and the way in which the teacher shall himself approach the problem.

May I comment, for example, on one or two things that have already been said with reference to the teaching of English? I am in most hearty accord with the speaker who suggested that if our engineers are going to express themselves properly they must have a good deal of English practice all through their course. I believe it is possible in our engineering schools to make the courses in English much more practical than they are now. For instance, if we entitle the course in English "business English," as is the

case in some institutions, it will focus the attention of the teacher himself upon the fact that he is not primarily to interest his students in Jane Austen or in Fielding and in the niceties of English literary criticism, but that he is to teach them primarily to write a straightforward business letter, a sales letter, a letter that will have to do with practice in connection with business.

The same thing would be true also with reference to any course we might have. Take, for instance, public speaking. In almost all of our institutions now there is an opportunity for the engineering students to have at any rate a short course in public speaking. That does not mean that the men must be made polished orators. It does mean that a man should be taught so to express himself that he can be concise and come directly to the point in a five-minute talk. In many of our institutions that kind of work is now done in a department of public speaking.

Let me take just one other illustration as to the practical end of the work. I may perhaps speak from my own experience here, because I have been a teacher for many years. I remember that in one of my graduating classes some years ago there happened to come up a problem in connection with the Philippine currency situation which at that time was in a troublous, parlous state. Some special problem was troubling the Government in Washington. My attention had been called to the question, and I thought it would be very useful to put that problem before the class. I said, "Here is a problem," and I explained to them what the situation was in the Philippine Islands. "What would you recommend the Government to do? That is your next lesson assignment. I wish you to submit a rather detailed report. Moreover, if you say anything that is good for anything, I will make it a recommendation to the Government. It may be that some of you may so develop your statesmanlike ideas as to help the Government, because this is a troublesome problem." I had some very interesting suggestions a few days later. The most interesting thing, however, was that probably the best man I had in the class, a man who had been appointed on account of the brilliancy of his scholarship in other institutions, said to me a week or two later:

> I studied economics as an undergraduate for three years. I taught economics for two years. I came into your class a few weeks ago, and the first time it ever occurred to me that economics had anything to do with practical everyday living was when you put that problem up to the class.

Economics is the science of business. I think the teachers can help the situation very much, not only along any one of these lines, but along all of the different lines. I think that so far as possible we should give courses in business management, business organization, salesmanship, and all of those topics, but, first of all, we should im-

prove our own mental attitude as teachers, realizing that we are fitting those men for life.

Chairman PRATT. I happen to know that at Yale University they have just consummated a rather radical plan of reorganization, both in the administrative and educational activities of the university, and the scientific department has been very definitely influenced by these reorganization plans.

I notice that we have with us this morning Prof. Tracy, head of the civil engineering department and also chairman of the engineering committee of the scientific department of Yale. The subject of the amount of economics which can be introduced into the engineering courses, including civil, mechanical, electrical, and mining engineering courses and other scientific courses, as carried on at New Haven, has had a great deal of attention. As the curricula which have now, I believe, been established for the forthcoming years have been made the subject of a very real study from this point of view, I would be very glad if Prof. Tracy would say something to us in that connection.

Mr. TRACY. Mr. Chairman and Gentlemen, it is true, as the chairman has stated, that we have just been through the throes of reorganization in the transition from a three-year to a four-year course. Our committee on engineering has been wrestling for some months with this problem. We started by asking ourselves the question, "what is the kind of work that an engineer really does?"

We felt that there were really three kinds of work—designing, construction, and operation. We said to ourselves that the last two of these really require some business training. Then we asked ourselves, "how can we introduce the elements of business training into a curriculum that is already overcrowded?" We thought we could do it in two ways, by the addition of certain elementary courses in business and by the broadening of some of the technical courses already given.

To gain time for the addition of elementary courses in business, we examined rather closely some of our highly specialized courses in engineering and we found that we could reduce some of them, especially such as those in bridge drafting, railroad curves, and other specialized courses, and thus gain a little time for the introduction of courses in economics, in accounting—taken in a broad sense—in business and finance. We felt also that the professors of engineering could bring into the courses which they were already teaching something of the business conceptions which the student should have to carry on work pertaining to construction, operation, and other business phases of engineering work.

Then came the problem of getting teachers for business courses. We can, of course, get from our other departments most of these teachers, but in addition we shall follow out the plan which we have

already in operation in our technical courses, that is, the plan of calling in experts from outside; but when we call these experts in we do not ask them to come and merely lecture to the students; we ask them to give conference courses. These are courses which are worked out by the men outside of the school in cooperation with the men on the faculty. When these outside men come they sit down with the students and, instead of giving lectures, they talk with them informally and discuss these subjects for two hours or more, giving the students the benefit of their experience.

These are some of the suggestions which perhaps we can offer from our own experience, but I speak of them rather reluctantly, because they seem rather inadequate and because we ourselves are puzzled as to just how to proceed. We are simply feeling our way in the development of these courses. We feel, moreover, much as Prof. Hughes does, that if a student desires to specialize in a business training, he should take at least one year of graduate study in a business administration course.

Chairman PRATT. Would Dean McCaustland, of the Faculty of Engineering, University of Missouri, say a few words to us?

Mr. MCCAUSTLAND. I am very glad to be called at the end of this discussion and will try to get back to the major topic, business training for the engineer.

It is rather striking that from four institutions we have practically the same report. I refer to the speakers from the State College of Iowa, from Wisconsin, from Yale, and from Harvard. After all, our old courses in engineering, our old curricula, while they need revision, are not, after all, entirely fossilized, but may be modified and brought down to date. However, like all good things, change comes slowly.

The presentation of the work at the Carnegie Institute is a little aside from the main question, as it appears to me, because that establishes a specific curriculum in commercial engineering. I have no opinion on that curriculum at the present time, but in the matter of the subject of business training for the engineer it seems to me our best method is to build on what we already have. The last speaker, from Yale, touched upon the difficulty that every institution meets when it attempts to get something new in the curriculum; that is, "Is there room for it?" In the old days when we found that we wanted to put something new in the curriculum, we just put it in. If it was something new we believed it was something worth while, and we put it in until we got so overcrowded that we had to stop. We now meet the situation differently. We have almost come to the point where we are ready to remove some special engineering courses and put in more fundamentals. I am not ready to go to the extent of the speaker, Mr. Miller, who says that the fundamentals of engineer-

ing are English, good character, and physical training. Those are good and necessary, but they do not cover the whole ground. We have got to get some science in the course, and by cooperation with the scientific departments, with mathematics, with business and mechanics which are treated on a scientific basis we are able to make room for some other work.

I was interested in a remark that Dean Shaw made on the floor here to-day as to the need for more chemistry. I agree with him, but it is a very difficult thing to determine just what are the essentials of engineering training. We will all agree on a certain amount of mathematics, drawing, and so forth, but when we get beyond these we appear a little hazy as to what are the fundamentals in engineering. But I do see a marked tendency on the part of teachers of engineering to be more ready to give up some of the highly specialized courses for which they are responsible and thus make way for more elementary work. Sometimes the same result is reached by a combination of courses, as, for instance, in the field of structural engineering. Instead of having a course in higher structures relating to bridges and a course in masonry structures and a course in concrete structures and a course in mill buildings, and various other courses of the same sort, they get together, boil it down and give a single course in structures. I was interested to note in the last issue of the bulletin that someone mentioned this method as a desirable modification. It is already accomplished in some schools.

Therefore, it seems to me that the procedure for the members of an engineering faculty is this: Carefully scrutinize all courses in the curricula and keep them restricted to essentials; train the students in English, in drawing, in the sciences, in economics, and if there is any room left, put in some of the special engineering courses. It does not appear to me to be at all impossible to follow very definitely the program of dividing a curriculum into a preparation for designing, for construction, and for operation. As Mr. Miller pointed out, students should go on after some practice with what may be called postgraduate work. This may be highly specialized and technical.

Mr. HARRISON. There is one point in regard to this matter which it seems to me that educators and practical engineers are apt to overlook. The point to which I refer is the training of the young men who come to our colleges in "polished manners and fine sense." Nor, as far as I know, is there anything done in our colleges to aid in training young engineers to meet other men or to so mold and adjust the personality of these young men that they will go out with a knowledge of diplomatic approach, politeness, and courtesy. Yet these are very important factors in transacting business and are as readily taught as physics, economics, or algebra.

The speaker worked for 10 years beyond the confines of the United States and the one thing that impressed him possibly more than anything else was the courtesy with which foreign engineers attack the problems with which they deal. There is absolutely no roughness, no unnecessary aggressiveness, no tendency to make a show of force. On the other hand, the American engineer is quite apt to start into a proposition in a good deal the same fashion that a section foreman drives into an unruly gang—plenty of use of the pick handle and no thought of sore heads if only results can be obtained. This directness is greatly to the misfortune of American engineers in their efforts to engage in business affairs, but it is to be traced not to any deficiencies in personal character or temperament, but to the fact that American colleges of engineering have quite generally permitted their student bodies to develop a concept of engineering which, while these men are in college, expresses itself in high top boots, rough wool shirts and rugged manners, and in later years in a brusqueness which is hardly an asset to any man who desires to succeed in a business career.

I feel that something should be done in our colleges to teach young men at least the elementary rules of politeness, courtesy, and a gracious manner. Some will object that such learning should be self-acquired, but it is the speaker's belief that there is no field of knowledge which can not be better and more quickly grasped under the guidance of good instructors than it can by self-training. Indeed, our whole educational system is based on this assumption, particularly as applied to the training of the young. I, therefore, see no reason for objecting to a statement that no matter how courteous a man's intentions may be, good training under good instructors will always serve to make the expression of that courtesy more effective and its possession more of an asset.

Mr. RANDOLPH. For some 25 years I have been teaching business engineering to engineers and have tried various and sundry methods. The difficulty which has bothered me most was that there were some men, quite a number in fact, into whose head it was almost impossible to get an economic or business idea. Several whom I worked over very carefully and took special pains to make it clear to them have not yet, after 10 or 15 years in the world, grasped the fundamental business principles; they seemed to be wholly unable to look at things that way. Others found it easy. In one case a young man seemed to have a much clearer grasp of the subjects than I did, and from him I learned a good deal. I found he was a book agent, making his living by selling books in the summer. A large number of the graduates told me that their success was due almost exclusively to what they got out of their business engineering course.

One specific instance was typical of quite a number of others. One young man could barely pass his examinations on other subjects; in fact, I am not yet sure that he really graduated, although he got his diploma. When he came to me for advice I outlined the business proposition and advised him to go in with a contractor. I understand he is now worth several hundred thousand dollars, which he has made in this line of business.

One man made his class near the top and the other barely scratched through. The first man is barely making a living, while the other man is well off and manager of a large plant.

Just what is the fundamental difference in these cases I am unable to say. At present everything points to the difference in mental make-up. A man suited for business is one who does not readily grasp new things but does the same thing over and over as a duplicating machine. A man suitable for engineering is one who normally does a thing in a new way and does not follow beaten trails. My own view is that there is a fundamental difference here which must be recognized in our educational schemes, and the failure to recognize this is to-day producing untold misery and the loss of millions of money.

The writer has attempted to differentiate his men in this way and has made it a rule for years not to recommend a man for executive or business positions whose grade is over 95 and seldom to recommend him when his grade is over 90. The ordinary academic processes are utterly unable to differentiate between these two types of men. I succeeded in my class work in differentiating in my own mind and could classify them quite accurately, but was wholly unable to differentiate them on the records of the institution.

There is another thought which I think should be considered very carefully. Business is defined as an occupation which concerns itself with the details of trade; economics as the art of production, preserving, and distribution of wealth. Is the purpose of this meeting for business training or training in economics?

My own experience in handling these subjects in the classroom unquestionably points to the fact that the fundamentals of business training, such as bookkeeping, etc., can be taught in the classroom in a relatively short time. It would be impracticable of course to teach all the detail processes, principles, and methods of all the different trades or industries. Economics can best be taught in the classroom and should form an integral part of the subjects of instruction. Our engineering institutions are now contenting themselves with teaching the structural side only, whereas, the economic side is always of more importance to the graduate and is usually much more difficult to teach.

As an illustration of the last point made, we may take the design of a cylinder head for a steam engine. The structural methods are relatively simple and can be easily taught, but a different class of cylinder head would be designed for a man-of-war where every pound must be put in guns and armor; a freighter where every pound must be put in cargo; a locomotive where we wish weight for freight service and boiler capacity for passenger service, or a stationary engine where the weight has little value other than the cost of the cast iron, or an aeroplane where every possible consideration must be given to the saving of weight. The saving of a pound of metal in each one of these cases has a different value and the design must be guided accordingly. This is but an illustration of one of the many methods in which economics can be taught, and the writer has in many cases handled his entire subject from the economic standpoint, making the structural merely a side issue. In his own practice he has found that economics was always a primary consideration and the structural, secondary in a large degree.

It is questionable if a large number of our engineering teachers are not so unfamiliar with engineering practice as to make them incompetent to teach economics as above defined.

Mr. SNOW. I do not know whether engineering subjects should be added to the curricula of schools of commerce. At the moment it is rather hard to see how any engineering courses save those of the most general and descriptive nature could be thus added with much net profit. But this part of the problem is left for those most competent to consider it.

I do feel strongly that some basic commercial subjects should be added to the curricula of engineering schools. Engineers are the greatest direct spenders in the world; and aside from timeliness, and the broadening influence of such studies, from a technical viewpoint it seems desirable that engineering students should learn more about commercial matters than they do. The value of such addition to the engineering curriculum is admitted. The question arises as to ways and means.

The present suggestions are not the only ones we have recently received. Others have come to us from other sources. Most of these suggestions are good, but all are impossible; and as a matter of fact an underlying problem at this formative moment is not so much what to add to the engineering curriculum, as what to remove from it.

Let us consider the situation from three standpoints, i. e., the curriculum, the teaching staff, and time.

Curriculum.—I think that engineering colleges as a whole are about to separate quite completely from colleges of liberal arts, of which most of them are the offspring, and that the average en-

gineering faculty will soon be as free to express itself as faculties of law and medicine are now. But as yet we are too near the time when our curricula were designed and guided by liberal arts colleges to think independently. Even those engineering colleges which stand most alone show the influence of the liberal arts college which prevailed when they were organized. We are told that our engineering curriculum produces narrow men at the very time when we are depending upon the so-called culture subjects of the liberal arts college to give breadth. It seems hard to convey the thought that some subjects not now taught may have as great a broadening influence as some which are.

The consensus of opinion seems to continue to favor four-year courses, so that if we are to take advantage of any of the suggestions which appeal to us so greatly, we must remove some existing subjects entirely, or else cut down others at the top which have been carried too far, or both. This seems obvious, yet when we endeavor to carry it into effect we meet with trouble. I believe that the time is not distant when *liaison* will have a meaning in engineering faculties which it now has in the Army. Then, the engineering curriculum will be more in the nature of a *chemical* combination, and less the *mechanical mixture* which it now is. In the college of arts each subject stands comparatively alone. It is a question whether much which we have failed to accomplish has not been due to the fact that we have followed the college of arts in this matter unduly.

Teaching staff.—We all admit that the way a subject is taught may be as important as the subject itself. We are all trying to secure something more than teachers. We are looking for adjustable, broad-gauge, friendly, sympathetic, and humane teachers, men who are character builders as well as intellect molders, and we are glad that we succeed in finding as many of these men as we do.

Time.—Some believe that the average engineering student may be injured by carrying his "book work" beyond a certain point. We can not yet know whether the future engineering course will be completed in four years or in five. It seems certain that it will not go much beyond five years, but even this longer term would be insufficient for all of the results we would like to secure. We have been asked to add to our subject matter, and at the same time have a feeling that our men are now too old when they are graduated.

The definite suggestion is offered that while we are doing so much to increase our efficiency at the top, we may be omitting some duty at the bottom. And the question arises as to whether we will reasonably meet our duty to our students without looking further into the preparation these students receive before they come to us.

Why should the studies we are making, the improvement we hope for be limited to the term for which we are more directly responsible? How many of us are satisfied with the time economy which prevails in and the general results obtained by the courses intended to prepare men for that part of their training for which we are responsible? I realize what it means to suggest carrying our investigation down into the preparatory schools, yet I venture to make it. If the efficiency which will shortly prevail in typical American engineering colleges could be made to extend down through the preparatory schools, how many of our problems would be solved?

Chairman PRATT. Our time is coming pretty near to an end; in fact, we have gone by our hour.

Before closing there is just one thing I would like to hear from Dean McCaustland, if he will be good enough to give expression to it. I think the dean has made a very excellent presentation of the problem which is confronting every engineering faculty. No one who has the love of engineering and its best interests at heart is prepared for one moment to sacrifice what might be termed pure engineering for commercial ends, nor is it necessary to do so. Everyone, however, recognizes that among the large number of young men who go through our educational institutions from year to year there is a great diversity of character and of purpose, and that the course which is going to develop one type of man with one purpose certainly will not develop another type of man with another purpose. Probably the deans of our engineering schools at large would consider themselves unworthy of their vocations and responsible positions if they did not hold to the idea that they are there to teach engineering in its highest forms.

Accepting that, perhaps, as a fair premise, we then agree that the engineer would function more thoroughly and effectively if he could, in his course of training, get a better appreciation of economics and of their relations to the business and undertakings with which he is to be associated.

The proposition has been made at an earlier conference that, working toward such ends, it would be desirable, if practicable, to devote 12 to 18 semester hours to the subjects of general economics, cost accounting, business organization, business law, etc. I presume there is practically no course in the land to-day that does not devote a certain number of hours to those subjects, to one or all of them.

At the last conference it appeared that, as far as we were then advised, there was only one college which approached that schedule, although there may be others. The dean of the Pennsylvania State College, I believe, showed that he did then have 12 semester hours devoted to those subjects, and felt that he had gone pretty well to-

ward the practicable limit without sacrificing things which he regarded as fundamental to engineering.

Have you, Dean McCaustland, tried to make a quantitative analysis of this project? Have you thought of it in terms of semester hours? In other words, do you believe it is possible to devote from 12 to 18 semester hours to those subjects without making an unwise sacrifice of other subjects?

Mr. McCAUSTLAND. Our faculty has been considering the question for some time before this matter was brought up by the Bureau of Education, and at our last meeting it was decided that we would find very little difficulty in raising it from 12 to 15 hours in the curriculum.

Chairman PRATT. That is very interesting and, I think, very encouraging.

Gentlemen, we have three other sessions and I think we should not attempt to go too far in this session. Unless someone desires to say something more I will declare the conference in recess until 2.30 o'clock this afternoon.

AFTERNOON SESSION.

Prof. J. W. Jenks, of New York University, presiding.

Chairman JENKS. The time for calling the meeting to order has already passed. Dr. Swiggett has received a notice from the chairman of this afternoon, Mr. Hurley, that, owing to public business, it will be impossible for him to be present with us and to preside. In consequence, Dr. Swiggett has honored me by asking me to call the names of those who are to speak this afternoon.

It is perhaps well, also, for us to keep in mind before the first addresses are made that the topic of the afternoon has a somewhat different viewpoint from the topic of the morning; so that as the various listeners are preparing to criticize severely the speakers of the afternoon, they might well note that.

This morning the topic was "Business training for the engineer." We were supposed to be looking at the question from the viewpoint of the engineer and the advisability of getting a certain amount of business training for him as an engineer.

The topic for this afternoon, you will note, is "Engineering training for commercial enterprises," and the point of view is that of the business man. We should, then, look at it from that viewpoint and see how well equipped a person with engineering training would be to undertake an important commercial enterprise. That, I am informed by the maker of the program, is the essential difference between the two topics.

The first speaker this afternoon is Mr. Walter Rautenstrauch, professor of mechanical engineering, Columbia University.

ENGINEERING TRAINING FOR COMMERCIAL ENTERPRISES.

By WALTER RAUTENSTRAUCH,
Professor of Mechanical Engineering, Columbia University.

As our chairman has very clearly brought out, there are two subjects before us to-day—the business training desirable for men who are to enter the engineering professions, and the kind of engineering instruction which should be given to those who contemplate entering our commercial enterprises, such as manufacturing or public service.

I think there are two distinct fields contemplated by these subjects, and if I may I would like to bring out some points which occur to me in reference to the first topic which was discussed this morning.

I feel that there is a distinct need and there will continue to be a distinct need for professional engineers—mechanical, electrical, civil and sanitary. I think it is a mistake to train these men for managerial positions. I think a mistake is likely to be made in some institutions in forgetting that there is always a demand for the distinctly professional type of mechanical and electrical engineer. The successful practice of any branch of engineering demands, however, a certain viewpoint which may be termed the business viewpoint or commercial viewpoint, and therefore the student should be taught the practice of his profession with a view to the economic significance of the things which he does. It would seem, therefore, that any business training for engineers requires not additions to the curriculum, but, as one speaker brought out very clearly this morning, it requires the teaching of economics in every engineering subject; in other words, it requires the economics or business or commercial point of view.

When a commercial enterprise is reorganized in order to put it on a more substantial business footing, that reorganization very rarely consists in any addition to the existing organization, but rather consists in an entire regrouping, in the creation of a different point of view, in the occupation of new ground; and so it occurs to me that if there is any revision in engineering instruction desired, that revision must take that form.

We can not hope to turn out men who understand the commercial point of view in engineering practice by giving them certain courses in business practice, but rather the economic theories underlying engineering procedure must be taught in the courses themselves.

By way of illustration, take the subject of pattern making which is taught to our students in mechanical and electrical engineering. We very often find that that instruction consists in teaching the student how to acquire a certain amount of technique in manipulating tools to make wooden or metal patterns. How much more valuable it would be, and how much more to the point, if it were taught that patterns are made in a variety of ways and the way in which patterns are designed and constructed depends upon conditions of use in manufacture and the maximum return which can be gotten out of the investment in the pattern and equipment.

The same situation obtains in the problem of bridge design. Many of the courses of instruction in bridge design and structures are very excellent so far as technique is concerned, and the students learn a great deal. What the engineer has to do is to determine what type of structure should be erected in this particular place or in that particular place with minimum investment and minimum upkeep charges. That is the engineer's problem; and it seems to me

that when you introduce that kind of viewpoint in the course of bridge designing we are giving the kind of business training which an engineer should have.

The same thing arises in the subject of machine design. A great many good courses in machine design are being given, but not always from the viewpoint of the economic adaptability of the machine to produce goods. A machine is built to sell, and it is purely a commercial enterprise, and its success does not depend so much on the question of stress analysis as to whether or not it is an economical proposition for one to have. It seems to me that when that point of view is introduced in our courses of instruction we will be making rapid strides toward getting the kind of business training which an engineer should have.

There are several obstacles in the way of a universal introduction of this sort of instruction in all of our engineering schools, and one of the chief of these difficulties is the man power difficulty. I have not very much sympathy with paper work. As I was telling Prof. Jenks this morning, one of the instructions that I like to give a man who has something to do for me is to go ahead and do it and not give me a report about it. I don't like reports; I don't want reports. I want the thing done. We are so much inclined, I think, each one of us—it is quite a common feeling—to think that the definition of a problem is its solution. I think we are all more or less constituted that way.

One of the big problems is man power, to get the right kind of men. I do not care whether you give eight hours to economics or three hours to economics or two hours to banking; if you get the right kind of power behind the courses of instruction and the right point of view and the men who can impress the student with the proper point of view and develop the character of the man, you are making all proper strides toward the development of good engineers.

The problem can not be solved very rapidly because of the economic pressure of our educational institutions. I was talking with a gentleman not very long ago with regard to the results being attained in one of our Government departments which is supposed to carry out a certain amount of research work, and we both agreed that the results coming from this department were not as satisfactory as they should be; and after discussing the various phases of the problem someone I think very aptly put his finger on it. He said, "They are paying $1,800 for the men who are doing that work and they are getting $1,800 results."

There, I think, gentlemen, is one of our chief problems. We are hoping to engage men at $2,500 and $3,000 a year, perhaps more and perhaps less, to present these broad viewpoints, to do these things, to train our men to a proper conception of engineering

practice, when the commercial houses will pay them $10,000, $15,000, and $20,000 a year. Until we get to the point where we can pay these salaries we are not going to get the men.

Unfortunately, engineering schools are laboring with a difficulty which the medical and law schools do not seem to encounter. An engineer has to sell his proposition. It is a selling game. You go to a physician, and the physician writes you a prescription. You do not ask him questions. You may inquire in a general sort of way, but, with absolute confidence in what he has written, you go to a drug store and get your prescription filled and take the medicine. You go to a lawyer in very much the same spirit and follow his advice.

The engineer has entirely different problems to solve. He has to meet a board of directors and explain to them all the fine points involved in his idea, in his report, and he has to convince them that what he has is an economical proposition and one in which they should invest. That is the peculiar thing about the engineering profession as a practice; and from the educational point of view it has the same peculiarities.

Our second topic, the one which we are considering this afternoon, is concerned with engineering training for the business executive.

We have had commercial colleges for a number of years; in fact, I think since 1875 the commercial college has been an institution recognized as capable of training men for commercial enterprises. Engineers have been trained for professional practice for quite a period of years. Now we begin to realize that there is a great middle ground to be occupied, that ground which encompasses both engineering problems and commercial problems. We are beginning to realize that those in control of commercial enterprises, particularly the productive enterprises, manufacturing, must have a knowledge of the things they purpose to control. Quite a simple matter when you think of it, but it has taken us a long time to get around to it. We would not put a man in charge of a hospital unless he knew something about medicine and sanitation; yet we very often find that the men in charge of our large productive institutions, our manufacturing institutions, have come up from the sales organization because they have been prominently identified with that phase of the business which stands out very clearly as the money-making side. A man having been successful in organization of sales is very often made the head of a manufacturing institution, and quite successfully so. But even though he has made a success, that necessarily does not deny the fact that he would be a very much better manager, that he would be very much better fitted to control the institution if he knew the technical side of the business.

So I would take it that the managerial talent which is demanded in our commercial enterprises is that managerial talent which is

able to appreciate the technical processes upon which the industry is founded. The manager must deal successfully with those in immediate charge of the processes; be acquainted with the commercial and economic side of business affairs, so that he is able to understand a balance and income sheet and be able to understand the significance of certain items there as to the general conduct of the business. I would say, also, that he should be very well informed on social and labor problems, because, as we know to-day, that is one of our big problems. It seems to me that any course of instruction that is designed to train men for managerial positions must occupy this ground, must encompass this group of subjects.

Moreover, there is that factor, that aspect of the problem which somehow is very difficult to formulate in any regular course of instruction. It can not be defined except perhaps on the basis of character. But there is that thing which enables a man to get others to work together. That, by far, is the biggest factor in management. A man may not be well informed on technical problems or economic and commercial problems, but his success may be quite large because of the fact that he can inspire the confidence of others and get them to work with him. That can not be taught very well except as men may come in contact with real souls and spirits in the university and get from them not by formal instruction, but simply by contact and living with them and being with them, that thing which will develop within themselves that spirit and attitude toward mankind. And that, it seems to me, is one of our big factors.

This seems to be a sort of experience meeting. Several this morning have referred to what has been done in different institutions, and so, while I had not contemplated calling attention to this, it occurred to me that perhaps it might be valuable to refer to what is contemplated at Columbia University in the training of men for managerial positions.

Columbia University some years ago established its engineering school on a graduate basis. Three years of college training are required for entrants to the engineering school, and the course of instruction in the engineering school is of three years' duration, so that a man graduating from the high school will require six years for graduation from the engineering school.

It is a mistake to set this up as an ideal. It would be absolutely foolish for every university in the country to come to a six-year basis. I would not advocate it for one moment, but I believe there is need for that sort of thing. I think perhaps one or two institutions can establish a six-year course and can do so quite successfully, but the great demand is going to be for the four-year course, without doubt.

After having had three years in the college, in which the fundamental topics of economics and physical geography are dealt with, so that the man knows the sources of raw materials, a course in the engineering school which we purpose to give them under the supervision of a department of manufacturing, will deal with these kinds of problems. There will be two years of instruction in accounting. I might remark by the way that I should be very pleased to have this course incorporated in the minutes, so that each of you, if you care to, may study it in detail. But I will give some of them now.

A two years' course in accounting will instruct a man in the technique of accounting, and in it he will learn what kinds of things are essential to account for and how the accounts should be drawn up. I am more interested in that. Accountants are quite numerous. There are quite a number of people who can deal with a simple account by keeping records on cards; but the man to find is the man who can determine what kinds of things are worth while accounting for.

Perhaps that might be well illustrated by the story of a young man who was engaged by a hotel corporation to draw up a system of accounts. After some days of effort he presented his report to the manager. The manager looks it over carefully, and the president of the company remarked that he was much pleased because the accounts went into great detail, but he said, "There is one very important account that I do not see; we can not run our business without that." The man was very crestfallen. "You have not accounted," the president said, "for the beefsteaks per mouthful per guest"—which is just about as valuable in the hotel business as it would be to you and me.

The technical foundation upon which this work is based has this principal feature. I believe that no course intending to train men, particularly for the manufacturing industries, can succeed except that it is well founded technically. I do not believe a man has any business in manufacturing institutions unless he is thoroughly grounded in the fundamentals of the technique upon which the manufacturing is based. I think it is a mistake to proceed from any other standpoint.

So we have courses of instruction in machine design that proceed not wholly from the standpoint of stress analyses, but also from the standpoint of economical manufacturing of the machine. Unless the machine is designed properly, unless a series of machines is designed properly, the manufacturer can not conduct his business economically. So that machine design taught from that point of view is the kind of machine design, it seems to me, that should be

given to the man who purposes to go into this kind of work. In fact, I think it should be given to all classes of engineering students.

I find that it is one of my big problems in the commercial enterprises with which I have been connected to start in the designing room. The cost of manufacture is high because the design has not been properly conceived.

We teach the subjects of metallurgy and engineering problems from the standpoint of thermodynamics. I do not mean the thermodynamics of a steam-engine cycle or gas-engine cycle, and all that sort of thing, but I mean the problems of heat, the problems of thermodynamics which arise in the carrying out of an industrial process. We are devoting a considerable portion of our time to engineering problems.

The other groups of subjects which stand out quite prominently in this curriculum are the labor problems and problems of employment and management. Quite fortunately we have at Columbia a group of men in the school of business who have given considerable attention to these problems and we are able to draw on them for instruction in this school without very much expense. That is one advantage which a university has over a strictly technical school. The problems of factory management, that is, what is ordinarily called works management, are dealt with, as is also factory construction and equipment.

Then we purpose to devote a considerable portion of the time to a group of subjects which all together may be termed manufacturing processes. It is intended to take up such problems, if the student is going to go into the metal-working industries, as the design of dies and fixtures and those equipments which bear such intimate relation to the economics of production.

I think our engineering schools are rather lax in that particular phase of engineering work; so that by these means, by the teaching of this particular group of subjects, technical, social, and commercial, we purpose to train men who can enter successfully the manufacturing industries.

I should be very pleased to have criticisms from any of you on this outline and would be very glad to have your correspondence at any time you care to favor me with it.

In closing I want to emphasize a point I brought out at the beginning. I do not believe our interests should center in hours of instruction in this subject or that subject, but our interest should center more in the proper aspects of the problem, the point from which these problems should be attacked, first; and, second, the kind of men who should teach that. I think if we have those two problems solved, all these other details will take care of themselves.

(The proposed courses which Mr. Rautenstrauch requested to have incorporated in the record are as follows:)

MANUFACTURING AND INDUSTRIAL ENGINEERING.

Based on a three-year college course.

FIRST YEAR.

Winter session:	Hours.
Bus. 89. Economic History of United States	2-0
Bus. 23. Principles of accounting	2-0
Bus. 209. Principles and methods of statistics	1-6
Bus. 51. Principles of money and banking	2-0
Ch. E. 161. Engineering and fuel chemistry	0-6
Ch. E. 181. Industrial chemistry	3-0
Met. 133. Metallurgy of iron and steel	2-0
Phys. 149. Physical laboratory	0-1
Mech. 103. Statics and dynamics	3-0
Total	15-15

Spring session:	
Bus. 90. Economic History of United States	2-0
Bus. 24. Principles of accounting	2-0
Bus. 210. Principles and methods of statistics	1-6
Bus. 154. Banking and foreign exchange	2-0
M. E. 102. Power	4-0
M. E. 104. Machine elements	4-6
Met. 156. Metallography	0-3
Total	15-15

Summer session: Manufacturing.—Eight weeks' service as apprentice in a well-organized factory. Directed study and report.

SECOND YEAR.

Winter session:	
Bus. 25. Advanced accounting	2-0
Bus. 71. Business law	3-0
Ec. 105. Labor problems	3-0
C. E. 155. Strength of materials	3-3
M. E. 120. Engineering thermodynamics	2-0
M. E. 161. Mechanical laboratory	0-3
E. E. 101. Principles of electrical engineering	4-0
M. E. 171. Machine design	0-6
Machine tools	0-3
Total	17-15

SECOND YEAR—continued.

Spring session:		Hours.
Bus. 26.	Advanced accounting	2–0
Bus. 72.	Business law	3–0
Bus. 46.	Corporation finance	2–0
M. E. 121.	Engineering thermodynamics	2–0
M. E. 162.	Mechanical laboratory	3–0
M. E. 124.	Machine analysis	4–0
M. E. 172.	Machine design	0–6
E. E. 118.	D. C. laboratory	0–3
	Machine tools	0–3
	Total	13–15

Summer session: Manufacturing.—Eight weeks' directed study and analysis of productive methods in a well-organized factory.

THIRD YEAR.

Winter session:		
Mech. Eng. 15a.	Factory management	2–0
	Factory construction and equipment	2–3
Mech. Eng. 167.	Manufacturing processes	6–0
	Employment management	2–0
	Analysis of selected industry	2–6
Specifications and preparation of productive methods		1–6
	Total	15–15

Spring session:		
Mech. Eng. 160.	Factory management	2–0
Mech. Eng. 168.	Factory construction and equipment	2–3
Manufacturing processes		6–0
Employment management		2–0
Analysis of selected industry		2–6
Specifications and preparations of productive methods		1–6
	Total	15–15

Chairman JENKS. I recall a little conversation that I had a number of years ago with a business manager which brought out in a most striking way the relative importance of men who were trained in the human side of managing business and the technical man, a point which I think ought to be brought out in the discussion very fully. This man that I am speaking of was not a polished man; he was not even a high-school graduate, but he did understand human nature, and he was a very successful manager of a large business. One day I happened to be speaking with him about training for business, and he said, "The essential thing, of course, is to know men. It is very easy to hire a chemical engineer. I can get a man for three or four thousand dollars any time I want who will solve any technical problem whatever; but to get a man who knows men, who knows what a day's work is and how to get that

day's work out of men and still keep them good natured—there is the problem." He said, "I am hunting for that man all the time and I have not found just the man I want, yet."

And he went on and gave me various illustrations.

I was very much interested in what was just said about the human side of business problems, and I trust that the technical side will be brought out a little bit later even more strongly.

The next speaker of the afternoon is Mr. E. F. Du Brul, president of the Pyro Clay Products Co., of Cincinnati.

Mr. DuBrul. I am very much interested in the various phases that have been brought up in this conference because I have had personal contact with all of them. I can appreciate the teacher's phase, particularly that of a teacher in a college of commerce, because I conduct a course on industrial organization in a college of commerce. It is just a sketchy, general course that bears rather strongly on the engineering side of commerce. So that the teacher's point of view I can appreciate thoroughly.

I can also appreciate the manufacturer's point of view, because that is the way I make my living.

I can appreciate the student's point of view from having had an education that was more along commercial lines than along engineering lines, although both of the industries that I am managing are engineering industries. One is a chemical industry, a firebrick business, and the other a mechanical industry, manufacturing specialized machines.

I have been in very close contact with the technical school, because for six years I was a member of the board of directors of the University of Cincinnati and chairman of the engineering college committee. During that time the cooperative course was installed there by Dean Schneider, and I am very proud of the fact that I had a good deal to do, from the inside of the board of directors, with getting that course installed.

I took a course in law under a very good lawyer, who, later, became chief justice of the Indiana supreme court. He told us as students of law that there was one kind of law that we absolutely had to have at our fingers' ends, when we came to practice, and that was the law of evidence, because that was needed from minute to minute in a trial. The next, in importance, was the law of pleadings. He therefore drilled us on those two subjects very thoroughly. But as to all the rest of the great mass of law, he said, "No man can remember it all, but you have to know, in a general way, what it is, but one particular thing you have to know about it is, where to find it when you need it." So with engineering knowledge for commercial men.

ENGINEERING TRAINING FOR COMMERCIAL ENTERPRISES.

By E. F. DuBrul.
President, Pyro Clay Products Co., Cincinnati.

Modern development of business implies increasing use of mechanical and engineering equipment in every line. Whether it be a shoe factory, a cigar factory, a cannery, textile mill, cement works, or what not, the lay-out and operation of the plant are important elements in its success. Lines of business that, years ago, were not considered as "coming" in the engineering field are now important inclusions, for production engineering is as wide as production itself.

Many a business has been promoted, capital raised, and a plant built, only to fail of success because the plant was not properly constructed. Only recently there was notice of a large cement plant in South America whose operation was delayed for months because of improper design and erection. It is astonishing how much of this sort of loss is prevalent all over the world, loss that would be prevented if commercial men knew enough engineering to call a good engineer into consultation at the very beginning of their project.

The keener competition becomes in any line of business, the more need of engineering knowledge applied to commercial enterprises. This fact is so self-evident that it is almost inconceivable that new enterprises should be started without first using the services of engineers; yet it is done frequently.

The technical journals in any line of business all carry professional cards of engineers skilled in that particular line. The textile journals carry the cards of mill engineers; iron trade journals the cards of steel works and blast furnace engineers, and so on almost without end. Yet, in spite of the availability of this sort of service, new concerns spring up without availing themselves of the engineering service, but based merely on the say-so of either a commercial, or, perhaps, a "practical" man in the industry, and as a consequence many of these plants are foredoomed to failure.

It is another self-evident fact that commercial training is as necessary for engineers as engineering training is for commercial men. If the engineer is to render his best service, he must be able to advise his client as to the proper amount of capital required to conduct a business of a certain volume in his particular line and also as to the cost of production in the plant he is designing. Mistakes are not all on the part of the commercial men in starting commercial enterprises. Often engineers, called into consultation, do not have proper appreciation of commercial questions. I have seen them undertake projects with available capital only sufficient to build the physical plant and equip it but later find themselves short of working capital. The most common cause of business failure is lack of working

capital, as all credit men know. Merchants and manufacturers get themselves tied up with no ready funds at hand or in reserve. Some financial stringency comes along and they can not weather the storm. Their fixed assets can not be turned into cash to pay their current bills. As a consequence, they go into the hands of a receiver, and the fixed assets are sold at a sacrifice, to the loss of all concerned.

Engineering training is deficient if it does not include enough financial training to enable the engineer to see when he needs good financial advice, and, conversely, commercial training is deficient unless it includes enough of the fundamentals of engineering to enable the commercial man to recognize a situation that demands engineering advice.

Courses in both engineering and commerce as heretofore offered in the schools have been greatly deficient in this respect. Some may say that there is no time to cover engineering subjects in connection with the requirements of a commercial course. May it not be that perhaps the course is too detailed, and unduly neglects collateral subjects that are important to the future graduate? We may not be prepared at this time to point out how far various courses should go in substituting some subjects at the expense of others heretofore deemed important. I should say, for example, that if one were to train a shoe-factory engineer, one might well only barely sketch out the theory of thermodynamics. A thorough knowledge of thermodynamics is essential to the designer of a steam engine, but a profound knowledge of that subject would be of little direct value to a shoe-factory engineer. A prospective shoe-factory engineer might better employ part of the time that in the ordinary engineering course is devoted to thermodynamics to acquiring at least some knowledge, if only a sketchy outline, of the fundamental principles underlying the financing of an enterprise. Conversely, a college course in commerce, when analyzed, may be found to include highly technical subjects that might have as little application in the commercial side of a shoe factory as thermodynamics has to the production of shoes. Such subjects, when found, might well be rather sketchily handled, and the time saved thereby be devoted to giving the prospective shoe-factory executive at least a sketchy knowledge of the problems of shoe production.

Engineering schools, in the course of time, found the field of engineering to be so broad that it called for diverse courses in the schools. An engineer is no longer expected to be expert in all lines of engineering. The old-time civil engineering has been divided, and one now finds railroad engineers, bridge engineers, sanitary engineers, water supply engineers, hydraulic engineers, mining engineers—all outgrowths of the original profession of civil engineering. In the

same way, the mechanical branch has been divided; one finds the power engineer, the production engineer, heating and ventilating engineer, refrigeration engineer, auto-motive engineer, etc. So it has gone with electrical engineering, where the telephone engineer does not undertake to design a generator for a Niagara Falls power station.

Must not the commercial schools surely find that instead of attempting to train a man for executive work in any kind of business, they must be content with the training of executives for the machinery industry, or for textile industries, or for the chemical, paper, shoe, tobacco, or some other definite group, just as the engineers have done?

Many a good research accountant thinks it a simple matter to lay out a cost system. I have seen one such that cost the client $7,000 but was not in practice worth 7 cents. Cost keeping is not purely an accounting matter, nor are cost methods universal to every industry, except in fundamentals only. A man to be best qualified to lay out a practical cost-keeping system in a given line of industry or even for a given establishment, must be familiar with the production features of that industry, and perhaps of the very establishment itself. He need not be a mechanic, nor a production engineer in that particular line, but he must have some general knowledge of the production problems of that line in order to lay out most intelligently a cost-keeping system for that line. In like manner, a salesman ought also to have some knowledge of the processes of production of his goods to be most efficient in his selling capacity.

For some time past economists have been forecasting the growth of a new profession, that of consulting economist. The germs of this new profession are already evident in the service of public accountants and so-called business doctors.

The consulting economist will probably develop along parallel industrial lines with the consulting engineer. He will have fundamental knowledge of general economics, will know the general principles of finance and their application, but he will specialize for the same reason that a consulting engineer must be a specialist to be of value. Perhaps the day will soon come when consulting engineers' offices will include consulting economists with some engineering training, and later, consulting economists' offices will include consulting engineers with some commercial training.

Does not the best executive in any line of business combine these two functions? Up to now he has come up either as a production man or as a commercial man. If originally a production man, he has acquired by himself the commercial knowledge that makes him a successful executive, and if he started as a commercial man, he has acquired, in perhaps an illogical and haphazard manner, enough

knowledge of engineering to know when he needs an engineer and to know how to pick out the right man for his work.

After all, does not the training of the officers of the United States Naval Academy reflect in a manner what we should definitely strive for in commerce? The general foundation is given the cadets in all branches of engineering and operation, so that when the cadets finally specialize, those who become fighting and navigation officers know what the engineering officers are talking about when ship construction and operation are discussed, and vice versa.

When we do have some engineering training for commercial men and some commercial training for engineers, both will better recognize their own limitations.

It gives me great pleasure to call the attention of this conference to a definite movement along this line. Many of those present know of the cooperative course in engineering that has been so successfully operated by the University of Cincinnati for a number of years past. This is a five-year course, and in general may be described as a half-time course—that is, the students work in pairs and spend alternate periods of two weeks, one student in the shop and the other at the university. At the end of two weeks they change; the one at the university replaces his partner in the shop and the one who was in the shop takes his turn in the university.

Recently it was decided by the board of trustees of the university to combine the college of commerce with the engineering college. Dean Schneider and the faculty are now studying the very question of giving some production training to the students of commerce. They are now working out a program that, while not definitely formulated, yet as far as general outlines go will provide that the commercial student spend the first two years of his five-year course in doing about the same sort of work that a cooperative engineering student has been doing during his first two years. In other words, he will receive shop experience of some sort that in after life will enable him to understand what the production men are talking about. At the university he will receive general instruction in fundamental sciences, so that later in life he will know something of science as applied to industry.

Personally, I have no doubt that the engineering contact given to the commercial students will have a reaction on the engineering courses, and that ways and means will be devised to give the engineering students more contact with the commercial side of industry.

We are very proud, in Cincinnati, of the fact that our university, under the leadership of Dean Schneider, was the first to recognize the possibility of giving both practical experience and theoretical

training to a young engineer. We are now proud that our university will be the first to do the same thing for the commercial student. Not only that, but it will be the first to give any engineering training to its students in commerce. I have no doubt that later on it will also be the first to give commercial training to its engineering students, in addition to the practical shop training they are now getting.

(Dr. Jenks yielded the chair to Mr. W. E. Hotchkiss, director of business education of the University of Minnesota.)

Chairman HOTCHKISS. I have the honor to be directing a business school at the University of Minnesota, or rather a division of business education. Our business school does not go into operation until July 1st of this year. It was created last week.

I am deeply interested in the subject as announced. I have been very much interested in hearing the discussion this afternoon. It raised in my mind a question which seems to me rather fundamental. Are we going to approach this matter of orienting the engineer on the business side of his problem and the man commercially trained on the engineering side from the standpoint of information or from the standpoint of discipline?

It is a matter of great importance to us, who are responsible for courses of study, how far we can go in orientation of an informational sort in the different things which a man may have occasion to use when he goes out into business.

This leads to another question, and that is whether or not our idea in giving engineering instruction to men who are training themselves for business ought to be to give each particular man some foundation in the particular specialty he is looking toward or whether to see that every man goes deeply enough into some particular phase of engineering work so that he may get the engineering point of view. In other words, if he gets the point of view will he not be able to use what he has obtained, whatever his specialty? Has not our study in the last 5 or 10 years brought us to a pretty complete realization of the fact that our approach to the questions of business administration has to be from the standpoint of likeness rather than from the standpoint of the difference?

A grocery store, a telephone company, a railroad, a department store, and a manufacturing plant are very different lines of business enterprises. Likewise with different kinds of manufacturing plants. Superficially, the differences are very much more apparent than the likenesses; but when you come to study them more closely from the standpoint of fundamental principles of business organization and management they are not so different as they appear. They all have to buy goods, they all must keep accounts. They must employ

labor. They all have occasion to see that the industrial relations in their plants are maintained upon some fundamental basis of industrial good will. So with the whole gamut of the things we include under business organization and management. Is it not true that when we get down to the real fundamentals, likenesses are very much more important than differences? Finally, if that be true, is not our real task to get our student of business to realize what the engineer's problem is, and how he has to recognize it? Is not the orientation we are after something which can not be achieved as a matter of information in a great variety of engineering problems? Is it not, in a word, a question of learning to appreciate and evaluate scientific method as applied in the engineering profession? I am not an engineer, and I am speaking purposely in the form of interrogation, but this is a question with which directors of business courses have to struggle.

I see my good friend Prof. Flather sitting back there. I have not discussed the subject with him or with the engineering faculty, but I hope the two schools will be able to work out some sort of cooperation. Every one who has any responsibility for business training in universities, where there is a possibility of cooperating with engineers, has to think very hard upon this question, what should be the basis of cooperation.

Naturally, if a man has in mind to go into the manufacture of a particular article, he will be inclined, and rightly, to follow a few basic courses in engineering, with something that he thinks will be of particular value in the line of business which he expects to enter. But the question arises in my mind whether that work will be entirely lost if he decides to go into something else. Here is a point that we in America have to think of particularly. A great many men have had to adjust themselves to a very different sort of career from what they expected, and American business men and engineers have shown real greatness in this regard. Our engineers have been conspicuously adaptable.

This adaptability is a national asset which should be preserved. When a man goes deeply into a subject from the standpoint of fundamentals, he develops a method and approach which is by no means lost when he has occasion to go deeply into something else. Furthermore, the very adaptability developed in applying his training in his new field is itself an asset.

If information is what the student has been stressing, it is largely lost when the man makes a shift. An entirely different sort of information will be needed in the new field.

Featuring likenesses instead of differences appears to me fundamental, likewise emphasis on discipline and thought processes rather

than information. However, I am not trying to answer questions but to raise them.

I hope there will be a large participation in the discussion. The subject is now thrown open. We have something like an hour for the general discussion, and I will ask you, each one, as you arise, to please give your name and where you come from, in order that we may keep the record straight.

Mr. BUTLER. I want to express my gratitude to Prof. Rautenstrauch for expressing so clearly and convincingly my own view of the proper solution of this problem which I believe concerns us all so strongly.

Many of us are deans of engineering and we are extremely anxious that our own institution shall take a leading position in any new movement that may be on foot. We do not want to lag behind, and I am very much afraid that some mistakes are going to be made by some of us unless we do give proper consideration to all phases of this subject.

When I first knew that this conference was to be held, or shortly thereafter, I had an opportunity to talk with a gentleman in my State who occupies a position of great authority. He is an administrator, an executive and organizer, the peer of any in the country, a man who deals not in hundreds of thousands or tens of thousands, but millions, and is a technical graduate. I asked him what he thought of the whole proposition of teaching the industrial applications of engineering and what he thought the engineering schools ought to do to meet the problem that seemed to be presented. He said a number of things that I want to pass on now to you. In the first place he pointed out that in his own experience he felt safe in saying that he needed 50 professional technical engineers to every one executive and that it would be folly for all of the engineering schools in the country to turn their attention entirely to training executives—that by so doing they might fail to meet the need for the technical men.

I assured him I did not think that was the intention; but let us be careful that we do not so modify our courses that we do not give the men proper technical training.

I said further, "What do you think of a four-year course in industrial engineering for the high-school graduate who wants to become an executive?" He said, "I do not believe that there is any high-school graduate that knows, when he leaves high school, that he wants to become an executive. I do not think he is in a position to choose then."

As a matter of fact, we all know that mighty few of them are in a position to choose whether they will go into that line or not.

He said also:

I think you ought to have five-year courses, or, better, six-year courses, if it can be done satisfactorily. You may make good engineers out of them and give them industrial training in six years, but not in four years.

Then he went on and talked more about the subject, and, incidentally, pointed out something I am sure most of us will agree to, that is, if we try to put in 12, 15, or 18 hours of industrial or economic work in our engineering courses, there are going to be a lot of mistakes made. Why? There are a number of reasons. In the first place, I believe most of you will agree that the majority of the engineering students do not want those courses. They are foolish; we will admit it, but they do not want them. They do not want English courses. More foolish are they, and they will realize it after ten years, perhaps. They do not want social courses. Again they are foolish, and perhaps they will realize that. But the fact remains that the students do not want the humanitarian courses. We have got to drag in this work incidentally if it is going to do our students good.

There are a few schools in this country so fortunate as to have teachers of English who can make their English courses popular with the students. I wish there were enough teachers of that kind to go around among all the engineering institutions. There are a few who make economics so pleasant that students prefer that course to something else. In a great majority of these courses which the students certainly need and must have they do not do so much work nor so good work as in the courses in which they are interested, and if we have too many of such courses it is going to mean a lowering of the standard of our work.

Also I think, in many cases, that if we put in 10, 12, 15, or 18 hours of industrial engineering work in our courses and label them plainly "industrial engineering" we all realize we have got to take something out. In some courses it may not be so difficult. There are many elective subjects, and you can put in a certain amount of work simply by eliminating some of the elective courses. In many others there are practically no elective courses.

My own experience with mining engineering has shown me that the course is so broad, so comprehensive, that you can not put in 12 hours without taking something important out. I do not think that in most cases we are actually going to take it out, but we are going to combine with other courses and we are going to cut down the amount of work in other courses, and that means that we are not going to give as broad training in those other courses. Any such change affects the fundamentals, because we can only give fundamentals in the mining engineering course. We are all urg-

ing a greater breadth of training in fundamental courses; but if we are going to put this course in we are going to introduce just the opposite effect, less breadth and training in our fundamentals.

In many cases the courses as taught under the subject of economics or industrial training or anything of that kind are going to be separated from the engineering subjects.

The illustration was given to-day about some young man who did not realize until the problem came up to him that there was any real application to his study of economics. If you give your course in one department as economics, in many cases the young man is going to gather the idea that it has no direct application to his engineering work. That will not be true in every case, because some of us are fortunate enough to have teachers of those subjects that will show to the men the application as they go along; but there are not enough of those teachers to go around. We have got to show them that there is a direct connection between their technical subjects and their industrial subjects, and that is not going to be done if those subjects are taught in separate departments, in many cases, at least.

I do not want you to get the idea that I am talking against humanitarian subjects in engineering courses. I am convinced that one of the greatest handicaps under which engineers start is the lack of these subjects. I believe that the reason why European engineers are much more highly regarded in their own countries, why they occupy positions of greater authority, why their advice is sought by great government commissions, and so forth, is because they are cultured gentlemen first and engineers second; I am afraid in this country too many of our engineers are engineers first and not much second.

You can not make men like that in four years, and they are not doing it in Europe. We have decided in this country to make our college course in engineering four years in length. You can not do everything in four years. We have decided to make technical engineers in four years, and we are doing it. We are turning out first-class technical engineers, but you can not do much more than that. If you try to train industrial executives and engineers, too, in four years, you are going to get a mighty poor product in both lines. But you can do what Prof. Rautenstrauch suggested, and that is what we are trying to do. We can give an economic meaning, an industrial meaning, to the technical subjects, and I believe that is the best way to handle the proposition in a four-year course. You can consult with your faculties and insist that your faculties handle the work in this way, and, if they do not do it, you can get others who will, but you can easily go too far along this line in a four-year course.

Some of the students may find that at the end of their four-year course they are interested in the industrial phases of the subject, and then you can provide for them graduate courses along those lines. I believe that is the best solution of the problem.

Chairman HOTCHKISS. Is Mr. McRae, of the Missouri School of Mines, in the room?

Mr. MCRAE. Yes.

Chairman HOTCHKISS. Have you not something to contribute to the subject?

Mr. MCRAE. I came to this meeting for information. What I have to say will refer to the topic under discussion this morning. We have been gradually introducing economics in our curricula. Our professor of mining gives economics of mining and mine management, also a course in mining law and engineering contracts. Our professor of metallurgy gives a course in metallurgy plant which includes some economics. Chemical economics is given by our professor of chemistry to chemical-engineering students. Our graduates have urged us to give a course in accounting, so that the men will at least know how to keep cost accounts and make out monthly statements and annual reports. We have introduced a course called economics of engineering in our freshman curriculum, which will deal with the history of industrial development. We have been considering the advisability of establishing a separate department of economics and introducing courses in economics in the junior and senior years to replace the work given in the several departments as outlined above. The desirability of making this change is a problem that we are still debating, and it is information along this line that I am seeking from this meeting.

Mr. HIMES. The subject of the morning conference seems to be much the same as the one under consideration this evening. The difference in statement is the result of viewing the same thing from different angles. As engineers the question is what commercial studies shall the engineering students take. As commercial teachers the question is what courses in engineering are advisable for the commercial students.

The discussions have seemed disconnected because the subject is complex. The Commissioner of Education dwelt upon foreign trade and our duties in working out world problems. Another speaker dwelt upon the need expressed by his graduates for certain training in accounts, commercial law, and economics. A third finds that students who have the engineering type of mind and training do not readily learn the commercial and economic subjects. A practical business man, who manufactures brick and tile, has just addressed us and has pointed out the deficiencies of our graduates as measured

by the needs of his business. It would be an excellent thing if our teachers could more frequently meet these successful business men and discuss with them the problems of educating the nation's youth. So the subject seems to develop into a maze of complexities, but if we keep the problem in mind these various views will tend to simplicity. The problem is to train a group of young people for living and for earning a living. Even after a student has decided to study civil engineering there is such a variety of positions for him to occupy after graduation that the course in engineering must be general. When the pupil enters college he does not know that his first work after graduation will be in a brick and tile plant. His employment there is typical of our way of choosing a vocation. Most of us delay the choice until necessity forces us to take the first job we can get. Having thus accepted a job, the job gradually throws its tentacles about us and draws us away from the balance of the world and we wake up some day to find that we never decided to be anything, but that we are what we are through an accidental combination of circumstances.

As teacher, therefore, I ask, "How could I have trained the boy for your brickyard when he didn't know until after graduation that he was going to work for you?" I use the brick business merely to typify our practice. This is my point. You can not do effective teaching without a clear objective, and the vital point in that objective in the case under consideration is the choice of a profession or vocation. The initiative, the power, the interest, and the alertness generated by a definite aim in life are incomparably superior to the exhibitions by the average student who is "going through college." A study of human industry indicates that most young people are equally fitted or adapted to a wide range of callings. It is so important that the pupil choose early some life work that I could almost toss a coin to decide what it should be. Within certain wide limits the important thing for the boy is not what particular field shall be his life's work, but that he should decide on one, exclude the others, and henceforth see the world from the height to which he has climbed in his selected field.

This course would not lead to narrowness, as some have said here to-day. Let me illustrate. As a boy I lived in a small town that had a wonderful store. You could buy anything in it from pills and toothbrushes to plows and wagons. It was a general store, a wide store, so to speak. Later, I visited a large city, and in it I found a drug store. It sold medicines and kindred articles. At first I was inclined to think it was narrow, but on investigation I changed my opinion. It was a larger building than my general store. Its stock of goods cost much more money. It served more people and each

act of service was of a distinctly superior type. It was a very broad store.

The first great thing, therefore, in the training of our young people to useful citizenship is to develop a definite purpose in the mind of each. When this is done, there will be little difference of opinion on the content of the courses of study.

The training in how to live has been touched upon. A speaker said this morning that we should train broadminded, great-souled men, who sympathize with the efforts of mankind to live happily. Our papers and magazines are emphasizing commerce. There is a feverish anxiety to win our proper share in the world's markets in the readjustment now taking place, and there is little doubt that what we term our proper share others will call an unfairly large portion. So there is a real danger that we may lose sight of the real purpose in this striving after trade and commerce. We must teach how to live as well as how to earn a living. Our aim must be to develop the highest type of men and women.

Mr. PRATT. The gentleman expresses some diffidence about including the ladies in his remarks, because he addressed himself particularly to engineers. I thought he might be interested to know that in the company which I have the honor to be associated with, the General Electric Co., there are a few women college graduates who are participating in our engineering work and in the work of our research laboratory, which calls for a high degree of skill on the part of these young ladies.

Mr. HIMES. I am glad indeed that I made the remark in order that I might elicit the information that the gentleman gives.

Chairman HOTCHKISS. Is Dean Walker, of Kansas, here?

Mr. WALKER. Yes, sir.

Chairman HOTCHKISS. Have you not something to offer on the topic?

Mr. WALKER. I feel more like speaking on the topic of this morning, because I wanted at that time especially to bring in a point which other speakers did not bring in, but I gave up the privilege of making a speech. The point is that which was emphasized this afternoon by Prof. Rautenstrauch on the importance of teaching.

In many institutions we are not situated so that we have commerce specialists. That means that we can give in those institutions a course in the fundamentals of economics, of course, and in accounting, but we will have to fall back on ourselves in the faculty of the school of engineering to give the other touches and the applications.

I say we have to fall back on ourselves; but I am not sure but what it is the best situation that could exist, and I believe that in the development of character and of personality in our students we need to

depend, not on putting them into specialist courses, but that we need to place reliance on our own teaching. The right man teaching a subject—I do not care what it is, whether it is the most technical engineering subject or some branch of science, or whether it is economics or sociology—the true teacher, the right man, will develop in the student those qualities which we all appreciate. And so I believe that the problem for us, mainly, is to get teachers, to get the men who have the right view point to handle the work in all branches, if we are to develop the men who are needed

Now, Mr. Chairman, with reference to the topic of this afternoon, it seems to me that it is a double topic; in other words, instead of having two topics, one under the heading given this morning and one this afternoon, we really have three. What I have in mind is, first, the one supposedly discussed this morning, of the engineer who is to remain in the practice of engineering as it is defined from the technical viewpoint; secondly, we have the man who is trained primarily in the commercial side and who needs to understand something of engineering. That, it seems to me, is the man to be considered in the topic of this afternoon. But between the two there is another man—the man who is primarily an engineer but whose work will be such as to demand from him not only a knowledge of technique, but the ability to adapt himself to the needs of the business side of production work.

We have recommended to us from the conference which met on March 31 that in all engineering curricula there should be 12 to 18 hours of work in commerce. That was to fit the need of the first type of man. Then there is the further recommendation that there should be additional optional courses on the business side made. It seems to me that that is the training for the middle-ground man.

I believe that is an important branch. I believe, in other words, that we can give a man so much of the fundamentals and the practical applications of engineering that he will be capable of carrying the work of the engineer and adapting himself to the requirements of the engineer in technical work, and at the same time possess the necessary qualifications for the business side, so that he will become, with proper experience, an effective manager.

With reference to the University of Kansas, I am going to say, very frankly, that we are going slowly with regard to placing in the list of required work as much as the 12 or 18 hours recommended. As it stands at the present time, in the mechanical engineering course we are including 9 hours out of 138. In some of the other courses it is only 6. We are going slowly, I say, because we see a possible source of danger.

Suppose every institution in the United States turning out engineers should immediately make a radical change; because, barring

some of these institutions which have such specialized courses as those at Columbia University, and possibly one or two others, it will be more or less of a radical change to go immediately to that basis. We do not know for sure that that will be the wisest thing, and we are inclined to be conservative in Kansas. Perhaps that does not fit in with the popular impression that people have of Kansas, but, nevertheless, that is our attitude at the present time. At the same time we are tremendously interested in the question of the training of men for the highest type of work, and we expect gradually to get to the point where we will know how far we need to go in order to turn out the best man.

We are making plans, also, to provide a training for this middle ground where, with less of the obligatory courses in engineering, we will include more of the business courses, based largely on the courses in economics. In this respect, probably, we are not so conservative; but, as one of the speakers recently has said, if we can get a man to decide what he is going to do, he will study toward that end with effect and I do not know why it is not just as easy for a man to decide that he will take a course which will carry all the fundamentals of engineering, with 20 or 30 hours of economics, as it is for him to decide that he will take a straight engineering course, whether it be civil, electrical, mechanical, or what not.

So it seems to me that a course which might be styled "Industrial-engineering," carrying 20 to 30 hours of the business course, is not at all unreasonable, and such a course can be made to fit into our scheme of education.

Finally, I believe, as I said at the beginning, that to train the men who are needed in industry, we need and must have men who are fitted by nature to be teachers, and who are willing and ready to give that broad training that is necessary in order that their students may relate their thinking to the real problems of production.

Mr. LANGSDORF. Mr. Chairman, the remarks that I wish to make relate more directly to the subject of this morning than to that of this afternoon; and if the editor will kindly transfer what I have to say to the record of this morning's proceedings, perhaps no one will be the wiser.

It is hardly necessary in an audience of this kind to call attention to the classical definition of engineering, but it might be well to repeat it for the sake of comparison with another definition which I happened to run across recently in one of the technical journals.

The classical definition is that "engineering is the art of directing the forces of nature for the use and convenience of mankind."

The revised definition which I saw reads somewhat as follows: "An engineer is a man who, by scientific design and by efficiently

directing human effort, utilizes the forces and materials of nature for the benefit of mankind."

The difference lies in the addition of the element of the human relationship, and it seems to me that it is the recognition of this human factor which is primarily responsible for this meeting, and for the discussion which we have had.

Engineers and engineering educators have come to realize that a course of study which deals primarily and solely with abstract principles is not sufficient to prepare men to take their part in the world's work as it is carried on at the present time. One of the blessings of the Students' Army Training Corps is that it has given a great many of us an opportunity to take advantage of the changes in the curriculum which became necessary last fall, and to introduce on a permanent basis some of the ideas which have long been under discussion.

In the institution with which I happen to be connected, we have taken advantage of the situation and have been engaged during the greater part of this year in a study of changes in the curriculum with a view to introducing them into the schedule of the coming academic year.

After considerable study we found that it was possible to include in our junior and in our senior years, in each of the courses in civil, mechanical, and electrical engineering, a three-hour elective course running through each of those years, in addition to a required three-hour course in economics running through the senior year. This will make it possible, in case a student is particularly fitted for such work, to take a total of 18 hours of work in economics and related subjects, such as business administration and cost accounting, which are offered in our school of commerce and finance.

But I wish to point out that we have not made these courses required, nor do we propose to make them required, for all engineering students. They are to be elective on the same basis as a number of other courses which have been listed. It is our opinion that not every engineering student is fitted for an executive position or even to be trained for an executive position. Executives require a certain amount of personality and tact as well as knowledge, in order to be successful; and personality and tact are God-given qualities that are very rarely developed in any four-year course that I have ever seen. Therefore, we feel that it is best to select the student material for such courses with the greatest care, admitting to them only those who in our judgment are suited to work of this character.

There is one other remark I would like to make; we hear a great deal about the necessity of instructing our students in the broad fundamentals, and at the same time we are told by business men that we should not waste too much time on such subjects as ther-

modynamics. Perhaps thermodynamics might be taught in the way that the business men would like it by defining it as the science of heat, and that "heat is a mode of motion." That definition is broad, but it is not deep. If I understand the meaning of the word "fundamental" it is, that it is something which goes to the bottom, and therefore it ought to be deep. Therefore, I have an inherent dislike for the term "broad fundamental." I would much rather hear it spoken of as "deep fundamental."

Mr. HATT. Education is a broad field for discussion and it seems to me that many of our good friends in the outside world talk upon side issues and do not have a center from which to think. University men are impressed with the fact that the university must retain an academic atmosphere. It is the home where ideals may grow. Professors, who are too much in the street, are usually diminishing their sphere of greatest usefulness. Another fact of which professors are conscious is that the ultimate unit is the student and his psychology. Courses of instruction must be built upon the material coming to the university.

Take, for instance, our middle western institutions. We have a young man coming from a small country town, with limited social experience and mentally immature. We must first of all train him in some methodical habits of calculating, to some neatness in records, and to some precise use of English in the presentation of his reports. Our aim is to train him to the habit of assembling facts and making his decisions upon these facts rather than upon impressions and sketchy notions. We try as far as we can also to create some standard of taste with reference to the things that educated men are interested in, literature, music, and the drama. Since all motion is relative, it appears that we do make a great deal of progress during four years in shaping this raw product into a very useful citizen.

We are now asked to do something more, to extend our curricula to cover definite courses in business training and to adopt new methods of teaching fundamental subjects. It appears to me that by making better use of the students' time we can find room in the curricula for some of this proposed training. Some of the possibilities in improving instruction may be suggested.

In the first place, we may some day hope to determine the fitness of the individual student for the particular course in which he is registered. In a group of 100 students there are perhaps 15 or 20 who have the mentality suitable for the work of an executive. Perhaps one-third of the 100 are not fitted for engineering work. By use of analogy, in material to be worked upon, some of it may be wood, some of it cast iron, some of it high alloy steel. The material should be separated and an appropriate educational tool used

for each material. I think it might be said with justice that at present there is but little attention paid to sorting out and designing educational tools to suit the material. I hope that our friends, the psychologists, will be able to help us.

I am also impressed by the fact that many students fail to keep up in their work and to receive the engineering training of the junior and senior years because the work of their freshman and sophomore years is not associated with reality. I think that we should have in the freshman and perhaps in the sophomore year a series of what we might call vestibule courses, where a student would come into the real atmosphere of a simple engineering problem and hang upon the framework of that problem some of the realities of engineering. Thus the men who like to keep their feet on the ground will become motivated. These are often the men who will develop into good business men, good constructors and who become exhausted in the highly rarified atmosphere of mathematics and physics of the freshman and sophomore years. I think that our conception of an engineer in college is too greatly taken up with the consideration of the designers, a man whose mind naturally takes to abstractions and who does very well in the so-called disciplinary work of the freshman and sophomore years.

It appears to me also that in teaching all of the courses, including mathematics and physics, the work should be presented in connection with the background of some real situation. A student should make decisions in connection with his work just as he does in his experience after he gets out of college. He should not merely perform the operations of calculating and drawing.

We must realize that the professors of engineering are in a large organization containing teachers of mathematics, of physics, and of chemistry, and that a curriculum is the product of the thoughts of all of these. It is, therefore, very difficult for one or two individuals to depart from the beaten path to accomplish new ends. The common method of teaching is to come from the abstract to the real, from principles to practice, and so the reality is postponed until quite late in the course. I think that we would improve our instruction very greatly if the abstract was reached through the real wherever possible, but this requires the softening down of the sharp lines between the separate departments of mathematics, physics, and practical mechanics of the freshman year and the early starting of mechanics and a new orientation of the professors concerned.

Mr. GLADING. I am attending with considerable pleasure the conference on "Business Training for Engineers and Engineering Training for Students of Business," as the personal representative of the National Fire Protection Association, and am deriving many benefits from this conference from several points of view.

It has been so common for the college to separate itself in its training from distinctly practical applications that it is no wonder the business man has regarded the abilities of the college graduate with suspicion. The follow-up of such an excellent conference for real cooperation between the business man and the engineering educational enterprises should result in inestimable advantage for the advancement of our foreign, as well as domestic commerce.

On the one hand the encouragement, as well as the practical and financial support of the business men, should indicate to our educational institutions what is needed for business life in the way of technical training of engineers to fill the requirements of positions having a relative importance and leading to the business management of the enterprises.

On the other hand, this cooperation should lead more directly to the selection of at least one or more men in the faculties of our institutions of learning who have the necessary business tact and experience, combined with engineering knowledge and training, to direct the young men to become business leaders, as well as engineers. To properly do this, it should be recognized that sufficient inducement must be offered to secure those men for the institutions. In doing this, it should not be understood that each and every one in the faculties must necessarily possess such breadth of character and diplomacy as this requires, nor is it to be understood that all such institutions should follow in the same rut of procedure. In fact, encouragement should be provided for the production of specialists out of our educational institutions so that different enterprises may find what they seek.

The neccessity of these plans becomes obvious if it be agreed that our institutions should turn out real embryos of engineering training to the end that such degrees as, for instance, electrical engineers, mechanical engineers, fire-protection engineers, business engineers, etc., mean just what they imply, and should not be regarded in any sarcastic attitude by the business interests. The latter are apt to consider a college education as a burden, rather than a real asset for the future aspiration and promotion of enterprises. Indeed, too many of our young graduates deserve this consideration, sometimes on the one hand because they have not made a proper choice of profession, but often because the course of instruction does not make them what was expected or intended.

Mr. RANDALL. I feel that we ought not to go away without further statement of the viewpoint of the industrial man. It does not make much difference in industry whether men in most cases are trained technically or not, provided they can approach the subject from an engineering standpoint. What are the materials and how shall they be put together to accomplish the purpose desired?

You to-day, as engineers, have a very fair sample of problems that are coming to us every day. You are planning to build a bridge from the mass of individual young people and to fashion them into a more or less large structure of industry. Some will be at the bottom and some at the top.

Our Government has recently gone through a period where the point was constantly made, "Oh, if we could only have chosen the right man and if we could have had the right man in the right place." The problem is not in your hands. You have the raw materials. You are engineers. Study it.

This war, for the first time, has brought to our minds the necessity of discriminating among people. How absurd to treat two men as equal material. It is not so. They will not stand the test. It is refreshing to see that Columbia, and, I suppose, other institutions, are making efforts at testing men. The old idea that a man may be born to the trade is all shot to pieces. The old idea that a man can buy a place no longer holds. If you could teach those young people to try to find the truth, to find an objective, to be sure of their facts and then put them together, it will be very easy. If he is a chemist he will find that the organization of an industry is a matter of chemistry very largely, and one bad bit of material put in may spoil the rest.

Accounting is a matter of physics, because it is a study of balancing. Impress on them that the model of all industry is to be found in that masterpiece of nature, the human body, where millions of cells work together and do business together. And in some way or other, people select individuals for the particular purpose for which they are needed. If you can act a little on that suggestion it will show what a grand study you have and what a grand opportunity. We do need technical men. The danger from technical men is so often that being put into an industry they are perfectly impervious to impressions except those that they have already obtained. They must be free. They must be able to take what they have and add to it from the outside. They must be able to change. I do not know what the definition of an engineer is, but it always seems to me that an engineer is the man who does the things that are essential to accomplish, the things which are essential. It is all engineering. Life is made up of engineering, and it is unfortunate that in our country in our training we have been trained toward the lines of the debating school—each man clamoring to show that he is right. The engineer must seek the truth; he must find the best way to put it together; and when he does he can accomplish it. His success lies in creating cooperation. It lies in putting things together.

Chairman HOTCHKISS. We have just a few moments remaining. It is nearly 5 o'clock. We want to adjourn at 5 o'clock.

Mr. RAYMOND. I was very glad to hear what Mr. Randall had to say. It seems to me that the engineering schools are on trial. There has at least been an inference that they are not doing what they ought to do toward keeping up with the demand of the times.

I, for one, would like to defend them. I think we have been keeping up with the times. We have an organization established in 1893 known as the Society for the Promotion of Engineering Education. It has a committee out on this subject. Its purpose is to study exactly the matters that we are studying here to-day.

It does not make any difference whether we have three hours or six hours or nine hours of any particular subject of economics or business. Our purpose is to teach the young men to analyze; and I submit that if we teach young men to analyze problems that come to them so that they will be able to determine correctly the effect of any certain cause and conversely the cause of any certain effect that they may observe, they will be able to succeed whether they are in administrative positions or in what you have been pleased to call the technical side of the profession.

One of the gentlemen said this morning that training on the technical side of the profession unfits men for executive positions. I think he even went so far, if I remember correctly, as to say that it would be impossible for them to overcome that training and become successful administrators. I suspect we forget that the presidents of the so-called greatest railroad of America for many years have come up from the engineering department, and most of them have been graduates of engineering schools of the olden time. It does not seem to me that that argues for any deficiency in engineering training.

We all noticed the extreme grace and force with which Mr. Miller presented his argument this morning. I wonder if we realized that he was an engineer trained in an engineering school, and that he is occupying an executive position of responsibility. He did make one statement that I would like to mention, because I should not like to have this body get away with the impression that he left. The statement was also indorsed by some one else from the floor, that the brilliant man in school is not a success in the world. We have lots of exceptions, of course, to prove the rule. Men who have been at the bottom of their classes often do well and become successful in commercial affairs. But some graduate students have done some good things in their research work, and one of the good things that one of them did at one time was to investigate this particular matter. He found that the statistics show that the successful men in college are the successful men in the world. I think we ought to remember that.

I think everyone who heard him will recognize the fact that Prof. Follows will make a success of any course that he undertakes to promote. But I think he transferred the residence of some of us to Missouri when he said that a young man was a success in radio work *because* he had taken a course in commercial engineering.

Finally, I say that the best we can do in our engineering schools is to train young men to analyze the problems before them and give them certain tools to work with in analyzing certain of those problems.

Mr. CARPENTER. It would seem unwise to omit from the recorded proceedings of this conference all mention of instruction by correspondence, a method by which many successful men in the business and commercial world obtained much of the knowledge on which their success is based. Members of this conference, who are eager to bring about the desirable end for which it was called, will be interested particularly in the possibility of rounding out or broadening a college or university education by correspondence instruction, either along engineering or commercial lines as the need may be.

The greatest good that most students obtain from a college or university course is the ability to locate and make good use of information already on record. Comparatively few of them become investigators or research workers in the sense that they place on record facts or observations not previously recorded in some form. Many of us may work over recorded facts and present them in some new form, perhaps more easily grasped by other students, but not many of us are originators.

If we have learned how to study and then find that we lack certain information needed for success along the line of our work, one of the ways by which that information can be gained most readily and with least interference with regular duties is by correspondence instruction. Courses of study are available along many different lines of endeavor, each course planned and arranged by some one who has demonstrated his or her ability, and with each course is given instruction service which makes it especially fitted to individual needs.

These statements may be illustrated by two cases which came to my personal attention recently. A man wrote substantially as follows:

I am a college graduate, but my course did not include anything along engineering lines. I have had considerable business experience, but now I wish to have a steam plant installed, and I know nothing about steam engineering. I would like to know enough to discuss it intelligently.

Another wrote:

I graduated from the University of ———— two years ago, and although I specialized on chemistry, I must review it and go further into some details in order to handle the job I am now up against.

Both these men asked for help and are now being helped. They will loose no time from their duties, will not be compelled to change their place of residence nor be put to any other inconvenience, but they will gain all the technical information needed to handle their work successfully. If they had been educated along engineering lines and had asked for instruction in commercial subjects their needs could have been met equally well. Approximately 8 per cent of our students are college or university men and women.

It may be of interest to refer briefly to a course recently compiled entitled "Business Management." It aims to give a good insight into the three principal parts of every business—production, distribution, and finance.

Chairman HOTCHKISS. Unless there is something further, we will adjourn until tomorrow at 9.30 o'clock a. m.

THIRD SESSION.

Maj. Gen. W. M. Black, Chief of Engineers, U. S. Army, presiding.

Chairman BLACK. Gentlemen, the subject for to-day is "The Significance of the War Experience for Engineering Education."

The first paper this morning is by Maj. Gen. John F. O'Ryan, commanding the 27th Division, United States Army, Municipal Building, New York City.

Gen. O'Ryan is unable to be here this morning, I am sorry to say. I do not know whether you are familiar with Gen. O'Ryan's career, but a few years before the war he was in command of a light battery in New York, and he made for himself a name for efficiency. The light artillery in the former National Guard service was in general about as poor an organization as could well be found anywhere. The records of the service show that at the outbreak of the war a very large proportion indeed of all of the light artillery material we had in the Army was in the hands of the National Guard. The National Guard organizations of the light artillery proved to be the least efficient that we had in the service. That is a strong statement, but it is so, and I have the documentary proof to show it.

Gen. O'Ryan, a few years before the war began, was appointed to the command of the militia of the State of New York. Fortunately, New York was so fixed financially and so far enlightened as to give her commanding general his full time and pay. Gen. O'Ryan then did exactly the right thing. He recognized the fact that his military education had been limited, that the opportunities for military education in the National Guard are extremely limited, so that he himself, of his own motion, first of all went to Fort Leavenworth and took the course there and then later completed the course at the Army War College so as to do all that he could to fit himself for the important duties of a general of one of the branches of the service, because the National Guard was then one of the substantial parts of the military forces of the United States.

The wisdom of Gen. O'Ryan's course was shown when the war broke out. All this occurred before there was even any thought of the United States going early into war, and it only shows that Gen. O'Ryan had foresight and judgment enough to know what was the right thing to do.

When the war broke out one consequence was that Gen. O'Ryan, I think, alone of the high officers of the National Guard—I may be making a mistake in this, but so far as I know—was the only man who had done all he could to prepare himself for the important duties that he would have in time of war; and his career on the other side shows the advantage that he and the United States obtained from his foresight and energy in this respect; so that I was very glad indeed to learn that he had a paper on this important subject to present to you this morning, but I regret very much that neither he nor his aide can be here, and therefore I am going to ask Prof. Swiggett to please read the paper to you.

Mr. SWIGGETT. I would like to say that I regret most profoundly that Gen. O'Ryan's paper is not to be read by one closely associated with him. Gen. O'Ryan made every effort humanly possible to attend this conference, and, further, to have Col. Crimmins attend the conference and read the paper for him, but we have just had a wire from Col. Crimmins regretting, likewise, the impossibility of his being here.

Expecting Col. Crimmins to attend the conference. I did not, therefore, ask in advance some one present to read this paper, and you will kindly bear with me if I fail at some particular point in giving proper emphasis.

The paper is called "Lessons of the War in Relation to the Future Training of Engineers," and is as follows:

LESSONS OF THE WAR IN RELATION TO THE FUTURE TRAINING OF ENGINEERS.

By MAJ. GEN. JOHN F. O'RYAN,
Commanding 27th Division, U. S. Army, New York City.

In this paper no attempt is made to discuss the scope or character of technical training essential in the education of those whose life work is to be in the field of engineering. As in other fields of effort, so in the engineering field, there are certain qualities, nontechnical in character, which are essential for accomplishment and success. These may be stated to be honor, loyalty, zeal, thoroughness, attention to detail, promptness, accuracy, tact, initiative, resourcefulness, and physical fitness. These essential qualities constitute what may be termed professional character. The interesting and pertinent query is to what extent and in how scientific a manner are these admitted essentials studied, estimated, stimulated, and developed in the institutions which graduate professional men.

The importance of professional character in relation to efficiency and accomplishment emphasized itself to me during the war, particularly in battle. When, during the progress of a battle, there

was here and there local nonsuccess when the unit concerned should have secured success, we found that seldom was the result due to lack of technical knowledge. Adequate and thorough technical training had fulfilled its mission; the technical knowledge and skill were there. The shortcomings were almost always to be found in the domain of professional character. Either the local leader was late, or failed to supervise essential details, or lacked thoroughness of preparation, or did not understand his mission, or lacked imagination, initiative or resourcefulness, or vacillated in his effort, or lost heart in execution, or demonstrated in some other way a failure in some essential of professional character. Is not this also the experience of men who command in big industrial effort? I think their testimony will support an affirmative view.

I think it may be said that, of all the possessions of the professional man, professional character is fundamental and of prime importance, for without it technical knowledge and skill are mere camouflage, at best but assets of circumscribed value to be employed in limited tasks, under the dictation of those qualified by character as well as by technique, to lead and direct.

If this appreciation of professional character in relation to technique is correct, then a reference to the curriculum and methods of training of professional schools and colleges will perhaps indicate an inadequacy of attention and effort in relation to character development as compared with the technical side. True enough, there are occasional homilies on virtue, admonitions concerning lateness at formations, and reminders that student days are the formative period of habit, but I think it will be admitted that there is no carefully prepared standard of professional character which must ultimately be met, no methods of estimating the approximation of the individual student to that standard, no course of training to guide, stimulate, and develop progress in character building.

Compare with the vague and uncoordinated effort in relation to character development the scientific methods employed in the development of the technical side of education and the neglect of the former stands out like an indictment. On the technical side we find the field divided into the theoretical and the practical side, each with its separate courses and expert instructors, and with its chapters and stages of effort prescribed and supervised.

In the colleges and professional schools the tendency is to establish the standards of the student body by forming it in the first instance, so far as possible, of the class who, by inheritance and early environment, possess dependable character, an appreciation of its worth, and an almost automatic responsiveness to the call for self development. It is said that in the old days of apprenticeships, the employer con-

sidered it a part of his obligation to school his ward in relation to character. That hand in hand with the development of his technical skill there was development of character, the employer pointing out not only the moral aspects of business effort, but its practical problems and the correct courses of action to be adopted from time to time, illustrating his points by the incidents of the daily experience. Certain it is that under the old apprenticeship system there existed a large class of skilled mechanics and contractors of noteworthy dependability and character, men who almost automatically entered upon their undertakings with an organized and developed sense of responsibility. How often have we heard the older men in industrial life harken back to their days of apprenticeship and commend the careful training in relation to character given by some sterling man who was himself the product of the same system. In those times also many of the colleges had their religious side, which constituted in some measure an effort toward character development. These practices and influences do not appear to exist in the present day to the extent that they did a generation or two ago.

With an appreciation and understanding of the shortcomings of the existing systems of professional training in colleges and technical schools, we come to the subject of the remedy. This is difficult to describe. The field, though not new, is undeveloped. Those concerned intimately with religion, will tend to see in sectarianism the needed solution. I believe that the men who attend colleges and technical schools go there primarily for academic or professional training as the case may be, and that if character development is as we believe it to be, an essential part of professional training, they would prefer its inclusion in the curriculum on the basis of nonsectarian moral law, developed and applied by courses in psychology, leadership, responsibility, physical training, etc.

All that this paper has attempted to do is to indicate the need among professional men of a high standard of professional character as that is outlined herein, and the further need for a comprehensive study of the subject by those in charge of the colleges and technical schools of the country with a view to including in the curriculum of such institutions a scientifically conceived and organized program of training for the development of professional character.

The principles and details of training in relation to such effort will vary to some extent in different classes of professional schools. The field is a wide one but worthy of skillful and zealous effort. In the engineering field the psychological as well as the practical side will probably play an important rôle in determining the methods of training to be pursued.

Chairman BLACK. I will now ask Dr. Mann, who needs no introduction to you, to present his paper. As you know, gentlemen, there has been a great deal of dissatisfaction with the results in the engineering training in our colleges. Dr. Mann's report of last year gives the most important piece of constructive criticism on engineering education that has ever been given to the United States; and I know, coming from such an authority, that what he will have to say to-day will be well worthy of attention.

EFFECT OF THE WAR ON EDUCATION.

By CHARLES R. MANN,
Chairman of the Advisory Board, War Plans Division, War Department, Washington.

Mr. Chairman, Ladies, and Gentlemen, I wish to preface my remarks on the effect of the war on engineering education by calling attention to the fact that the war has as yet had very little effect on education. We have all been aroused to much enthusiasm, and we have had our emotions deeply stirred, but very few new conceptions and very little of the new point of view have percolated into actual practice. Therefore, we must recognize at the start that it has been thus far largely a matter of wistful wishing. It is for the future to reveal what the results will be by showing how we interpret the experience and how we reduce our findings to practice.

Several years ago, before the war, the members of the National Engineering Society were asked what were the determining factors of success in the engineering profession. With a surprising degree of unanimity some 7,000 of them agreed that personal qualities, such as character, discipline, common sense, and initiative, have greater weight in shaping a career than have knowledge of the science and technique of engineering.

Reports coming from France indicate a similar conclusion. The story is that a battle resolves itself into a number of combats between small groups of men. Some of these combats are successful and others unsuccessful, and the general result is determined by the relations between the successful combats and the unsuccessful. It has been the practice to investigate every case of unsuccessful combat in order to discover the causes of the failure. The results of these investigations are that failure is practically never due to lack of technical knowledge of military science, but is generally due to personal weaknesses of character. A commanding officer is late in executing an order, or he is not resourceful in meeting new conditions, or he is timid and delays when positive action is required. The general conclusion is that the most common cause of defeat is weakness of personal character. The most successful military training,

therefore, is the one that develops to the highest degree what may be termed soldierly character.

Starting then from the main thesis that the development of personal character is the fundamental purpose of education, a thesis which is as old as the hills, what has the war contributed to the solution of the educational problem? Before analyzing the experience it is desirable to note that the war has not yet had any marked effect on educational practice, because the schools have not yet had time either to reason out the lessons or to apply them. Whether there will be a large effect or not depends upon what is done in the immediate future. If the schoolmen see the vital points that now stand out so clearly, and if they interpret them intelligently and apply the results to education, much will be accomplished. The result is a matter of the future. Impressions and hopes are all we have at present.

A first hint at what appears to be the main lesson of the war was given the other day by a college professor who had just returned from France after more than a year of intensive experience in Army activities, part of which was training. He said that he had taught college students for 20 years, but had never discovered how rapidly a man would learn provided only he was eager to do so. Never again would he attempt to teach unwilling students. He had come to realize the full force of Mr. Dooley's remark that "you can lead a man to a university, but you can not make him think."

The schools have recognized the educational importance of the emotions in an abstract and theoretical way for many years. There has been a large literature constructed about the ideas of motivation and transferable training. Many a battle has been fought over the question whether it is right to spare the rod and spoil the child, and whether Latin grammar is not an essential experience for every boy because it is dry, hard, and disagreeable. The war, however, has clothed these theories concerning the dominance of the emotions and the necessity for motivation with a garment of reality which makes them fit for presentation to the public gaze and for introduction into school systems.

This first glimpse of the fact that emotion is the driving power in every learning process does not reveal how to proceed in order to secure like results in times of peace. A war situation fortunately does not exist every day, and the problem is to discover the conditions that tend to produce the emotional state in which energy is released, so that learning and character building become a rapid process.

One of the most striking developments in training methods of the war was made in the field of physical culture. The old setting-up exercises consisted largely of calisthenics, in which whole regiments

went through regular motions together. After a few hours' practice these became more or less automatic, and while they developed vigorous muscular systems, they did not occupy the minds or tend to coordinate physical motion with mental activity. Men quickly got bored with them and regarded them as a drudgery that must be tolerated for the sake of physical strength. The men so drilled were robust and able to endure a strenuous campaign, but when something unexpected happened they did not adjust themselves quickly to the changed conditions. Their physical strength was of little value when it was uncoordinated with alert mental action and speedy adaptation to a new and unexpected situation.

To meet this difficulty the old routine setting-up exercises have been largely superseded by what are known as quickening exercises, or O'Grady games, which require close mental attention and quick mental reaction to new and rapidly changing situations along with vigorous physical exercises. They keep the men on the alert and appeal to their instincts for competition for achievement and for sport. They appeal to one's pride to make good, and inspire to utmost effort because the result is objective and can not be distorted.

While analogies are dangerous, it yet seems a safe inference that the underlying conception of the quickening exercises may to advantage be applied to the intellectual activities of the school. The old forms of routine class drill may develop robust minds able to stand a steady campaign of customary labor. Do they produce intellects which are resourceful in the face of unusual conditions? Do they keep the students "on their toes" striving eagerly to make good and win the game? If not, they are probably not making their best contribution to the development of soldierly character.

Valuable as are the quickening exercises and the O'Grady games, they may be ineffectual if the men do not enter them with the right spirit. If the program is not changed frequently and enlivened with new elements, a soldier may easily react with indefiniteness and control his motions with a coldly intellectual attitude, which destroys the results in the way of physical recuperation and coordination. To prevent this the teacher must develop what is known as a good morale. It is now generally agreed that if the morale is fine the required results follow.

Although morale is an illusive thing to define, everyone has a reasonably definite conception of what is meant by the morale of a classroom. The war has done much to clarify our notions of the character and fundamental importance of good morale. At the beginning of the war the Germans seemed to grasp its importance more fully than did their opponents, as indicated by their extraordinary performances in attempting to undermine the morale of the Allies. The first Italian campaign is said to have been won by this

process. No doubt they counted upon keeping the United States out of war by similar means. They have been past masters in developing morale of their peculiar brand, and this has compelled the other nations to study the matter and devise methods of creating a morale suited to their characters and philosophies.

It is now fairly clear that morale is an expression of the spirit and inner nature of individuals and groups of individuals. While it is illusive, it is not so illusive as character. It can be sensed, rated, and judged, and therefore is a more tangible means of grasping the dynamic elements of an emotional situation. Observation of morale enables an officer to size up the character and moral tone of his men. Appreciation of morale enables a teacher in like manner to judge of the emotional reaction of his class. It is morale that the athletic coach seeks above all things to develop in every team.

In order to analyze the experiences of the war so as to apply them to the activities of peace, it seems evident that the largest returns will come from a study of the problem from the point of view of morale. It is not possible here to do this in detail, but a few of the more striking lines of study may be mentioned as lines of investigation that will surely prove fruitful in preserving through education the fine national morale that has developed during the war.

As a primary policy a nation at war is obliged to recognize that every individual is an asset capable of useful service in some particular line of work of direct benefit to the country. In order to make the most efficient use of all is resources, it is necessary to make strenuous exertions to discover what each individual is best qualified to do and to train each to use his abilities in the most effective manner. Applied to education this fundamental attitude produces two results that are of importance in the development of morale. The teacher's point of view shifts from a critical one, with attention focused on discovering whether the individual measures up to the academic standards fixed by school authorities to one of friendly, not to say eager, interest to discover what each individual really can do well. The student's spirit also changes from one of discouragement and doubt of his ability ever to make good to one of interest and desire for achievement. Both of these results are of large importance in releasing energy for both the teacher and the student. They also have an immediate bearing on the enhancement of morale.

Hence a first practical suggestion for training the national man power for team play is that the schools study and adapt to their own use the methods of classification, rating, and testing individual abilities that were developed by the Army. These methods, as worked out by the committee on classification of personnel and the psychological department of the Surgeon General's Office, enabled

the Army to utilize effectively more than 98 per cent of the physically fit men who entered the service. Similar methods adapted to school work would supply a sort of national vocation guidance that would enable young people to select their occupations more in accordance with their abilities. They would also enable the Nation to discover its geniuses and to provide for their adequate further training.

A reasonably efficient system of classification, rating, and testing in school would also prove a powerful incentive to more thorough work. It is well recognized that competition which is settled on the basis of objective results is one of the most powerful means of inspiring men to maximum effort of releasing creative energy and of enhancing morale.

A second important feature of the war training that can be transferred readily to school practice is the direct drive made for the development of moral characteristics and virtues. Intelligent military training through its evolutions, its courtesies, its ceremonies, its emphasis on service, and its discipline, makes an emotional appeal to the student which accounts in a measure for the zest of the Army work. The insistence upon responsibility and consideration for one another all tend directly to developing soldierly character and morale.

The schools on the other hand place their great emphasis on mental discipline and regard moral qualities as by-products of intellectual activity. Both forms are essential for complete development, and therefore it seems probable that a combination of the best elements of military and academic training is far more effective than either alone.

The country has a proper fear of what it calls militarism, and no one, least of all the Army itself, desires to develop anything that looks militaristic. On the other hand, all must agree that our brief military experience has revealed a physical, mental, and moral stamina in which the Nation has surprised everyone, particularly the Germans. This outbreak of willingness to work together for the common good proves that the sturdy virtues are a genuine part of our national character, although they were but latent before the crisis came. It would be magnificent for the future industrial development of the Nation in the coming years of peace if this cooperative spirit could be as definitely fostered and as freely expressed in civil life as it is in military operations.

Hence the second practical suggestion for development of team play and a national civic morale is that the best elements of military training be combined with ordinary schooling. The most effective way of doing this at present is through summer camps and through the methods provided by the Reserve Officers' Training Corps.

If the responsibility for team play and civic morale among the entire people is left wholly to the present school system, the development will be a long and tedious process. The process may be stimulated by national campaigns similiar to those of the Food Administration and the United War Workers. It was the selective-service law, however, that completely released the spirit of national service which resulted in universal cooperation. This experience suggests that possibly the quickest way of stimulating the growth of the team-play spirit and of directing it toward peace time would be through a universal service law that would require all young men and women to train themselves to some form of useful skill beneficial to the Nation in case of an emergency. If such a requirement were made, and if it were applied in the same thoroughgoing, democratic manner as was the selective-service law, it is reasonable to expect that its effect as a moral stimulus upon the Nation would be no less profound that in was during the war.

Chairman BLACK. Gentlemen, you have heard Dr. Mann's thoughtful address, and I know that he too has given us a number of texts for discussion.

Before opening the discussion in general the chairman is going to take advantage of the privilege that is his, and say a few words on these lines.

The great lesson that the war must have taught to all of our people is the value and the effectiveness of coordinated action. In our country we have been over-individualistic; each man has been allowed to go ahead as he pleased. Each function of the Government has been more or less allowed to go as it pleased, to develop as it pleased. There has been too little coordination. The result has not been the best. Individualism is necessary. It is the great privilege of our country that every man has opportunity. Therefore it is wise and best that those opportunities should be developed. This can be carried too far. You all know that at the beginning of our country's life, when the population was greatly scattered, individual liberty could be carried to an extreme. There were scarcely any restrictions whatever. A man could do as he pleased, because he did not come in contact with his fellow man. Then, gradually, as the population increased each man's rights were diminished because they trespassed a trifle on the rights of others; and if you analyze conditions in our large cities, you will find that individual liberty of action is necessarily greatly restricted because of other people's rights, and we have to get, in a measure, coordinated action.

This goes through the entire body of life. All of our activities must be coordinated because of their effect, the friction, on other activities.

The Army is the best illustration possible of coordinated action. It represents the maximum that humanity can do. To get a good effect, then, this army must act as a great machine composed of many, many parts, and each part must do its own work at the proper time and without interfering with any other part.

That cooperation and coordination is attained by organization and discipline. Organization is nothing in the world except the broad conception of a field of work, the division of that work into certain definite parts which are distinct, and the assignment of each of those parts to a certain agency. Within its sphere of action that agency must be entirely independent, must have initiative to do all that is required within that sphere, and it must not go out of that sphere.

That, then, requires a certain self mastery which is termed discipline. Discipline is not something imposed from without. True discipline is something that a man imposes on himself so as to subordinate his body, his mind, his actions, to duty, whatever that duty may be; and the truly disciplined man is the man who first looks for that duty, then performs that duty, despite its effect on himself.

That is essential in an army. It is equally essential, or should be so considered, in all civil work, wherever great work is to be performed.

As Dr. Mann said, that self-mastery, that spirit of willingness, is made much more easy by what is termed morale. It seems to me that not enough effort has been made to develop morale. The primary object, undoubtedly, of our institutions of learning is to fit the young men for their future life, for their future work, and doubtless the very large majority of young men come to our schools with that object. But it is in a measure lost sight of. There is very little advantage taken of that fact, by showing how, in order to fit themselves, certain things must be done and how done best, and the cultivation of that morale that would lead men willingly to do this work. It has been in a measure neglected. It can be carried out, and carried out to the widest extent.

I heard an address given a short time ago; it was during the war, during the training period, and it was by an experienced officer. In speaking of this matter he called attention to the little question of the salute, how it should be rendered. To a man who does not know anything about it a salute looks, in its worst sense, like a confession of servility. Absolutely it is different, absolutely different. If a soldier, in coming in and being compelled, as we call it in the service, to render honors, considers that rendering of honors a servile task, he has entirely a wrong idea. He starts out entirely wrong, and the first thing that is necessary to do in raising

the morale among our men is to give them proper conceptions of that.

The salute and the other honors rendered are nothing more than the courtesy that should prevail in civil life but which does not. It is enforced in the Army. It is just as right in civil life that the young man should rise when his elder comes into the room, just as he does for a lady; that in passing his elder on the street he should give the first salutation. It is equally incumbent on the elder to acknowledge that salutation. It is a mutual obligation. That is true in the service. But as this officer put it, there is a great deal more in the salute than that. He said that when you salute an officer, do not do it as a perfunctory matter, as a matter that you are compelled to do, but look him in the eye, raise hand to head and feel, and let him feel, "Here I am, wearing the uniform, proud to wear the uniform, ready for service. What will you have me to do?" And the officer, in returning the salute, says, "I am glad to see you, glad to have your help as a comrade. Therefore, I recognize you as a comrade, as a man participating in the work."

That was simply a little illustration in morale. That can be carried all the way through the work. Morale can be brought up by a simple appeal to reason; and I am sure that by that the work of the colleges will be greatly bettered.

Now, that sense of duty—how can it be developed? That sense that when something is to be done it is to be done despite anything. It is a duty, and, therefore, sacred.

At West Point one of the means taken for that was one that you, as educators, may probably smile at a little bit. In the instruction that was given in the class a certain lesson was assigned that had to be learned. When the cadets were called up to recite they were first required to demonstrate that they had learned that lesson. Original thought was not wanted, not asked for. The lesson was given. It was there for them to learn, and the first thing they had to demonstrate was that they had performed that duty.

That can be carried to extremes, of course, but the fundamental idea is good. Here is something to be done; have you done it? That can be carried all the way through college life. It means much that when the chapel bell rings or ceases to ring the students shall be there; just as much that when the hour for the lecture comes the students shall be there, as it does that they shall know what they are supposed to be taught or what they are supposed to learn.

The first thing, I think, that is necessary to inculcate in the young man, is that sense of duty. The task either imposed or voluntarily assumed is something that must be done, and done with one's might. I do not believe that in the schools this is as much

insisted on as it should be. Slipshod methods are bound to ruin that idea. It must go through the teaching body, just as much as through the student body.

One of the lessons we learned in the war was the great undesirability of overspecialization. An officer who went out in command of a light railway regiment organized for the purpose of building and operating light railways, sent over to France for that purpose and at the front for that purpose, said to me yesterday, "At the front I had no use for a specialist." He did not mean that specialization is not very valuable, not that special knowledge is not of very great advantage and must be used; but what he meant was this, that in addition to being a specialist, a man must be prepared to do whatever comes up in the engineering line. I have yet to find a specialty which is such a specialty that the man who rises to the top of his profession in that specialty does not have to be an all-round engineer in addition. We know that for subordinate positions we can use a man who knows only one thing, and he is a very valuable man, but he is strictly subordinate and must be so all his life, for he knows only that one thing. He never can rise to the top, because he overspecialized. I do not care where it is, when you get up to the top there is something broader than that specialization, and therefore it seems to me that before a young man is allowed to specialize he should have a thorough grounding in and broad outlook over all fields of engineering, so that he will know how to coordinate the different parts, know the relation that his specialty bears to the other parts, and, ultimately, after he has arisen so high that his own specialty alone can not be exercised, he can go on on the broad lines of engineering. This he must do if ever he rises.

That means, then, that specialization, or the teaching of specialization, should not be permitted until a certain broad general foundation has been laid; and I believe that is quite essential.

At the front, again and again specialists were of little use. Men came to me, as the chief of engineers, throughout the war, and said, "I am a specialist in this or that or the other, and I want to go over to France and lend my services to the Government in this speciality." I was obliged to say to them, "Gentlemen, there is a need for the exercise of that speciality over there, without any doubt, but whether you will be at the point where that need exists at the time the need exists is another matter. We have to have at the front men who will do anything that comes up because it is needed then, and we can not have an enormous corps of men, one man to do an hour's work and another man to do another hour's work two weeks from now. We have to have men who are continuously busy; and while your speciality is very desirable, and very, very necessary, yet you must be more than a specialist if you are going to serve."

Is not that, in a measure, true also in ordinary engineering experience in our country in time of peace? Certainly it was one of the lessons of the war, for engineers.

There has been something said about the development of character. A certain amount of that must be done in the schools, most particularly in the development of the sense of duty. But the important development of the character that must come for all engineers can hardly be gained at the schools. At the school it is difficult to put such a responsibility on a man that he is able always to assume responsibility willingly. It is difficult, also, to give him an opportunity for initiative, to enable him to exercise his powers of resourcefulness; and it is only by the exercise of those powers that a man develops them.

In the Engineer Corps of the Army that matter is recognized. Our younger men are not considered real producers until they have been in the service for about 10 years. We send them through the schools, put them on different duties as assistants, and the country has been most fortunate in this war in that its civil works were to a certain extent administered by the Corps of Engineers prior to the war.

I do not think you gentlemen realize how deadening is Army life in time of peace, how little opportunity there is for real initiative, for the development of a sense of responsibility. By having these civil works we had the opportunity of giving our young men responsibilities, of calling on them for initiative, for the exercise of resourcefulness, and, therefore, for their mental development. It was a most important asset of the country, and the services of the engineers during the war were a proof of what came from this.

So this same development which is needed can be obtained by the young engineers in civil life only in actual work. It becomes, then, a question whether it might not be advisable so to revise the system, the requirements of our educational system, the system of giving degrees, as to permit the educational institution to have responsibility for the starting of the young man and to follow him through his career for a series of years to see that he has the work which will develop him best, and then only to give him his degree after he has shown that he has made full use of his opportunities, and not to stop even the supervision of education with the four years of the course.

I do not know just how that could be accomplished, but if it were possible to do so, I am sure it would be greatly to the benefit of the profession. Now, Dr. Mann, in the final part of his discussion, touched on something which is another lesson of the war, and that

is that if we as citizens are to do our full duty to our Government we must be prepared to defend the Government.

Some years ago in my service I met a young Englishman who was a very exceptional man with very exceptional business ability. At the time when I knew him first he was the head of a single branch bank of one of the greatest banking institutions in the world. I watched him through five or six years during which I was able to observe him, and he gradually arose from that position until he became the head of all the branches of this particular institution, in quite a large section of the earth, showing that he had tremendous powers of organization and that he was naturally a leader of men.

When the war broke out he had been called back to the parent institution in his home country. He was a man still young, vigorous, without family ties, and he felt it his imperative duty then to go to the front. Then he found that he had folded all the talents that he had for that particular class of service to his country in a napkin and had buried them.

He was offered a commission as captain. He was a leader of men; he had shown it; but he was compelled to go to his superiors and say, "I am sorry. I know nothing whatever about military affairs. That I have neglected completely, and I can not accept the responsibility over the lives of other men which would be given by a commission. I must go as a private."

There was a man eminently well fitted to serve his country, whose service to his country should have been of the highest order, and yet, through his own neglect, he was not at that time, in his own opinion, of any more value than the humblest laborer, the wielder of a pick and shovel.

Is it not the duty of each one of us to our country to see that that line of preparation for citizenship is not neglected? Is it not our duty, then, to prepare ourselves for that greatest service that we can render to our country when our country needs it?

We have been instituting military instruction in our schools. I hope the experiment will be successful. I do not know. To get oneself thoroughly disciplined does not mean an hour a day or two hours a week. It means daily living with self-discipline. Army methods are certainly conducive to efficiency. You have heard a great deal about red tape. By the way, I want to speak on that thing. You know that that is one of the most maligned things in the world. Do you know that we, in the Regular Service, since this war began—I am going to say something that I do not know whether I ought to say or not—have had a great deal more trouble than help from many of the so-called captains of industry, because in civil life these men had gone ahead, a law unto themselves, doing what they pleased, re-

sponsible for their own money, or at least, not responsible to anyone really for what they did, and therefore they accomplished results outside. But when they came into this great, big military machine they tried to carry those same methods with them, and the result was confusion worse confounded. Not having ever been accountable to anybody else for the way in which they handled money, they attempted the same procedure. I do not think I shall need to specify to you examples that we had. Some of them wore uniforms; some of them did not. It does not make a particle of difference; their methods were just the same, and Congress is now investigating why so much of the public wealth was spent without results.

So, along with every organization must come that self-subordination to rule, that readiness and willingness to account for one's actions, that ability to do so—and that is red tape.

There can be too much red tape. I have been just as much a kicker against that as anybody else. There is unnecessary red tape, and any quantity of it, but there is a certain amount of orderliness of procedure which is absolutely necessary. I know in my own department we have not been free from it in the stress of war.

A case came up the other day in which we had an order from the other side for a number of cranes, the cost of which was very large. Instead of putting in a requisition and having it go through the proper channels in my own office, so it would be accounted for, the order was sent out in writing, and a copy of the letter was put in the ordinary correspondence and did not get into the proper channels of accountability. The result is that the bill for those cranes came in the other day, and now we are having a hard time to find out exactly how they were ordered and when. We saved perhaps two days by sending the order out in that way. We are going to lose a great deal more than that in getting the case cleared up. We tried to cut red tape, and the result was disastrous. Just one day more delay in putting those papers in the regular order and getting them in the regular channels would have saved a very great delay to the Government in the end.

So do not be deluded about red tape. A certain amount of red tape must exist in every organization. It means system, and it is necessary. The larger the organization, the greater the amount of system that must prevail. The action is a trifle slower, to start in with, but, like the wheels of the gods, they "grind slowly, but they grind exceeding small." In coordinated action of that kind there must be system, and that must be taught at the schools also, for every great human endeavor must be made by coordinated action, and that coordinated action must be organized and arranged to work properly on definite lines.

I am not going to bore you any longer.

At the outbreak of the war we of the Engineers had the great advantage of having the whole profession at our disposal, and we got such fine material and the results were so good that the other arms of the service became envious, so that before the war was over there was a very great competition for engineers, so much so that it looked as if we could not get any engineers any longer for engineering. The greatest competitor I had and the greatest rival was Gen. Coe, chief of the Coast Artillery, and I am going to ask him to make a few remarks.

Gen. COE. I came only as a listener, Gen. Black. I have only a word to say. As Gen. Black said—or did not say, rather—he had all of the engineering graduates locked up in his safe when I came back from France in June, 1918.

While only a small amount of engineering knowledge is required in the Coast Artillery, that little knowledge is very essential.

We had to go to work and build a military academy at Fort Monroe, which we did just about a year ago, comprising 2,400 students. We established a three months' course, graduating 200 every week. That was only to meet the needs of the Coast Artillery, which at the end of the war had a little less than 100,000 men out of the 2,000,000 in France, and that number of officers was necessary to meet our needs for those men and for the others which we would have to send before our quota was filled. We drew for the course at Fort Monroe upon the students in the engineering courses of the universities, not altogether, but largely.

I think it will show you the character of men we got when I tell you that over 80 per cent—about 82 per cent—of those men whom we took finished the course at Fort Monroe and were commissioned as officers.

There are four qualifications for an officer of Coast Artillery, some of which are the same as the qualifications for an officer in any branch of the service. The first, the elementary one, is a knowledge of engineering, to include surveying. He must be a practical surveyor. The next qualification is a technical knowledge of artillery, which knowledge we can give a young man of fair education and ability in a very short time. The next qualification is the ability to lead men. That depends upon the soul of the officer, I think. It can be judged sometimes from his countenance, from his bearing, from his temperament. It is a difficult thing to judge, and you often make mistakes, but we found that we were able to arrive at fairly correct results in the 12-weeks' course which we gave to the young men down at Fort Monroe.

The final thing, and, I believe, really the most essential thing, in an officer of Coast Artillery, is that he must absolutely will and determine to overcome difficulties; and the difficulties which were to

be overcome by the heavy artillery in France were, I think, not exceeded by those in any other branch of the service.

I believe that the young men we sent over there overcame those difficulties in a perfectly wonderful way.

I do not know that I have said anything particularly bearing on the subject, but I thank you very much.

Chairman BLACK. In November of last year, due to the exigencies of war, there were a lot of young men commissioned as engineers from West Point who had never passed beyond the pure mathematics. They were not engineers, although they were commissioned as engineers. It was necessary, then, for me to organize a school to give them a fundamental engineering training before they were fitted for engineering work. In order to do that I called on the resources that we had for getting up a proper course. Fortunately, I found among our officers a number of trained instructors from the various engineering colleges, and they gave us most needed and most valuable assistance in this work.

One of them is here present this morning, Col. Marston, dean of the Department of Engineering of the Iowa State College, at Ames, Iowa, and I would like to ask Col. Marston if he would kindly give us a few remarks.

Mr. MARSTON. Mr. Chairman, I have already said on the floor here yesterday about all that I know.

Chairman BLACK. I don't believe it.

Mr. MARSTON. I will say that it was a privilege for me to be associated with the other officers in planning this course for the Army engineers. I shall always remember it as long as I live as one of the greatest privileges which I ever had. That course is an important experiment in engineering education which all of us will need to watch, and I feel that the results secured there may be of great value to us in engineering education in the post-war period.

I feel, also, that while in the Army a great many engineering educators acquired certain new ideas which may be of use in their work in civil life. Personally, I believe that every engineering student should be given an Army rating (or an equivalent rating) of his manhood qualifications as well as his class attainments, by every one of his instructors, and that a high standard of attainment in physical qualifications, leadership, intelligence, and personal qualities should be required for an engineer in getting a degree as well as a high standard of class attainment.

I believe that we should adopt the principle adopted in the Army that every officer must always be a student, always striving to improve. It was a lesson to me to find that we went to school every week in the year in the Army. The officers after doing a day's work had to attend an officers' school. Why should not members of our

I think I ought to add to what Dean Evans has said by stating that I visited some of the classes in mechanics and hydraulics.

These students are young men from West Point with a good mathematical training to begin with. They are studying mechanics by the method outlined by Dean Evans. They are very much alive. They deluged the instructor with very intelligent questions, getting down to the root of the matter.

That may be due either to the method of presentation or it may be due to the splendid qualities of these two instructors. I think there is a combination of both.

I was particularly interested at Camp Humphreys in the courses that I have been teaching myself for the last six or seven years. Let us take, for instance, a course in foundations. Usually this is a matter of studying through a treatise, and the students have a certain chapter assigned to them. They read that chapter; they come to class and discuss the chapter with the instructor, and the various constructions are illustrated diagrammatically and with lantern slides. I feel that in our senior courses of engineering construction the matter is apt to be too descriptive. It is very difficult to get a reaction from the student, so that we professors, I think, feel that the fundamental courses in mechanics are more solid and more worth while in developing students than these so-called senior courses in construction. Down at Camp Humphreys they are going ahead on a little different idea. They have there some 10 experienced constructors. The man writing the course on foundations, for instance, has built dams in California. He is a thoroughly competent constructing engineer. I think that is true of all of the 10 men who are building up these courses.

In the first place, if I may speak of this from hearsay, I understand the old West Point method was the reading of so many pages of a treatise and coming to class and certifying that these pages were read. A man might turn over pages pretty quickly late at night before he got the reading finished for the next day.

In some of our civilian colleges those courses in construction engineering involve a considerable amount of performance by the students in the way of drawing and calculating. There used to be more rivet spacing than there is nowadays. Down at Camp Humphreys the courses occupy an average position between those two extremes of broad reading and detailed performance. Take, for instance, the course in wharves and docks. The student is assigned a certain situation, the design of a certain wharf or dock in a situation below the city of Philadelphia. He has a full description of that situation, a plan of the water front, the soundings, borings, and so forth, and upon that situation he has to design a wharf. He has, first of all, this problem to solve. He has the framework

of the problem upon which his reading of the text is hung and a series of developing questions and minor problems which throw him back to the text for material upon which he must base his decision as to the particular thing to be done in the design of the dock. His designs are in the form of sketches rather than detailed drawings.

Those courses are all being prepared with that particular motive, and all instructors have this orientation in reference to the purpose of their work, and the student, to use rather technical language, is motivated through a real situation.

I feel that this offers, then, a promising method, a more conscious reaching out for the training of our seniors to engineering work. By saving time, I believe, we can condense our senior courses and leave room for many of those activities that are being pressed in upon us by the outside world.

Of course, it is difficult to adopt any great changes in connection with education, because we have very little science in our educational methods. They are very largely the result of experience and tradition, and instructors are necessarily very conservative. We have so much impression, so many individual experiences without real scientific laws, but if we can get our students classified as to material and then work on that particular material, we will have a more scientific approach to many of these educational problems.

I can only say, in conclusion generally, that the work at Camp Humphreys has given me a new horizon and has been the most stimulating thing I have come in contact with for many years.

Mr. PRATT. Mr. Chairman, I would like to interject something here which was brought to mind by Dean Marston's comment about the Army requirement, that each day should be a study day for officers of the Army.

There are a few things going on in industrial concerns which are analogous to this and may be of interest.

Just this past week the manager of one of our largest departments conceived the idea of getting his men together in groups of 50. These were the workmen and the foremen. He intended to talk to them for half an hour, but actually talked for an hour and a half, trying to point out what their individual efforts meant in the work of the department, and to give their relatively simple tasks more meaning by showing that they are parts of a broad undertaking. He told them that anyone could put in a card for the time so spent, and the company would pay for it, but he was going to ask them to go back and think the talk over and deposit a ballot saying simply yes or no as to whether those courses should be continued. The courses would not be onerous. Each group of men would attend only half an hour once a month, on his own

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That may be due either to the method of presentation or it may be due to the splendid qualities of these two instructors. I think there is a combination of both.

I was particularly interested at Camp Humphreys in the courses that I have been teaching myself for the last six or seven years. Let us take, for instance, a course in foundations. Usually this is a matter of studying through a treatise, and the students have a certain chapter assigned to them. They read that chapter; they come to class and discuss the chapter with the instructor, and the various constructions are illustrated diagrammatically and with lantern slides. I feel that in our senior courses of engineering construction the matter is apt to be too descriptive. It is very difficult to get a reaction from the student, so that we professors, I think, feel that the fundamental courses in mechanics are more solid and more worth while in developing students than these so-called senior courses in construction. Down at Camp Humphreys they are going ahead on a little different idea. They have there some 10 experienced constructors. The man writing the course on foundations, for instance, has built dams in California. He is a thoroughly competent constructing engineer. I think that is true of all of the 10 men who are building up these courses.

In the first place, if I may speak of this from hearsay, I understand the old West Point method was the reading of so many pages of a treatise and coming to class and certifying that these pages were read. A man might turn over pages pretty quickly late at night before he got the reading finished for the next day.

In some of our civilian colleges those courses in construction engineering involve a considerable amount of performance by the students in the way of drawing and calculating. There used to be more rivet spacing than there is nowadays. Down at Camp Humphreys the courses occupy an average position between those two extremes of broad reading and detailed performance. Take, for instance, the course in wharves and docks. The student is assigned a certain situation, the design of a certain wharf or dock in a situation below the city of Philadelphia. He has a full description of that situation, a plan of the water front, the soundings, borings, and so forth, and upon that situation he has to design a wharf. He has, first of all, this problem to solve. He has the framework

of the problem upon which his reading of the text is hung and a series of developing questions and minor problems which throw him back to the text for material upon which he must base his decision as to the particular thing to be done in the design of the dock. His designs are in the form of sketches rather than detailed drawings.

Those courses are all being prepared with that particular motive, and all instructors have this orientation in reference to the purpose of their work, and the student, to use rather technical language, is motivated through a real situation.

I feel that this offers, then, a promising method, a more conscious reaching out for the training of our seniors to engineering work. By saving time, I believe, we can condense our senior courses and leave room for many of those activities that are being pressed in upon us by the outside world.

Of course, it is difficult to adopt any great changes in connection with education, because we have very little science in our educational methods. They are very largely the result of experience and tradition, and instructors are necessarily very conservative. We have so much impression, so many individual experiences without real scientific laws, but if we can get our students classified as to material and then work on that particular material, we will have a more scientific approach to many of these educational problems.

I can only say, in conclusion generally, that the work at Camp Humphreys has given me a new horizon and has been the most stimulating thing I have come in contact with for many years.

Mr. PRATT. Mr. Chairman, I would like to interject something here which was brought to mind by Dean Marston's comment about the Army requirement, that each day should be a study day for officers of the Army.

There are a few things going on in industrial concerns which are analogous to this and may be of interest.

Just this past week the manager of one of our largest departments conceived the idea of getting his men together in groups of 50. These were the workmen and the foremen. He intended to talk to them for half an hour, but actually talked for an hour and a half, trying to point out what their individual efforts meant in the work of the department, and to give their relatively simple tasks more meaning by showing that they are parts of a broad undertaking. He told them that anyone could put in a card for the time so spent, and the company would pay for it, but he was going to ask them to go back and think the talk over and deposit a ballot saying simply yes or no as to whether those courses should be continued. The courses would not be onerous. Each group of men would attend only half an hour once a month, on his own

time in the future, and the instructions would be given by the foremen. The classes would be held at 4.30, which was the closing hour in the afternoon, until 5 o'clock. The results were rather remarkable, for out of that group not one man put in a time card, preferring attendance at his own expense, and there was a unanimous vote in favor of the continuation of those talks, not one dissenting voice.

It simply shows, I think, very graphically, the desire of the plain workman for further knowledge and more intelligent understanding of his undertakings.

In another department the engineer in charge gets his men together periodically and talks to them on the engineering phases of the particular line of business in which they are engaged, and a fine response is always made.

With our company continuity of service means something. It affects supplementary compensation, consisting of a semiannual bonus payment of 5 per cent at the end of five years' employment. It affects vacation periods among a considerable number of men; for instance, every man of 10 years' standing has a week's vacation with pay, no matter whether he is a laborer or a skilled dayworker. It also has a direct bearing on old age and disability pensions.

Any man in the company who wishes temporarily to leave its employ for the purpose of securing a higher education is at liberty to do so, and his continuity of service will be assured.

Another thing which we maintain during the winter months, in cooperation with Union College, is a series of elective study courses, consisting of elementary and advanced electricity, chemistry, physics, mathematics, English, Spanish, French, etc. It is very interesting to observe those classes, which include not only men who are recently out of college, but also some of our oldest and most advanced engineers who have carried responsibilities over a period of time. One man told me that he was going to take a course in chemistry, as he had not studied chemistry since he was in college and wanted to brush up on it.

Still again, young men who have come to us with only a bachelor's degree and wish to study for a master's degree, are privileged to take recitations at the college each Friday morning without loss of time. With home work the higher degree may be thus acquired in three years.

I thought it might be of interest to those present to know that industrial concerns are keenly alive to the desirability of all classes of employees continuing their studies.

Chairman BLACK. We are very glad to hear from Mr. Pratt; and now I think that Mr. Dietz, who is the educational director of the

Western Electric Co., can perhaps elaborate still further on this subject and tell us some more things that we would like to hear.

Will Mr. Dietz kindly come forward?

Mr. DIETZ. Industrial concerns are making a very serious and careful study of training problems within their own organizations. We, in the Western Electric Co., are coming to feel that it must be a part of every executive's job to develop his men.

We, for many years, had a plan of centralization at our principal manufacturing plant at Hawthorne, which had for its main purpose the gathering together of a group of young men coming directly from college, many of them mechanical and electrical engineers, others who had courses in business administration, or even more general courses in arts or sciences. They were put into a sort of reservoir or training center, from which they could be drawn after they had shown their aptitude for certain lines of work, whether manufacturing, commercial, or engineering. That went very well for awhile, and we developed through that plan some very capable young men.

Careful analysis of the needs of our organization and the reaction of the young men to the plan of training have led us within the last few years to experiment along other lines. We now feel that the practical training of these men must not be done in a place apart from their regular job, but they must be put, as our people say, right up against the real thing after they come directly to us from their outside educational preparation.

Of course we have numerous methods of helping all of our men (both new and older employees), to broaden their knowledge of the company's products, the company's methods, and the company's policies, and to broaden their acquaintanceship among the company's own people. These are accomplished through organized educational programs and in cooperation with outside agencies.

We, too, like to inspire the men with the feeling that their job is an everyday one; that a man does not get an education and come with us and remain stationary, but that he is living and growing and that his education must continue, and that his usefulness to the company will depend upon how fully his growth materializes through his everyday work.

The real fundamental, we feel, is to get thoroughly established the conviction that it is the part of every executive's job to properly develop the individuals within his organization, and that his success as an executive is as largely dependent upon this phase of management as are those parts which can be measured in terms of output or profits, or dollars and cents.

Chairman BLACK. Gentlemen, we have with us to-day a man who before the war was professor of engineering at the University of Washington, Seattle, and in his work there he developed methods and original lines of thought. In the engineers we were most fortunate to find him at the time we were organizing the school at Camp Humphreys, and he has been an essential factor in the success of that school. I would ask Maj. More to say a few words now as to his work, both before entering the service and after his entering the service.

Mr. MORE.[1] Mr. Chairman, Ladies, and Gentlemen, one of the effects of the war grew out of the tremendous demands made upon the educational resources of the country. It was necessary to train large bodies of men effectively in a very short time. Naturally, this led to some rather hasty overhaulings of curricula and modifications of courses in general. Fortunately, however, previous to the war a number of experiments had been carried on for some time with the view of making education more effective in the attainment of its avowed purposes. It is noteworthy that the demand for engineer officers, which grew out of war needs, was a prime factor in the establishment of a school which would attempt to give the officer a more basic training and more efficiently fit him for engineering activity. The chief of engineers, Maj. Gen. Black, after years of observation and study, had become convinced that better results could be obtained in engineering education if some rather radical changes in method could be brought about. His convictions were confirmed by the investigations and report of Dr. C. R. Mann, and so with rare foresight and strong initiative he seized the opportunity offered by the war demands, and reorganized the Engineer School, with a view to working out some progressive educational methods. Working under the broad ideas laid down by the chief of engineers, Col. V. L. Peterson, commandant of the school, carefully fostered the details which led to final success.

Under the personal supervision and direction of Col. Earl North, and with the enthusiastic cooperation of instructors, this idea was carried out in the Department of Mechanics of Engineering by the adoption of methods similar in form to those which have been in successful operation at the University of Washington, Seattle, for the past six or seven years. These were described in an article in *Engineering Education*, for May, 1917. At the opening of the course no textbook was used, and there were no schedules or long-established rules of procedure to hamper an unprejudiced attempt to improve

[1] Editor's Note.—Owing to lack of time available for discussion, Maj. C. C. More was limited to a few remarks concerning the unusual enthusiasm and cooperation of the directors and instructors at The Engineer School; but assisted by Capt. W. E. Duckering, he subsequently prepared the detailed statement which is presented here.

the educational situation. Those engaged in the work were actuated by a single purpose, and all cooperated enthusiastically in the effort to secure definite results for the utmost benefit of the student. In this method the primary purpose is to stimulate and encourage the student in the exercise of his power of independent thought, reasoning, and judgment, and to increase his ability to cope with new engineering situations as they confront him in his career. This purpose is opposed to the usual method, which seeks merely to provide the student with a fund of engineering information and abstract theory, and which centers the entire instructional effort around such an aim. In the method adopted the principal effort is devoted to training the student in practical methods of attacking, analyzing, and solving engineering problems, and the endeavor is made to draw out and develop the possibilities which lie within the student, rather than to inhibit his thinking processes by supplying him too early with the final conclusions worked out by others. The effort is made to surround the student with difficulties similar, in their engineering setting, to those which would normally confront an engineer, and by this means quicken his mental reaction and lead him into an engineering attitude toward any problem which may be presented.

This purpose is best attained by the use of two distinct types of work. The student is first thrown into the analysis of what is called a "study problem," and by his efforts to extricate himself from the engineering difficulty into which he has been plunged he develops his individual powers and increases his desire for engineering information and training. With this desire stimulated to the point where satisfaction must be given, it is easy to hold his concentrated attention throughout the solution of problems demanding, as tools, the most intricate abstract theory. He actually demands increasing difficulty, and objects to delay on simple problems.

In order that the greatest freedom of thought may be secured in the analysis of problems of the above type, the student is not graded on work of this kind where he is encouraged to take chances and try things for himself. But because he needs training and needs it badly review problems are assigned for the purpose of fixing the use and understanding of the fundamental principles. These problems are marked zero if mathematically correct results are not obtained, because an engineer's work is worse than worthless if it is incorrect; it is positively a menace to the community. Usually students are deliberately trained throughout most of their schooling to believe that accuracy is not important if theory is understood. This false attitude must be thoroughly rooted out by severe disciplinary training. For this purpose, the review or "drill problem" furnishes the means, while at the same time serving the equally im-

portant end sought in profitable repetition. In order that the student may get the full benefit which can be derived from drill, complete sets of specifications are drawn up so as to guide his efforts to secure system, clearness, and accuracy along those channels which the best engineering office practice has developed. He is taught to recognize the importance of each step which he takes in the solution of his problem, and to surround his work with as many safeguards and checks as necessity demands and time will permit. Under this system he not only makes fewer mistakes but he learns to find and correct his own errors.

It is an encouraging fact that when earnest men get together with a determination to do something for the student, the experience at the engineer school proves that it can be done. Whatever results were obtained were due primarily to the definite and earnest cooperation of directors and instructors in the one great object. Nonessentials were swept aside and bare psychological facts faced with a determination to make education effective. While it is unlikely that identical methods would be developed under the varying conditions met in other places and in other courses, it is absolutely certain that, where there is an open-mindedness among directors and instructors, and an enthusiastic interest in the development of the student, the educational product will be far beyond what it usually is at the present time.

Chairman BLACK. Will Dean Walker, of the School of Engineering of the University of Kansas, give us some of his experiences? He was in the Army and has had regular Army experience as a colonel, and he is now back again with his civilian clothes on. We would like to hear from him.

Mr. WALKER. There are several things which I have felt like saying this morning as this discussion has developed. Perhaps what I say will be in a way to turn back slightly from the trend which the discussion has taken. It has been quite largely along the line of officers' training. I want to speak of the experience which I had during the months following last September. In September, the regiment of which I was in command was organized, and we proceeded in the training of that regiment on a basis as to time quite different from that which had prevailed when the earlier Army organizations went into training. That is, we had the task of taking practically green men, because while some of our men had been at Camp Humphreys, many of them had been there but a short time and had had very little training, and, in 3½ months were to be ready to go over seas with the organization.

That was different from the conditions for most of the divisions which were organized in 1917, many of which took 8 to 10 months, or even more.

I want to point out the method. We had our officers, and some of those officers were reasonably expert. Some of them were not. As a matter of fact, two-thirds of my officers were young second lieutenants just out of the training schools, many of whom had not even had the technical engineering school training, at least not the complete course of training.

Now, this is the program as followed: We had schools organized at first, while we remained at Camp Humphreys, the regular schools at that camp. To those schools we sent the men who in their previous civil life had worked at the trades. For instance, to the carpenter school we sent men who had carpenter experience; to the blacksmithing school we sent men who had blacksmithing experience, and so on. That system was continued after we moved to the division rendezvous at Camp Dodge, Iowa. That is, we had our own regimental schools there, supervised by our own officers, selecting for the instructors in those schools the officers who had the most training in those lines.

By that method we were developing a group of men who would take the position below the officers as to training and as to their capabilities. The next step was to organize entire company groups so that every man in a company would go through his specialty training period, and in this secondary school work the men who had been trained in the first were employed as instructors. The object was to develop a complete working organization with the highest technical men at the top, and, secondly, a group of men who were capable of acting as supervisors or foremen, and then the men, many of them pick and shovel men, of course, but all of them trained to do some phase of the work which it was expected that they would be required to do.

I speak of this for the purpose of drawing a comparison. We are discussing this morning the question as to how the Army methods of training will affect the schools of engineering. I want to point out the fact that in the schools of engineering the first object is to train the engineer who will occupy a position in industrial life similar to that which the officer occupies in the Army. We are dealing with only one phase in the engineering school, only one phase of the Army problem.

My comparison of the Army system with the educational problem in civil life is with the entire educational system. We have been training engineers, gentlemen, for 50 years or so, and there has been too little attention to the training of the men of the second grade. The work which Mr. Pratt and Mr. Dietz have just explained to us shows how industrial organizations are taking up that problem.

To my mind [illegible] Hughes Act for vocational training is one of the greatest [illegible]ward in the educational plan which we have made in this country, because it provides for the training of that secondary group of men, and, believe me, the corps of noncommissioned officers in various lines of the Army organization is a most valuable one. I have sometimes thought that we could get along without some of our officers better than we could get along without a great many of those trained noncommissioned officers.

So I say that we should draw lessons from the Army experience with reference to the entire scheme of industrial education fully as much as, and perhaps more than, with reference to the developments in our schools of engineering as such.

Do not think I am depreciating the fact that important lessons may be gained and experiences applied to our work, but I have wanted to call the attention of the conference this morning to this, which seems to me one of the most vital points with which we must deal.

I spoke yesterday afternoon here with reference to teachers and teaching. I want to say another word. The paper of Gen. O'Ryan and the address of Dr. Mann called attention to, and stressed really, the matter of the development of personal qualities in our men. I want to repeat or amplify what I said yesterday afternoon and that which some others said here yesterday with regard to the value of the teacher.

I want to draw again from my own experience. I went back to the university in March. The school year was pretty well over, but I took up one class, a class of seniors which I had always taught, a class in organization and administration for industrial work.

We speak about the development of character, of the development in our men of a sense of professional ethics. I believe this, that the teacher while he is carrying on his class work can find opportunity to impress upon his students points with regard to a proper professional attitude, questions of ethics which fit immediately into their surroundings. The point of application is right there. For instance, in this class of mine where I have been dealing with the question of valuation and the basis for establishment of rates, there come unexampled opportunities to impress upon the student the fact that the engineer, given a certain set of facts, can arrive at only one conclusion, that he must, for his professional standing and for his standing as a citizen, approach that problem with an attitude of the strictest impartiality; that his results and his reputation as an engineer ultimately will depend upon the truthfulness and the accuracy of his work, and the strictness with which he applies in his reasoning the data which is given him.

There is another thing in which I believe teachers of all kinds are lax. I have been connected with the faculties of three different schools of engineering in my teaching experience. I have not seen very much difference among them, and I have looked over the several departments in both engineering and academic school branches of university organizations, so I believe that much the same situation prevails everywhere. I believe that there are three points on which we, as engineering teachers, may do much to improve the situation, and, in so doing, apply principles which have been emphasized in the Army work.

These things are, first, definiteness in our work, definiteness in our assignments, definiteness in the demands that we put upon the students—not to be severe, not to increase the amount or scope of work, necessarily, but to make it very clear and positive that certain definite standards are to be met.

Let me say, parenthetically here, that I believe that the Army system of having the organization that is being trained by one set of officers inspected and tested out by other officers, whether of the same divisional organization or from the inspector's department at Washington, is a very good thing. I am not sure but what it would be a wise thing to have something like that established in our civil schools. I thoroughly believe that there should be developed at all of our institutions that practice which has perhaps reached its peak of excellence at the University of Cincinnati under Dean Schneider, the matter of cooperation and consultation with reference to the setting of limits of the work and seeing that each instructor's work properly coordinates with the others.

My second point is that of insisting upon promptness. I took up this class work in March with a group of 22 students, and I made a statement to them in the class that notebooks or exercises would be passed in on a certain date. I think practically every instructor will admit that there is laxness in the matters demanding promptness.

I made the statement to the class in very simple words. I did not issue orders in a military way, but said very simply and clearly that this work is to come in on such a date. I had discussed with them the time. It did not make any especial difference whether it was to be Thursday of this week or Tuesday of next week, but I said, "When the time is set and the day indicated when the work is to come in, I mean that every one of you will have his book or exercise here on that day." Every one of them was there. As I say, I did not employ any special argumentative manner of speaking; I simply made it as a plain statement, and they knew that I meant it, and all the work was there.

My third point is this matter spoken of before, of the teacher in his work making the applicatory connection while carrying on his regular work, giving the economic connection as to cost of construction and its significance in the industrial world at the same time that he is giving his fundamental principles of design or operation.

I want to say, with reference to what has been said regarding the method at Camp Humphreys, that years before the war I was employing exactly that same method, in substance. I have taught organization and administration on an industrial basis by the applicatory method.

Some years ago I was handling a course in hydraulic power development and used exactly the same method which Prof. Hatt has described as being employed in the design courses at Camp Humphreys. I know it is good and that it can be employed in a great many courses.

I fear I am taking too much time, but I was just itching last night when the conference closed to get on my feet to speak with reference to one point and will take two or three minutes now, if I may. It is the matter of intelligence tests. They were referred to yesterday two or three times. I want to say at the outset that I am very much in sympathy with, and very much interested in, the intelligence tests.

Two or three years before the war I was having the instructors in the school of engineering in Kansas rate their students. Of course, rating is not an intelligence test; let us have no confusion on that. But I had insisted upon that, and had tentative plans under way with the psychologists at the university to proceed with the examination of students on somewhat the basis that was adopted in the Army.

I speak of that merely to make it clear that I went into the Army and came under that system with a sympathetic viewpoint. I took the test myself. I do not know what I made—I never asked; but when my regiment was formed down here at Humphreys I went into the thing with a determination to get out of it everything that it was possible to get.

I studied the individual records of the men. I conferred with every company commander with reference to the employment of the test records. We decided on a course of action. There was the matter, as there always is, of selecting noncommissioned officers; and the intelligence test is of great assistance in selecting the men who have knowledge and capacity to develop into those positions, which I have already said are positions of great responsibility. Further than this the test records were of no use.

The thing that I want to do is to warn you—perhaps it is unnecessary—but to warn all not to be misled into thinking that the intelligence test, with the amount of data which we have on hand at the present time, can be made the basis for vocational guidance. It may be that in the course of 12 to 15 years if we have intelligence tests of our students taken at different times, perhaps every year, with a record taken in the closest possible manner to show what those men have done in after life and how they have developed, it may be that in such a long period of time we will get to the point where we can do something in the way of exercising vocational guidance on the basis of the intelligence test. At the present time, however, the data is entirely insufficient. The intelligence test is of tremendous value when it is used rightly, but it has very little value and, I fear, is worse than valueless at the present time if it is made the basis for exercising vocational guidance.

Chairman BLACK. Gentlemen, we have with us this morning Lieut. Charles Davidson, First Lieutenant of Engineers, who represents a manufacturing company in Cincinnati, Ohio, where they have been carrying out a very interesting experiment in engineering instruction. We would be glad to hear from Lieut. Davidson as to his experience in and out of the Army.

Is Lieut. Davidson here? (No response.)

If not, we shall be glad to hear from any other gentlemen who may wish to add to the interest of this meeting.

Mr. MARSHALL. I just want to say a few words in connection with Mr. Pratt's remarks. I am connected with a manufacturing company where the foremen and superintendents of the mine meet every two weeks and discuss these subjects. The desire of the men to learn is very marked. One fellow, for instance, who is today a superintendent of blast furnaces, started as a helper in the machine shop. I advanced him because he was eager for work of any kind and was studying with a correspondence school. He is a thoroughly equipped man now in all lines of blast-furnace work, and anything connected with coal mine.

The same plan is followed with the general superintendents of the Aluminum Company of America, in North Carolina, where the men are all anxious to learn, especially those who have never had a chance. It is remarkable how some of them come to the front through the help of those who were more fortunate in securing training in early life.

Mr. EMORY. Mr. Chairman and Gentlemen, I desire to add a little testimony.

At West Virginia University we had some experiences which I think perhaps might be interesting; and it may do no harm to repeat

some of them. It became part of my duties during the late unpleasantness to lay out a schedule for each student in the Students' Army Training Corps. Many students for the first time were surprised that there are 24 hours in the day. Experience demonstrates that the lessons must be shorter. We covered perhaps not over half the ground during the hour that the men were there, and they did good work and were keener. Work which is fundamental may up to a certain point be done in that way, that is with little preparation outside the classroom. But there comes a time when a man must enter the visualizing stage. There comes a time when the student should go to the top of Observatory Hill and lie prostrate with his eyes to the great zenith and forget his contact with the earth and think a little bit for himself.

If we wish to train men to think and visualize, they must get away from limited instructions. We must preserve a course of study for men who wish to go beyond the training stage. My experience has been that so far as the work was applied at the time by special problems they did very well, but when we began to discuss a problem that in a future time may have some application for them, they did not follow.

The control of State universities is largely what we ourselves can make it. Every instructor in a State university in this country does most of his work within the sphere of his influence in his own classroom.

Therefore, Mr. Chairman, we must lead these men up to the heights by the training that they need; we must take them on top of the Alleghenies and say, "Behold the promised land." There you will see it—blue grass growing as soon as you cut the timber, cattle on a thousand hills, the coal 70 feet below.

Chairman BLACK. I would only answer the last speaker by asking him to go to Camp Humphreys, where we have both the mental sphere and the vision, and let him see for himself from our young men whether they learn to think or do not.

We have only five minutes more, gentlemen. Will not Prof. Flather give us a few moments?

Mr. FLATHER. Mr. Chairman and Gentlemen, there have been so many excellent suggestions in the papers that have been presented and in the discussion which they have evoked that I am tempted to speak on many of those points, but on account of the lateness of the hour I shall confine myself very briefly to the topic before us, which is "The significance of the war experience for engineering education."

There has been much presented here this morning in connection with producing morale in our teaching. The one thing that has impressed itself upon me with reference to the men who have come

back from the war and have reentered their classes during the past six months has been the fine morale—the interest and enthusiasm for work. They went away from us as boys, irresponsible. They have come back to us mature men with definite ideas and with high ideals, and a desire to get as much as they can out of the work which we were providing for them.

Now, if I have learned any lesson from this war experience, it is that we must introduce in some way that spirit which has been produced in the boys during their war service, that stimulates them, that gives a spirit of earnestness which makes for better work, which makes for manhood, and what we call character. In our upper classes we do have some opportunity within the subject matter which we are teaching to present and discuss questions of ethics which make for high ideals, and I am inclined to think that the older boys realize the importance of those things and approach their work with a fine spirit of enthusiasm. But we lack the same contact with men lower down; it may be, as Dr. Mann pointed out, and as Dean Marston has emphasized, that we need not only a scholastic rating for the subject taught, but it is quite likely and probable that we must use a method of classification and rating in addition to the scholastic, which may produce this stimulation that has been so effective in making men of character of those boys who have come back to us from the war training.

Chairman BLACK. We have about 3 or 4 minutes, Gentlemen. Dr. Swiggett, have you anything to say?

Mr. SWIGGETT. I would like to say just one word in reference to the concluding session over which Mr. McLean, Director of the War Finance Corporation, will preside this afternoon.

I think we all agree that at the three sessions of our conference proper attention has been called to the very great help rendered by the engineer, not only during the prosecution of the war, but to the help that is now being given by the engineering faculties in training men for industrial and commercial management. I wonder sometimes, however, whether the engineering faculty has fully caught the vision which we find large groups of enlightened business men in the United States to possess, enabling them to see that the path which this country must take with respect to future economic prosperity lies through foreign trade.

We are beginning to agree that the engineer is very essential in training men for home production, production for trade at home. Attention will be called in the program of this afternoon to the very large part, an increasing part, that the engineer is to play in production for overseas engineering projects and commercial enterprises.

I felt somewhat constrained to make this statement at this time for fear that some of you who have been very faithful in your attendance thus far might feel that the afternoon session does not directly bear upon your major interest in your institution. We want you very much, therefore, to be present this afternoon.

Chairman BLACK. Gentlemen, I wish I could sum up what has been said this morning. I was a little surprised to find that you were at sea as to any lesson to be drawn. There have been some very valuable things said here. It certainly has been pointed out that it is possible to improve methods of teaching.

I have already told many of you before what our conclusion was. We in the engineers had been driven very hard sometimes to obtain men in our corps from civil life. We concluded that there was something very wrong about the methods of teaching, that the student did not learn what the curriculum was supposed to teach. The curriculum was all right as a rule, but the student as a rule did not apprehend it. That is one reason for our course at Camp Humphreys, and I invite those among you who are interested in it to go down and see what we are doing. Unfortunately, the class is about to leave for France, so you can not see very much, but perhaps you can get Prof. More and some of our officers to tell you more about it at the Baltimore meeting this week of the Society for the Promotion of Engineering Education.

One other lesson that I think has been brought out this morning is the necessity for every man to get self-discipline. Vision is necessary. But directed vision is what we want, not vague vision, and the man who has achieved self-discipline and has learned that, is the man whose vision is worth while. The vision of the other man is little better than a dream.

We have heard talk about morale. We can not talk too much about it. We have had a tremendous incitement to morale in this great war. After all, is it not our duty as citizens to preserve to the world this Government which the war has proved to us all, if we ever had any doubt, is the most wonderful Government ever devised by man? Is not that an object for morale? Is it not necessary for each man of us to play his part in that Government as a citizen, as a producer, doing what he can? Is there not sufficient incitement to earnestness of purpose in that? It is, then, only necessary to arouse that spirit and direct it in order that we can fulfill our part as kings of this earth. Those are the men who direct not only their own destinies, but point out the right direction for the rest of humanity. Surely, we citizens of the United States have an incitement to morale in all of our work.

The time is now up, Gentlemen, and I declare the meeting closed.

FOURTH SESSION.

Mr. Angus Wilton McLean, Director of the War Finance Corporation, presiding

Mr. SWIGGETT. May I say, Gentlemen, that the hour has come to begin the concluding session of this conference. I take great pleasure in presenting as the presiding officer for the afternoon Mr. Angus Wilton McLean, director of the War Finance Corporation.

Chairman MCLEAN. Gentlemen of the conference, I confess to some degree of hesitancy as I appear here before this learned and highly educated audience to discuss a subject about which I realize I know very little, but in accepting Dr. Swiggett's invitation to preside this afternoon, opening the discussion of the subject which has been assigned, I promised to discuss it principally from the standpoint of the business man. So I shall attempt to confine my remarks to that phase of the subject.

TRAINING OF THE ENGINEER FOR OVERSEAS ENGINEERING PROJECTS.

By ANGUS WILTON MCLEAN,
Director of the War Finance Corporation, Washington.

I have been requested to preside at this session of the conference, and to open the discussion by a brief address from the standpoint of a business man, upon the subject of training of the engineer for overseas engineering projects.

The general question of business training for the engineer is one to which I have long given consideration, for the reason that in my past experience as a business man and an investor, as well as during my more recent experiences as Director of the War Finance Corporation, I have often had occasion to realize the existence of an unfortunate lack of contact between the viewpoints of the engineer and the business man. The existence of this gap has occasioned many unnecessary financial losses, because of the construction or operation of projects sound from the purely technical engineering stand point, but unsound from the financial or commercial aspect.

Without a full understanding between the business man or investor and the engineer, and a more comprehensive knowledge on the part of each of the other's viewpoint, railroad lines may be located and constructed, producing masterpieces of engineering skill, but which may result in practical failure from a commercial standpoint, because of insufficient traffic to yield a reasonable return

upon the capital invested; permanent structures of a commercial or business character may be built which would serve only temporary needs; mines may be developed and mills constructed for the treatment of ores therefrom during a period of abnormally high prices, to be followed later by the discovery that such prices are temporary only and that under normal conditions the investment can not yield a profit.

It is because of a general realization of the necessity for a broader training to bring about this closer contact that your conference is in session. Earlier speakers have already discussed the necessity for business training for the engineer and engineering training for the business man. This session is to discuss the general and commercial training necessary for the engineer engaged on overseas engineering projects, and this subject is in many respects closely related to the subjects previously discussed.

Generally I feel that the engineer preparing himself for the investigation, construction, or supervision of engineering projects overseas will require the same training from a business or commercial standpoint as would be required for an engineer engaged in similar projects here, but the necessity for such general training in connection with overseas projects will be much greater, partly because of the fact that the engineer will be farther away from his principals and required to depend more upon his own judgment and initiative, and partly because he will need to adapt himself to the totally different financial, social, and economic conditions prevailing in the field of his foreign operations.

I am speaking now in respect to an engineer holding an executive or advisory position. The educational requirements of the purely technical engineer working under technical supervision are practically the same whether his operations are carried on here or abroad.

The activities of the engineer may be considered as twofold in character. The first is the purely technical side, involving the designing or construction of engineering projects whether of a civil or military nature; the second is of an advisory or consultative character, involving the investigation of the physical value or prospective earning power of engineering projects for the guidance of promoters and investors. The first relation is more important from the standpoint of pure technique and also in respect to the number of engineers engaged, but the second is of far greater potential importance because dependent upon the correct solution of the commercial problems involved. For these reasons promoters and investors are rapidly learning to seek the services of the engineer who, in addition to his technical skill, is possessed of extensive practical knowledge and keen business foresight. Many of the heads of our great railroads and industrial enterprises are types of this

important combination. With increased American investments abroad, there should be even a greater demand for the engineer with commercial training and, consequently, the capacity to act as a safe adviser to the banker or investor. These considerations make it highly important that our schools and colleges should broaden their engineering courses so as to produce a constantly increasing number of engineers of this character.

From the standpoint of purely technical training I have no suggestions to make. Our engineers have proven their technical ability in every line—military, civil, economic, electrical, and mining. Our railways, our industrial plants, our power stations and mines, under both war and peace conditions, are monumental evidences of the excellence of their skill.

It must be conceded, however, that the average engineer, because of lack of proper commercial or general training, is not so well qualified to act in an advisory or consultative capacity to bankers and investors. Too much stress has been placed by our technical schools and colleges upon the purely technical phases of the training of the engineer, and not enough attention has been paid to his training in respect to social, financial, and economic conditions. There has been too much of a tendency to neglect the practical or business side in the course prescribed for the education of the engineer. The engineer whose experience has been purely technical is not always able to master practical business problems in the interest of the investor. The average engineer is too often inclined to view the project from the standpoint of the technical expert, whereas the investor's chief concern must always be the probability of a reasonable return on the capital invested. To enable an engineer to qualify as a safe adviser to the promoter or investor, he should, like every other professional man, have a liberal education. The more extensive his general knowledge, the greater will be his capacity to cope with the new and varying problems which will necessarily confront him, especially in connection with operations carried on in foreign countries. He should have sufficient training in financial matters to enable him to think not only in terms of construction and design, but also in terms of the earning power of the capital invested in the enterprise.

Special training in expression is also desirable for engineers entering this latter field. The technical man may understand his subject thoroughly and yet be unable to discuss it in a way to produce full understanding and conviction on the part of those not accustomed to technical phrases and expressions. It is often difficult for the engineer to forget, in writing reports for the consideration of laymen, that he must act in a sense in the capacity of an interpreter, and write in terms intelligible to laymen about matters which to

him are elementary, but which they can not fully understand. Ability to write a clear, concise, nontechnical report on an abstruse and technical subject is therefore an asset of the greatest value to engineers planning to take charge of overseas projects.

In order to fit him for overseas duty an engineer should have an accurate knowledge of world geography, and particularly of the geography, history, habits, and racial characteristics of the people of the land in which he proposes to operate. It is probable that our immediate field for engineering projects overseas will be found in Latin America and the Orient, and in my opinion Latin America (including, of course, Central America, Cuba, Porto Rico, Mexico, and the Dominican Republic) offers the most inviting field.

Knowledge of the language of the territory in which the engineer proposes to operate is highly important. Of the principal foreign languages, a knowledge of Spanish and French will no doubt prove the most useful.

It is also very essential than an engineer entering the higher ranks of the profession to serve in an advisory or consultative capacity, and particularly if his duties take him overseas, should be a man of broad vision, with a proper conception of the human relationships. This is particularly necessary in dealing with foreign people. He should withal have the capacity to deal tactfully with people of other races whose language, customs, and methods of business are often very different from his own. An engineer so equipped will be able to avoid much friction and misunderstanding in the prosecution of his work.

The same degree of tact, knowledge, and sympathy is of paramount importance for the engineer who is to deal successfully with the labor element, whether here or abroad, and the necessity for this is particularly emphasized by the present unusual conditions of labor in foreign countries.

Within the past few years we have seen a rapid change in the relations of labor and capital, and we are now considering the engineer as a representative of capital. In the past, there was usually an excess of labor. The conditions now are reversed. On any large construction project the direct expenditures for labor usually represents more than half the total cost of the work. Labor is therefore the most important of all the elements which the engineer must consider in the successful performance of his work. Under present, and probably future, conditions labor will require more and more the attitude of sympathetic bargaining and cooperation rather than the old method of coercion. In these days and the days ahead of us no engineer can hope to deal intelligently with labor unless he realizes the new relationship between labor and capital, which is now recognized by thoughtful business men everywhere.

The necessity for a broader training for the engineer such as I have suggested is even more manifest when it is remembered that a large part of the overseas engineering work which our engineers may have occasion to undertake may be done on the "cost plus" basis, and this will likely be the basis of most contracts, especially those involving overseas projects, as long as labor is high and the cost of material is subject to unusual fluctuation. The duties of the engineer, in these circumstances, will require him to be familiar with the sources of production, economy of transportation, and relative cost of the various materials needed for the work of construction. The engineer who undertakes to design, estimate the cost of, and supervise the construction of, projects upon this basis, must master the technical side of engineering not only, but must have the general training such as I have been discussing, and, above all, business acumen of a high order, if he expects to justify the confidence of those who furnish the capital necessary for the completion of the work. The engineer who has the widest knowledge of general conditions in foreign lands and who has been trained by experience and education to adapt himself to these conditions will, beyond doubt, be the one who can most successfully accomplish the unusual tasks involved in overseas projects, and obviously his services will be in greatest demand, without regard to the question of salary.

In conclusion, let me say that the engineer is the pioneer standing at the frontiers of civilization. The characteristic that distinguishes the Occident from the Orient, mobile and sensitive Europe from static and inert Africa, are the works of the engineer, the railroads, telegraph, telephone, the factories, the cities, in short the works of man who shapes his environment.

Contact between men, between nations, between races, stimulates them to rise to new planes of effort. As the Crusades brought on the renaissance in the ancient age, who dares to predict what new life the crusade of 1914–1918 may stimulate? Senegalese, Kafirs, Hindus, Chinese, Australians, Canadians, and Americans, all met in a great common cause of all European nations on the fields of France. Millions from all the continents and from distant lands will carry back to their homes new economic wants and new intellectual concepts, which will impose new demands on the engineering profession. Africa, as large as Europe and North America combined, has but one-tenth of the railroad mileage of the United States. In Asia are hundreds of millions whom the extension of western civilization will convert into a new world of producers and consumers on our own scale of living. In their present state they are restricted in their wants, live on a low scale, and are a menace, as producers, to the western democracies. The backward world will be awakened by the magic touch of the engineer. The wireless, the

airplane, the oil-burning ship may extend the area of civilization in its mechanical, and consequently, in its cultural, aspects. They will create new centers of industry and mark out new lanes of trade.

The American engineer forged ahead of the American merchant even before the war. It was the American engineer who built the railways in China, worked at the gold mines of South Africa, developed the copper mines of Chile and Peru. Our engineering organizations that specialize in foreign construction enterprises laid out the public utilities of many South American cities.

The conditions of commerce after the war will accentuate the interest of the American engineer in foreign construction and development. Before the war we had an annual debit balance of about five hundred million dollars, which we settled for by the expenditures of our tourists abroad, remittances of our immigrants to their families and relatives, and by payment of freight, insurance, and banking charges to Europe. As the result of the loans and advances we extended to Europe during the war, we shall have an annual credit balance of about five hundred million dollars, and we shall be left dependent upon Europe for freight, insurance, and banking facilities. For a long time Europe will be unable to pay us in goods, and we shall be compelled to turn to foreign investments to absorb the credit balance which will accrue annually.

At the beginning of the war a syndicate of American bankers financed an Argentine railroad which had always obtained its accommodations from Europe. During the war the prestige of American engineers was increased by the work of the Stevens Railroad Mission in Siberia, by the feats accomplished by our engineering division behind the lines in France. Not only has the prestige of our engineers increased, but the financial community has followed close behind the trail blazed by the engineer. Recently American bankers have made loans to Brazil and Sweden. Further loans for the rehabilitation of portions of Europe will be necessary for the building of bridges, the relaying of railroads, and the replacement of factories and equipment. These foreign investments will call for new effort and a new attitude on the part of our engineers.

Furthermore, in a large sense the engineer precedes the merchant in foreign fields. Export trade follows permanent investment more surely than it follows the flag. Recently the head of a large London bank stated in his annual report that the trade between the United Kingdom and Argentina was the result of British investment in engineering enterprises in the River Plate. The contacts between engineering and commerce and industry are multiplying daily. They call for not merely more extended courses at engineering schools and accounting, finance and commerce, but they demand that

the engineer act as the link between his professional field and the many aspects of life which are so profoundly affected by it.

It is hoped that our bankers and capitalists generally will have the vision and the courage to take full advantage of the great opportunity now awaiting them, and furnish the money to open wider fields for American enterprise, and thereby utilize the eminent abilities of our American engineers.

To accomplish this result the American investor must cast aside his previous timid attitude toward foreign investments which has confined the industrial activities of this nation within narrow and provincial limits in the past. We should forthwith assume the leadership of world trade and world finance and world-wide engineering projects which our incomparable resources and the natural ability and enterprise of our people so completely entitle us to assume among the great nations of the world.

No one who contemplates the stupendous results America has achieved in the past two years can doubt the ability of American business men and American engineers to take and hold the leadership in all the great work of construction and reconstruction now awaiting them, if they will only practice in peace times in some degree at least the courage and enterprise which characterized them in time of war.

Chairman McLEAN. Now we will proceed to the regular formal program.

The first speaker will be Mr. C. H. Gardner, of the American International Corporation, who has been requested to read the paper of Mr. Lavis, who was unavoidably prevented from attending the conference.

We will now hear from Mr. Gardner.

THE TRAINING OF THE ENGINEER FOR OVERSEAS SERVICE.

By FRED LAVIS.

Consulting Engineer, American International Corporation, New York City.

When I accepted the invitation to take part in this discussion, it was with the understanding that I would speak of the *results* to be attained by the training and education of engineers for foreign service, rather than of the *methods* by which these results might be achieved.

The nature of my own experience may perhaps qualify me to say something in regard to this, that is, to speak of the necessary and desirable qualifications of the engineer who may be engaged in foreign service, but it does not permit me to indulge in any discussion, least of all of any criticism of *methods* of education; if, therefore, in what

follows I may criticize the results or lack of results which the present methods of education achieve, it must be understood that I do so with all due reservation of a lack of knowledge on my part of the difficulties and limitations which may, for all I know, be a part of our present educational system.

Speaking generally, I should say that it is most desirable that engineers engaged in foreign work should have a wider culture, a better general training in what, for lack of a better term, is usually referred to as a "classical education" than American engineers usually have. I suppose I shall be liable to bring a hornet's nest about my ears for saying so, but I have met also with more than one instance where a little more intimate knowledge of, and a facility in the use of, the ordinary social usages of cultivated people would have done no harm and might have been a distinct benefit to the engineer abroad.

In connection with the development of foreign enterprises, as also indeed with the development of enterprises here at home, the engineer is the first man on the ground, and the foreigner is very apt to form his ideas of the people in America connected with the enterprise—in fact, of all America and Americans—by these first persons with whom he comes in contact.

The engineer who goes abroad, at least the engineer in charge of an enterprise, is usually sure to come in contact at once with the officials of the country, the heads of the State, and to be the recipient of social attention. If he meets foreign engineers, he will find that they are usually men splendidly equipped technically and of a broad culture, and while we Americans may pride ourselves, and I believe we do so with perfect justice, on our ability in the practical application of our profession in a business way, yet we must have, if we are to succeed in foreign countries, the broad general education and "savoir faire" which will permit us to meet all these people on an equal basis, whether socially, culturally, technically, or in business.

Before taking up, specifically, the question of the special qualifications of the engineer engaged in foreign work, I wish to touch very briefly on certain *fundamental matters* necessary in the training of all engineers, and which have seemed to me to have been rather lost sight of in the training of many of the young men, graduates of our technical schools and colleges with whom I come in contact, the lack of which is especially apparent when the engineer is away from home.

The training of our engineers in the mere technique of engineering is generally good if they have graduated from a good school, but it has seemed to me that they are often deficient in general, all-around culture and in those elements of knowledge that go to make up the really well-educated man.

Many engineers who graduate from our technical schools are little better than skilled mechanics, perhaps with some little added knowledge of the principles of chemistry, metallurgy, or geology, or the ability to calculate the strains and stresses in structures, but, after all, such a man is little more than a superskilled mechanic.

The engineer, to be successful, must be a man of vision, must be a trained observer, and must be able to describe in simple plain English in an orderly manner what he has seen. Let me emphasize that last sentence a little more—*simple plain English* used in an *orderly manner*. Speaking generally, our engineering students can not write the English language clearly and accurately, they can not arrange a report in logical sequence, nor do they think in an orderly way, and, above all, they lack a realization of the point of view of the nontechnical business man who is providing the money for the work they propose, or may be carrying out.

It is my task to read from time to time all sorts of reports—reports from junior engineers to their immediate superiors, from these to the man in charge in the field, from experienced chief engineers to the officers of a corporation, reports by eminent consulting engineers, and it is truly astonishing how few really fill the bill.

It is not to be expected, of course, that our schools and colleges will turn out men of 22 or 23 years of age with all the attributes of a man of 25 or 30 years' experience, but I do think that some effort should be made, and I believe it should be made in our ordinary lower grade schools, to instill in the minds of pupils and students habits of neatness and carefulness in all their work. Poor writing, carelessness in arranging computations, and poorly made figures are responsible not only for mistakes but for sloppy mental attitudes which persist for many years, often for the rest of the man's life.

Young graduate engineers also seem to lack, or to show a surprising lack, of interest in the fundamental economic principles which move and keep going the affairs of the world in this modern era of complex civilization. It is probably true that most people lack this realization, but it seems to me that it is particularly necessary that the engineer should have a real knowledge and appreciation of these principles if he is to convert the forces of nature to the use and benefit of mankind in an intelligent manner, whereas, as a matter of fact, he is generally so obsessed with the technique of his profession, or his time has been so fully occupied in acquiring it, that he has lost sight of these larger principles which are really a necessity to the true engineer.

Take as an illustration only one instance, the effect of modern transportation on the affairs of the world. The average person, and many engineers, think of a railroad as so many rails, so many

ties, a series of bridges, tunnels, etc.; the engineer of vision sees it as one of the greatest revolutionary agents for the benefit of mankind which has ever influenced the world.

The true significance of the transportation development of the last century was hardly recognized five years ago; it is doubtful if it is fully recognized to-day, but it is only necessary to recall the statement so frequently made that the tremendous conflict now drawing to a close has been a war of whole nations rather than of armies, to realize what a tremendous change transportation has brought about in only 50 years since the Franco-Prussian war.

Only a comparatively few years ago each community was for all practical purposes sufficient unto itself; it could usually live, whether trains ran on land, or ships sailed the ocean, or whether they did not. To-day, as the result of the disruption of the transportation service of the world, the whole Continent of Europe is on the verge of starvation and is threatened with a complete upheaval of its social system because men are out of employment for the reason that the products of their labor can not be interchanged.

Modern transportation made it practicable to produce great quantities of wheat in one area, beef in another, iron and steel in another, and so on, and permit their interchange so that the inhabitants of each of these areas might do the work for which they were best adapted, or which the particular qualities or properties of the locality in which they lived made most profitable, and reap the benefits of production under the most favorable circumstances.

Now, perhaps we may seem to be a long way from the training and education of the young engineer, but I wanted to give you at least a glimpse of the tremendous field he must cover and the wide vision he should have if he is to be more than the mechanic who can build a bridge that will not fall down, or find the number of acres in some back farm lots.

Of course I do not mean to say that these facts to which I have alluded—of the effect of transportation on our modern civilization—are entirely unknown to engineering students, or to you gentlemen who direct their studies, but I would like to leave with you the thought that a real engineer should have this breadth of vision of the great significance of the effect of general economic principles on all the activities of mankind, and if the student is to develop this breadth of vision later on, his thoughts should at least be turned in this direction while he is in school, and he should be taught there their importance as part of the engineer's equipment, especially for foreign work.

To avoid misunderstandings, it may perhaps be worth while to say that of course this training in the broader principles of general economics, however far it may go, or however little it may be, does

not in the least obviate the necessity of thorough training in the principles of the profession. Above all must the engineer stick to facts, and facts of the coldest kind, and be thoroughly grounded in basic principles.

I am rather inclined to think that the engineering training of to-day looks rather to a certain specialization, with a view to turning out men who can actually do some one thing when they graduate which will enable them to earn a salary, rather than to the turning out of students thoroughly grounded in the principles of their profession.

May I emphasize again the need of accuracy and thoroughness, the ability to read and write the English language properly, the ability to do addition, multiplication, and division correctly, the ability to set down a column of figures in order, to do straightforward, clear, orderly thinking about anything—these are the essentials, and I feel sure that greater attention to these matters throughout the training, not only of the students in our colleges but the children in our schools, is of the utmost importance.

Now, gentlemen, my time is drawing to a close, and you will wonder why I have said nothing about special training for foreign work. I doubt very much if any is necessary. I can not conceive that the engineer I have pictured above should not be able to go anywhere and practice his profession successfully.

No man is properly educated who does not know at least one language other than his own. Personally, I advocate the study of French and Latin, but Spanish will also be very useful to Americans, and I would advocate the study of a modern language from a native teacher for every child in our public schools. A competent knowledge of one modern language might well, I think, be a requirement for entrance to a college or technical school.

The engineer who is to go abroad needs to have certain mental and physical characteristics. He must have a keen sense of justice and fair play; he must have no race prejudices, or, at least if he has, he must learn to control them. He must be temperate, honest, conscientious; but here again these are only the virtues which make for success at home. Of course at home he is within reach of help, sometimes; independence and self reliance are more necessary 5,000 miles away from headquarters than they are 500 miles away, but these qualities are rather inherent in the man than the result of education, though education may help.

Summing up, therefore, let me say that aside from the question of knowledge of a foreign language, the engineer engaged in foreign service needs little, if any different qualifications, that is, qualifications which are the result of a school or college education, than those

of the true engineer anywhere. I emphasize again the need of thoroughness in detail, orderly thinking and vision, combined with a general knowledge of world affairs, and ability to meet on an equal plane anyone from kings and princes to presidents, ministers of State or captains of industry, and with this our engineers will go far.

Chairman McLEAN. I think I may say that I voice the unanimous sentiment of this audience when I say that the paper which we have just heard read is not only very interesting but very illuminating. It evidently was written by a man who was thoroughly acquainted with the business side, and with the usual difficulties which arise in bringing the technical engineer and the business man together. I have had occasion to know something of the work of the International Corporation, and I know that that corporation is one of the pioneers in carrying American trade and American industry to all parts of the world.

The next speaker is Mr. W. W. Nichols, chairman of the committee on education of the American Manufacturers Export Association and assistant to the president of the Allis-Chalmers Manufacturing Co., of New York City.

We will now hear from Mr. Nichols.

Mr. NICHOLS. Mr. Chairman and Gentlemen of the conference, the chairman's announcement, I think, furnishes a commentary indicating the keen practical interest that business associations are taking in education; that is, the systematic preparation of the engineer for what he is expected to do. I must confess that I feel a good deal of embarrassment and some hesitancy in presenting the few thoughts that I am going to present, particularly after listening to the splendid session this morning. I shall probably be guilty of submitting to the consideration of gentlemen highly trained intellectually many elementary thoughts. My own thoughts are elementary: there is no question about that. My only excuse is that in presenting them I am trying to give emphasis, perhaps by reiteration, to some of the things that in my humble judgment lie back of what you are trying to do for the industry in which I am very much interested.

TRAINING OF THE ENGINEER FOR OVERSEAS ENGINEERING PROJECTS.

By W. W. NICHOLS.

Chairman, Committee on Education, American Manufacturers' Export Association, and Assistant to the Chairman of the Allis-Chalmers Manufacturing Co., New York City.

Anyone who has followed the trend of business thought expressed in our war and postwar or reconstruction conventions of business must admit the exalted position given foreign trade in our business readjustment. Though the habits of provincial limitations still assert themselves in some minds, in some localities, a preponderance

of opinion looks upon foreign trade as the specific to alleviate many ills resulting from war demands; in the application American pride of accomplishment can have but one aim, namely, to promote a foreign trade by the same forces that have spelt success so conspicuously in our domestic industrial evolution—the same managerial excellence, the same sales genius coupled with fine enthusiasm, initiative, and enterprise, the same constructive ability and, above all, the same engineering skill and foresight.

The rank of the engineer in an industrial development which effectually assisted the needs of the cruelest war in history and made the United States great in the estimation of the world, invites no comment; American manufacturing industry is to-day mainly what the engineer has made it.

To repeat, there is strong evidence that a preponderant public opinion commits us to foreign trade and consequently the Government and private initiative are exhibiting extraordinary diligence in organizing all sorts of measures to that end. If our best thought be applied to the undertaking, in which, to a certainty, American engineering will faithfully perform a distinguished part, success is assured. American industry and engineering—each depends on the other and neither can attain its traditional success without the other. The character of the former may indeed be decided by the quality of the latter, and this, education alone will determine. Success, it seems then, rests on engineering education, and it behooves us to choose with care if it is to be adequate to the task before it.

In contemplating our achievements under old conditions we may be pardoned a feeling of some satisfaction, and though our native disposition, under the incentive of the extraordinary opportunity a free democracy affords, aspires to better things and ever strives for perfection, if our destiny involved only prewar normalities our course might be simple, our experience could ordain procedures, confident that regular effects would follow easily understood causes, and we could expect a comparatively smooth progress under an increasing knowledge and growing ability in solving the problems of our life. But war has torn precedents to shreds; it has not only dragged us out of our complacent, self-sufficient career in shaping to our national growth an over-abundance of natural resources, but at the same time it has forced us into altogether new and tumultuous conditions, fraught with perplexities to test to the utmost every faculty American opportunity and American genius has expanded.

We are gradually beginning to learn that we are bound to assist in something more than the physical rehabilitation of France and Belgium, as difficult as that will be; we are compelled to appreciate that a caste of thought encompasses the globe which must needs be reckoned with in all that we do. An orgy of consumate destruc-

tion, the aim of five years of frightfulness, seems to have evolved a curious mental warp in a large population, a sad perversity that may prove an embarrassing factor in any plan of readjustment society must organize, in which we are certain to perform a principal part. The active troublesome principle is mental, and education alone can cope with it.

I am trying to draw a picture of conditions as they appear, conditions which must be considered in any training to-day for business administration in which engineering performs its important function. We see a world trade effectually and forever superseding the relatively simple domestic affairs formerly engaging our attention. Such foreign trade as we have had was frequently an accident, more often without premeditation and usually without preparation. Now it is *the thing*, whether we would have it so or not. In much that has happened there is ample evidence that the United States has before it the greatest opportunity ever offered a nation to serve mankind, and by its service, to be abundantly rewarded, to influence the world for good. May it accept its opportunity in the same spirit it ultimately did participation in the fight for democracy, and apprehend fully that the late victory is but a step, that the democracy of trade—for trade is the one tangible expression of a nation's life—may be after all the great structure to rest on the foundation just laid by the Allies.

I would have you feel that these reflections are distinctly pertinent to our topic, because engineering overseas projects as a controlling factor in shaping the character of our enterprise will be henceforth a part and parcel of our foreign trade, and such considerations should therefore underlie every educational process on its behalf.

In a discussion of the technical requirements in the training of engineers for foreign trade we may treat the subject as in two distinct parts, one basic, the underlying principles of more or less general nature which shape the intellectual character of the student; the other, the composition of the curriculum which prescribes the course designed to develop mental faculties to meet special professional demands the future presents. I am content to leave to professional educators the determination of curricula, confident that they will be guided by the peculiar needs of each particular profession as indicated by a collective judgment in the many engineering associations, including such bodies as the Society for the Promotion of Engineering Education, all of which are alive to the matter. Permit me, however, to suggest that as the training of engineers for overseas engineering necessarily implies a world understanding, the curriculum must be designed with this feature distinctly in evidence, to influence first of all the teaching specialists who may lack conceptions consistent with the need.

With your permission, therefore, I shall confine myself to the first division of our subject, and submit to your consideration what appeal to me as two fundamental, basic ideas that should permeate every educational plan already instituted, or under contemplation in our schools and colleges for engineering, which, for reasons given, we may expect henceforth to be world-wide in its exercise.

In the first place, the distinction between "pure" and "applied" engineering is rarely suggested in any curriculum; in fact I wonder whether the distinction may not have been so dimly comprehended in our educational institutions as to lead, in obedience to an insistent demand, to the present attention given the business training of the engineer. Because time is an element of prime importance, pure engineering can easily be carried to the same extreme in practical business that the application of pure mathematics to applied engineering sometimes proves. Both are intellectual means to an end, not the end itself. The most dismal industrial failure I recall was induced initially by the abstractions of a highly trained engineer which had no reference to that commercial progress upon which all industrial life depends. I do not deprecate theory as commonly understood, in antithesis to practice, or the student's mulling over abstract conceptions; on the contrary, I imagine that most great achievements of modern engineering are founded on the comprehension of minds highly trained by concentration on abstract ideas, but as a habit this belongs to rare genius and should not be allowed to impede the efforts of the rank and file engaged in material production.

The business training of the engineer merits careful attention to the cultural side—a study of the so called humanities—because it induces that practical sense sometimes known as commercial instinct, although I fear too much importance can sometimes be atached to a study for what it contains rather than to its value as an intellectual practice. It is well to keep in mind in our undergraduate education one great aim, namely, the training of the intellect rather than the accumulation of data, which time often proves much less important, if important at all, than was supposed.

Because the training of the engineer should be predicated on a vision that embraces the world I am convinced the study of modern languages should hold a high place in every curriculum. The old-fashioned drill in grammatical construction, vocabulary, and idiomatic expression in order to teach a student to read foreign works on engineering topics with more or less ease—rather less than more, usually—does not by any manner of means give him that sympathetic understanding of a people's mental processes and correlative attributes so necessary in all trade relations. To understand a people we must have some conception of their mental attitude to the

incidents of life. Even at home, ignorance of motive and intentions often induces misunderstandings and grave differences between us and our neighbors. On the other hand, between us and our cooperators abroad, a more dangerous ignorance of much besides motives and intentions will certainly defeat every prospect in foreign trade we now entertain unless due consideration be given to that which offers the easiest means to the requisite understanding.

I am so strongly persuaded that what is needed in training for foreign trade service is a practical teaching of language of a kind to induce in the student's mind reflections on racial differences in thought method that I wish to describe two of many instances which continually come to my knowledge to confirm my judgment. Furthermore, they are the rule and not the exception, and constitute examples of conditions decidedly detrimental to all foreign relations.

Several years ago one of our leading manufacturing corporations executed a contract with Russia which stipulated an acceptance of a manufactured article based on a careful joint inspection. Notwithstanding both classes of inspectors were closely associated in their work, agreement seemed impossible until it was discovered that differences in interpretation due to different lines of approach and logic of procedure, in short, racial difference in mental processes, created misunderstandings that actually halted progress. This clever discovery suggested an easy means to harmonize the differences, and thenceforth transactions proceeded with eminent satisfaction to all concerned.

A situation has developed and is developing now, incidental to the continued presence of our troops in France, which deserves our most careful consideration. When our Army first entered France the acclaims of the populace to "their saviors" very naturally predisposed both sides to the warmest friendliness. After the signing of the armistice, however, more intimate relations under different circumstances proved decidedly disconcerting. Ignorance of language principally, combined with an incomprehension of many things connected with French life, habits, and customs, business methods, particularly the French provincial proclivity to bargain, usually unfamiliar to Americans, opposed to a similar misunderstanding of the Americans on the part of the French, jointly conspired to disturb in a few weeks an entente cordiale of a 150 years' growth. Already, with but a portion of our troops returned, the reputation given the French would astonish and grieve them. Later, when the majority of the two million or more of our citizen American Expeditionary Forces create throughout all the States such extreme prejudices as I myself have encountered in the few I have recently visited, what support can be obtained from public opinion in the framing of Fed-

eral measures necessary to further Franco-American trade relations? This example is particularly pertinent to our argument when we recall our old feeling toward France.

It has been repeatedly suggested that close Franco-American relations of every kind are easy of promotion because both nations have striven along similar lines for half a century, which naturally makes for a similitude of thought. A similar form of government, founded on substantially the same principle, would, in itself, constitute the principal factor in the evolution. To be sure, the American Nation has much the longer start, and under widely different conditions; the difference between the absence of tradition and the pride of a tradition of many centuries would influence progress as would also the difference between utilizing without hindrance unlimited natural resources for an isolated existence in the one case, and, in the other, adapting to daily needs, more limited resources often affected by a propinquity of unfriendliness, if not actual antagonism. But the best intelligence in both nations recognized the growth of a more intimate understanding than appeared elsewhere, where there were equal differences in language. What I wish to note is that judges of this condition comprehended the difference in viewpoint; that comprehension inspired their faith in the future entente and induced an agreement of minds which accounts for the earlier attitude of the masses toward each other. Now comes the American soldier, and his testimony to upset previous calculations!

In closing this brief exposition I wish to affirm my confidence in that plan of engineering which, in the evolution of engineering talent, cultivates a constructive imagination with a fine sense of proportion and values, with an ability to paint comprehensive perspectives expressing the best in American practice. Ultimate success depends upon a full recognition of these effects as fundamental. A lack of the necessary effort to this end in any educational scheme can only result in failure in the light of our past advancement. Probably we agree as to this, and it would be trite and quite needless to refer to matters so elementary were it not that unfortunately they are too frequently forgotten and ignored by our teachers in the performance of their high calling.

Before our financial preeminence, a future dependence on our labor-saving, efficient, mechanical devices was explicitly indicated in battle-scarred Europe, and since our participation, the extraordinary feats of our American Expeditionary Force engineers in planning and constructing for a critical emergency have excited the admiration and astonishment of our allies. Our engineers are everywhere needed in a huge reconstruction; in truth it is even more than this, a rehabilitation of industry on a stupendous scale, because in Europe

whole industrial communities have operated their mechanical plants under the compulsion of a terrible demand, almost to the verge of destruction, and this creates a demand far beyond the borders of the devasted regions. This calls for quantity production in skilled minds.

Consequently, our argument points to but one conclusion—to meet our very definite responsibility in this gigantic task our dependence will in the last analysis be upon the prescience and practicalness of our engineering teachers.

Chairman McLEAN. On behalf of the conference I desire to thank you, Mr. Nichols, not in any perfunctory way, but in all sincerity of heart for the very able, practical, and scholarly address you have just given us.

The next address will be by Dr. Jenks, member of the Committee of Fifteen on Educational Preparation for Foreign Service, and Research Professor, Government and Public Administration, New York University. Dr. Jenks is a man, as you all know, not only of a national, but of an international reputation, and we shall hear him with interest.

TRAINING OF THE ENGINEER FOR OVERSEAS ENGINEERING PROJECTS.

By JEREMIAH W. JENKS,
Research Professor in Government and Public Administration, New York University.

Mr. Chairman, Ladies, and Gentlemen, from the opening address of the chairman, as well as the address just given by Mr. Nichols, it seems that there is urgency in this matter of the training of engineers. These problems of overseas engineering are immediate; so that this question is not only one for the universities which have to prepare young engineers who are eventually to take the headship of enterprise abroad, but it is an immediate problem for our business men who have to select engineers at the present time to send away to-morrow to head these enterprises.

So I think we should consider, as Mr. Nichols has done, not merely questions of training in schools, but we should think also of the fundamental characteristics of the men whom we may already have in hand.

The very topic itself implies that we are dealing in the first place with engineers trained in the old way and that we will add to that old strictly technical engineering training some types of business training. We may assume that many of our men who are going abroad will not have the additional business training, and we should see what can be done to give them some idea, at any rate, of how they can meet this need and meet it promptly. It is fair to as-

sume that the engineers in question are men of ability, men of character, men accustomed to accurate thinking. We are not dealing with boys; to a very considerable extent we are dealing with mature men who are in the habit of thinking and who can take up new ideas promptly. Most of these engineers also, I should judge, are to be given positions as managers of the business. They are not simply for one department, heading a small division of it, but a large proportion of them must be general managers; they must have an all-round business training such as a manager of a business needs.

The first characteristic, I suppose, would be this: That they must have the business viewpoint. They must make their enterprise pay. Unless we are cautious in thinking along those lines we may overestimate the value of the experience that many of our school engineers have had in war work. The question of cost was of entirely minor importance in connection with war work. It was a question of getting production and getting it quickly, and cost was entirely a side issue.

In the new enterprises which we are undertaking now the situation is different. These enterprises must be made to pay, so that the question of careful accounting, of knowing what the costs are, and how they can be kept down, as well as how output can be produced, is something that must not be neglected.

The second point is one that was emphasized very wisely by Mr. Gardner in his admirable presentation. These men are going abroad into a new environment, dealing with officers of the Government, but dealing also with the ordinary workmen and the business men of all types. The consequence is that they must be men of a certain social or diplomatic cast; they must be good mixers and good mixers in new conditions that they are not accustomed to; and that implies a special type of man, if not a special type of training.

All of the speakers of the afternoon have referred to the humanities as a type of study suitable for training engineers for this new work. I quite agree with that, but I think that most of us have not recognized that the study of business and the training for business, if the word, as one of the humanities.

A little while ago I was asked to speak at an educational gathering upon the subject of the place of business training in a college curriculum, and what was in the mind of those who prepared the program was the ordinary smaller college of the old-fashioned type. What part should the training for business play in a curriculum of that type? It seemed to me, as I considered the matter, that we might very well put training for business on a par with history, with political science, with economics, with literature in the best sense of the word as one of the humanities.

My reason for feeling that way is that suggested in one of the discussions yesterday.

Let me contrast for a moment the business man's work with the engineer's work in the technical schools of the engineers. I remember many years ago one of the distinguished engineers of the country—many of you probably knew him—J. B. Johnson, at that time the dean of the engineering college, in Wisconsin University, but also a practical engineer who had been in the Government employ for a long time. In speaking with me in reference to the engineer's work, Dean Johnson said this: "The difference, you know, between a ditch digger and an engineer is that the engineer digs the ditch accurately." And that is practically the sole difference. The engineer is a scientific student who does his work with absolute accuracy, and, as we know, the engineers who have dug our biggest ditch, the Panama Canal, are looked upon as great men in their field.

That conception of the engineer is that he shall do accurately and well a piece of work which has to do, not so much with men except possibly in the handling of the workmen, but rather with the forces of nature. Men might deal with the forces of nature splendidly, and still have none of the social gifts. But, on the other hand, if you take the management of a business—I do not care what business it may be, whether a manufacturing business, or the management of a railroad, or of a mercantile business—he has other things to keep in mind continually; and so this managing engineer of whom we are speaking, has these other things to keep in mind continually.

In the first place he has his problems with his working men. In many cases they come from different nationalities. They are men of little or no intellectual training. They have all sorts of habits of thinking and doing. Nevertheless, he must get on with those people. He must get the work out of them in a way that will be for their benefit instead of their detriment. He must know this work, as has been suggested, and he must at the same time see to it that the health of his men is maintained. That is certainly a humanitarian viewpoint in the technical sense. It is a humanistic study, if you like, of the lives and souls of the men he is dealing with.

But another group of men he has to deal with is his directors. There is a study of human nature from another viewpoint that I am sure has fully as much of a humanistic tendency as the study of history. It takes a knowledge of practical psychology to direct pleasantly but firmly a group of directors, your superiors in authority.

Then, again, he has the stockholders of his company to think of, because, after all, the directors largely act upon his advice and the stockholders of the company often present the most serious problem. Many of them want dividends at once and must have them regularly.

Many others can see, when the accounting period of the year comes around and there is a surplus fund, that it might be better to devote most of the surplus earnings to improving the enterprise. That is a problem whether to do the wise thing for the enterprise from the building-up point of view, and turn the earnings back into the business or to pay the surplus out in dividends. That is a social and ethical problem and really a very serious one.

Again, there are customers that want A-1 products at C-1 prices. What is the wisest thing to do with them?

We can see, then, that the manager of a business is dealing with a type of problem that is bound to train him in the humanities, and in doing this type of work conscientiously and well, he is getting a training that is equal to Latin or Greek or history or anything along that line, and of quite the same type.

Of course if we start early enough, and especially if the boys have this point of view in mind, they can get a good many of those things in college. I myself laid it down as a principle that I have followed out in my own family, that I did not want my own boys to go to college until after they had earned their living for at least one year, and, preferably, by the work of their hands, because I wanted them to get the viewpoint of the working man; I wanted them to know that they could get their hands dirty and still be gentlemen. I wanted them to have such an experience, so that if later on they came into control of business in any way and were dealing with workmen, they could feel as the workmen feel. Otherwise, they would not have the proper sympathetic attitude, and would not have the right training.

I have also found as all other teachers have, I have no doubt, that the best men in our classes are men who have to earn their living either before or after they come to college. Their viewpoint is the right viewpoint. They were working for something that would help them later on in life and they had the practical outlook on life, which every student should have.

We should keep that outlook on life in mind. But also after men are out of college, in many cases they need to get this training. If there is not an opportunity for them to go to college and get personal contact with the teachers themselves, the men who know these questions (and that by all odds is the best plan), there are still opportunities for men to get a large part of the technique of this training by reading. There are now reading courses in business and good books on special phases of business, salesmanship, business organization and management, the way in which goods should be routed through a factory, and all that sort of thing; so that a trained man, such as an engineer is, can read up as a boy could not, and he can make a good deal of progress in that way.

Most of these points have been touched upon either by Mr. Nichols or by Mr. Gardner, but I wish to repeat some of them and to emphasize some new points.

For example, when an engineer takes a job overseas he should know the country to which he is going, and he should get time to make some special study of it. One of the first things he ought to study is the character of the government of the country itself. It may be that he is going to some South American Republic; it may be that he is going to China; it may be that he is going to Russia. The problem is an entirely different one in each one of those several countries. I have known some rather sad experiences of engineers who went with great problems in hand to China and had no conception at all of the type of men they were to meet with in the high Chinese officials, had no conception at all of the way in which they ought to deal with them: and the consequence was that very serious blunders were made.

I have known others to make blunders equally as great in dealing with Latin-Americans. The way of doing business with the Chinese or the Latin-American or the Russian is entirely different from that of doing business in the United States, and a large proportion of the business done by our great American corporations, when they undertake these works abroad, is through dealing with governments, not with private business corporations. There ought, therefore, to be a very careful study of the foreign governments and of the type of men they find in the officials of those countries, and the ways in which they should be dealt with. There are other points aside from the personal characteristics of the men. There are certain phases of the legal side of the question in these countries that need to be taken up. A man may very well think that he is living up to his contract, and find he is not, if he does not know the laws of the country with which he is dealing.

It may not be necessary to put any new emphasis upon the very great desirability of a man's understanding, so that he can speak it correctly and fluently, the language of the country to which he is going. To my mind this is not merely a question of the mental training of the man, although that is important, but it is a practical question, too.

May I venture another illustration in addition to the one given by Mr. Nichols? This happened to affect me most unfavorably when I first went to China. I found after I had been there two or three months that my very conscientious skilled Chinese interpreter had used wrongly one word that came into use in connection with the work that I was doing, a word that gave a false impression to the Chinese officials with whom I was dealing, and it took me months to overcome that false impression. The word was the word

"comptroller." I was using the word "comptroller" in the technical sense in which it is used here in the United States Government, when we speak of the Comptroller of the Currency—not a man who runs everything, but a man who is himself under the Secretary of the Treasury, under the Government, who has a certain routine to carry out with more or less discretion, of course, The Chinese character that my interpreter was using implied that the comptroller was the man who controlled everything. He would have in his hands the power of our Secretary of the Treasury and the President and Congress combined—and no wonder it made trouble. But had I known the Chinese language as I should have known it, I could have avoided that difficulty.

And similar things, of course, have come up with all of the countries with which we deal. So it is of very great importance when we are selecting men, if other things are equal, to take the man that knows the language of the country. It will smooth things all along the line in his dealings not merely with the government, but with the customs and with the working men; and, moreover, he can then find out much more easily than he otherwise could what the newspapers think of him, and that is often a very important matter.

Again, he should know in a good deal of detail the customs of the country, the way, for example, in which wages are paid, the perquisites that go in many countries with many positions. The people have been brought up to them. They know nothing else, and if he attempts to impose some other system upon them which they are not familiar with, and to interfere with an age-long system because he thinks they are doing something dishonest when they have no intention of doing anything dishonest, then he has great difficulty.

Take, for example, the age-long and much criticized system of "squeeze" that we find in China. It is perhaps a source of dishonesty in many individual cases, but, I venture to say, that in 9 cases out of 10 among the Chinese themselves, the squeeze is not dishonest in the least. Nobody thinks it is; there is no attempt to cover it up. It is just as legitimate as the commissions that are allowed in our own country, where we send down some orders to New York and the purchasing agent sends back the goods at the regular retail price charged and takes out his commissions of 5 or 10 per cent. We might just as well call that squeeze and imply that there is something dishonorable in it as to attempt to fight against the system of squeeze in China, which, in 9 cases out of 10, is nothing more than the ordinary systems of commissions that we are used to here; only they apply them there in places in which we do not apply them here.

The same thing is true in every foreign country. They have their business customs, and if we and our men do not understand them,

we shall be misconstruing them and getting ourselves into trouble because we have misconstrued them.

Again, our business manager should go rather slowly, I think, in foreign countries in attempting to change customs. Many of the customs are bad. They are not good from the business viewpoint at all, and they ought to be changed. Perhaps they must be changed before business can really be effective. Nevertheless, one should go about that slowly.

Let me give an illustration, or an example, in running a railroad. I recall one railroad system that I became somewhat familiar with, where the custom was, of course, to have a schedule of the hour and minute when the train should start from the stations, but if a high official did not happen to be ready at that time the train would wait until he got ready. Finally, the custom grew to be that when the train got about ready to go the engineer would blow the whistle loud enough so that it could be heard all over the town; and this was a warning that the train would start in about 20 minutes. Then everybody was supposed to start for the train and to get there in 20 minutes. Those who did not would be left. But still, if one of the higher officials telephoned that he would not be there right away, the train would wait at least 25 minutes. A new American manager came, and decided to start all trains on time. Everybody, especially the officials, was angry and raised a row. He insisted, and the trains did start on time. Finally, when he fined the station master for waiting five minutes for him when he himself happened to be late, the people saw that he was sincere and impartial, and that smoothed things over a good deal. Now the trains run on time and people like it, but there was serious trouble at first. There was a custom of carelessness about the way of doing things that had to be overcome. We must overcome those things, but we must give reasons why, and must work reforms through gently.

I have already intimated in speaking of business customs that there may be a difference also in business conditions and ethics. I do not mean to imply that the honest American engineer who has very high ethical standards should lower his standards; not at all. But he must understand the differing standards of the people with whom he is dealing, or else he can not get along and maintain his own standard anywhere nearly as efficiently. If he understands the people and knows the different standards, he can gradually work them over to his own higher standards, and it will be for his benefit as well as for the benefit of the country itself.

Attention has been very often called—although this applies more to the younger man—to the fact that a man going away from his home environment into one that is entirely different, where the moral standards of the community are entirely different from ours,

is likely to find himself gradually slipping into a lower standard. That is a most unfortunate thing, not merely for himself but for the country to which he has gone, in very many cases. The first and most important quality of all is upright character, sound character, an unchanging determination to do the right thing. A man does not intend to slip when there is a little temptation. Nevertheless, in spite of all that, a man needs to be always on guard, because temptation is often so insidious that gradually, after a month under changing conditions, he will find that he has gone, without any special consciousness of it, further than he intended to. A man needs to keep on guard over himself, and when we are picking men we should have that thought in mind, and see that a man with self-control, power of self-mastery, is sent.

I was very much interested in what the chairman said with reference to the way in which we are going abroad into these new enterprises, and I should like to add just a word, because I think it is pertinent to this phase of our discussion.

A very large number of suggestions that appear in the public press at the present time are with reference to the way in which the United States must finance Europe and must finance especially the backward countries. And we ought to do it. It seems that we are planning to loan money to those countries and take their securities in the form of bonds. The chairman implied—although you did not say it, Mr. Chairman, I thought you had that in mind—that probably the wisest method for our business men to follow in financing foreign countries is to buy the enterprise, own the enterprise, or own the controlling share of the enterprise, at any rate, and take the stocks instead of the bonds. In very many cases it would be much better for us, and it would even be more beneficial, relatively speaking, to the country itself. That is something which I think ought to be emphasized continually in our financial circles. The reasons, of course, are simple. If the management is conservative, a trained American management, there will be more profits to begin with for the American financier, and the investment would be very much more secure than it would be otherwise. Then, too, if the enterprise makes money and goes ahead in a proper way, there is very little likelihood of political interference. Again, in the backward countries if we make those investments in such form that we are ourselves the managers, that we ourselves are interested in the profits which come from the enterprise, the profits will go back into the business there, and not be sent home, and that will help solve the difficult problems of our balance of trade very much better than if we make a loan and bring the interest on it home. That plan will be more profitable to those countries, too, because the work will be carried out in such way that we can pay better wages than would otherwise be paid, and elevate the

whole level of their working classes higher than would be possible if we simply lent the money and they expended it; and in a generation, if you like, they may well be in a position where they can buy back control of the enterprise.

It was along those lines that our Middle West was developed. If it had not been for the wise financing of this country in earlier days by Europe—England, France, Holland, Germany, Belgium—in our enterprises in the Middle West, we never should have been able to finance Europe as we did when the war came.

So we shall improve the financial situation in those countries best if we arrange our plans in such a way that our engineers or our business managers control the business there and give them the best modern administration that is possible all the way through. That is our duty, and I believe the American engineers are the men to do it.

Chairman McLEAN. I think I may say that in Dr. Jenk's address we have seen a very fine example of the happy combination of practical common sense and learning; and I want to say in reply to your suggestion, Dr. Jenks, that when I referred to the American investments abroad I had in mind that we should become the managers and owners of the enterprises in foreign lands, and not mere money lenders.

We have finished the set program and we want to have a free-for-all discussion, and are very anxious to hear from some of the practical engineers here. Some of you may have gotten the impression, as I did when Dr. Swiggett asked me a few days ago if I would not preside at this meeting, that those of us who had not had practical training as engineers or who had not had experience as educators would feel at a very great disadvantage in attempting to discuss the subject in the presence of these learned men, and I confess I did feel very much that way. But Dr. Swiggett reassured me, and for that reason I decided to make the attempt.

It is very important we should have some remarks by those who have had practical experience in engineering work. It is the only way we can really apply the various suggestions that have been made, perhaps the only way we can get at the real viewpoint of the technical engineer.

We expect a number of those present to favor us with remarks, and I want you to feel perfectly free in expressing yourselves upon any phase of the subject which you have in mind.

In looking over some of the registration cards, I find the name of Mr. Francis C. Pratt, vice president of the General Electric Co. I wonder if he would not favor us with some practical observations.

Mr. PRATT. Mr. Chairman, I would be very happy to do so, but I have to leave on the 4 o'clock train.

I did not come prepared to speak upon this topic at all, and I do not have more than five minutes to devote to it. As a matter of fact, I have been associated with foreign commerce since my youngest boyhood, at least, through my family.

It is rather an interesting thing to note that, when Germany came out victorious from the war of 1870 and undertook the rejuvenation of her industries, my father went to Germany at that time and entered into a contract with the Imperial Government for the equipment of armories at Erfurt, Danzig, and Spandau, for making the first model of the Mauser rifle. This was practically the first experience which German industry had with interchangeable manufacture.

He installed in those armories everything from the drop forging machinery to the finished gauges.

Such great machine tool manufacturers as Ludwig Loewe & Co., the greatest in Germany, took those machines as models and reproduced them. This was the foundation, I am sure, of the modern machine tool industry of Germany.

To illustrate the exactness with which the Germans copied those machines, I recall that when first visiting Berlin in 1891, I saw in the Loewe factory machines which appeared, at first glance, to be all of Pratt & Whitney make. They had the same distinctive design which had marked our practice over a period of years; they also had a litle brass scroll-shaped nameplate, the outline of which had long been familiar to me. When, however, I looked more closely I saw that it carried the name of "Ludwig Loewe & Co.," and not that of "Pratt & Whitney Co." All of this made me realize the lack of engineering originality displayed by the Germans at that time.

Since then Germany has developed ability in designing machinery.

Nearly 50 years ago the company to which I have just referred was a small company, and the machine tool industry of this country was small in the aggregate. To secure and execute a contract for one and a half millions of dollars worth of machine tools for export was, in those times, a very unusual undertaking. To-day, of course, the movement has broadened.

The company with which I am connected has recognized this by doing a thing which I think is rather illustrative of what is going on. The company has participated in foreign business for many years. The ratio of its foreign to its total business is rather greater than that of most concerns in its line. It has selling companies in Australia, South Africa, and South America; it has manufacturing interests in Great Britain, Japan, and China. It has long maintained a foreign department, but now, since the declaration of armistice, the International General Electric Co. has been organized,

and all foreign interests, not only selling, but also manufacturing and financial, have been concentrated in this new company. New blood has been put into this company. The former staff of the foreign department has been retained, and men added here and there; one of very high character and legal ability, and another, who is an astute merchant and business man.

We believe that in concentrating our foreign interests in a separate company we are in a better position to deal definitely and effectively with foreign problems than we possibly could be if they were, as in the past, handled by a department of a great business.

As far as the demand for foreign engineers is concerned, the subject has, in this convention, been discussed and described in different words and in different ways, but all telling very much the same tale. I speak very feelingly in regard to this matter, because for the better part of 10 years I spent at least half my time traveling over Europe, from east to west and north to south. The day has long since gone by when the American drummer can, with a pack on his back, go to a foreign country and expect everyone there to speak his own particular language and understand his mode of thought. If there is anything that I thoroughly believe in, it is that, if we are going to succeed in South American business, our representatives should be men who are not only skilled in their own business affairs, but who also are familiar with the Spanish language, literature, customs, and ways of thinking. If one should be fortunate enough to receive an invitation to dine at the home of a Spanish customer, he could then meet and talk with his host as a social equal.

Foreigners are not going to continue to interpret Americanisms indefinitely. We must treat them on a parity, and be their equals in a social, as well as in a business way.

The American engineer has high standing in his community and in the gatherings in which we are taking part to-day, and justly so; he also has a high standing all over the world. I spent two winters in Russia nearly 30 years ago, and then learned that the early railroads there had been largely constructed by American engineers.

At the second meeting of this series of conferences, called by Dr. Swiggett, there was present Mr. John Hays Hammond,[1] whose reputation in the South African mining industry is known throughout the world. America has been very fortunate in the representation given her by her engineers in the past, but to-day it is not a question of an unusually competent individual here and there; it is rather a question of numbers of well educated, highly trained and mature men of sound understanding who will help carry our trade throughout the world.

[1] See printed address, p. 6.

Mr. HARRISON. I do not know whether I can add anything at all, Mr. Chairman, to what has been said this afternoon; but there are two or three things that the gentleman who has just addressed us has emphasized which lead me to remark that this gentleman has certainly traveled beyond the boundaries of the United States, and that he has been a close student of the conditions that exist beyond our borders.

Among the things which he has emphasized, and which, it occurs to me, it is necessary to emphasize and reemphasize before men who are perhaps not personally familiar with foreign conditions, is the need of tact in all contact with foreign peoples. Their customs are different from ours. Their methods are different from ours. Their sensibilities are often very different from ours. The easiest way of getting in touch with foreign peoples is to learn their customs, their ideals, and their manner of doing business, and the easiest way to get out of touch with them is to offend them, even in the slightest degree, by doing what they may construe as reflecting on their customs or their ideals.

The governor of the Province in which I was at one time working in the Philippine Islands, in recognition of one of the local holidays, sent out a number of invitations to dinner. He was very anxious that everyone should be on time. It is, however, a common custom in this region to name a dinner hour with the expectation that the guests will be politely late—an hour or two late in many cases. With this custom in mind he put at the bottom of his invitations the little phrase, "American time," by which he intended to request promptness. Scarcely a guest came to that banquet because of the offense which that little phrase caused! Being prompt was, to the minds of these people, being rude, and their sense of propriety was shocked.

Another matter, based on the series of customs which it is necessary to recognize, is that governing the "commissions" that are regularly taken on labor and on commodities, and on other business transactions, commissions that look to us very much like petty graft. However, these customs must be accepted. If a man offers to sell or to deliver labor or to sell material, it will be found that he is probably charging his laborers, the men that he delivers, quite a considerable commission for finding them work. He may also be loaning them money and charging them exorbitant rates. If these men are not paid at the customary time and paid in cash, under the customs and conditions with which they are familiar, it will usually be found that he is paying the laborers on Saturday night at 95 cents on the dollar and collecting for them on Monday morning at par. This is a usurious rate, but it is a custom of the country!

To us, these and similar practices look outrageous, but as they are, nevertheless, very much in vogue, and as anyone who endeavors to abolish such practices finds himself disliked and in opposition to the men with whom he must deal, he must content himself to let such conditions gradually right themselves or he will find that the opposition which he raises nullifies his usefulness.

Another thing which the engineer in a foreign country often has to learn to recognize as a necessity is the giving and the accepting of gifts of one sort or another. There are many places in this world where a man never thinks of asking a favor without bringing a gift. He may bring a bunch of bananas and ask for a hundred-dollar favor, but it is the custom that he should so prepare the way for his request, and he feels that if the gift is refused he has been personally affronted. The gift should not influence any man's judgment in the matter, but if the gift is refused, the giver's honor is reflected on, and thereafter the man to whom the gift was sent is looked upon with suspicion!

A great many engineers go to foreign countries and, with their American viewpoint, give wholly needless offense in minor matters of conduct of this sort. Really no man should lose his character by frankly, while in Rome, doing those things which he must do if he is to be understood by the Romans. Character is deeper than that, and can, in all countenance, be as real under the Roman code as under the American.

Above all, let me say again, perhaps a little more in line with the thought of the day, that diplomacy, finesse, and graciousness of approach are invaluable in foreign trade. In this country we known nothing whatsoever of the graciousness of manner which is instilled into the foreign representatives of a large number of the European countries. If you meet a Frenchman in the Orient, no matter what he may think of you personally, he is always the soul of graciousness. He is always courteous. There is nothing which you can do which will make him discourteous to you short of a personal and an open affront. Under all circumstances he carries that gracious manner of personal politeness which is both the marvel to and the undoing of his American competitors.

I might say in this connection that such courtesy is not a matter of natural characteristics. I do not for a minute think that the foreigner is, at heart, any more polite or that he is more friendly or that in any way he is naturally more acceptable to foreign nations than is the American. But he has a finesse, a graciousness of manner, and a tact in approach which have been trained into him until he never forgets them.

I mention this because these matters are largely matters of training. Grace in the expression of ideas is not a matter of personal

information, nor is it a matter, by any means, of personal feeling. It is largely a matter of knowing how to express one's self in a formal and a pleasant manner. American universities could do their students no greater favor than to give more attention to training along this line.

A knowledge of the language of the people among whom an engineer must work is also of importance. Take my own case: I learn language rather slowly, but particularly in the Spanish language politeness of phraseology is essential. Because of my poor knowledge of Spanish I fell into the habit of going into places of business and, translating the English into the Spanish, of saying, "Will you do this or that for me"? only to find that wherever I went I met a surprisingly cool attitude on the part of the men addressed. My purposes were entirely proper; my attitude was entirely friendly; nevertheless, the requests were poorly received. But when I learned to say "Hagame el favor"—"Do me the favor," I had no further trouble! On such seemingly unimportant details a man's reputation often depends.

Another thing which is perhaps worthy of mention is that, from the standpoint of the engineer who is selling American products or representing American interests in foreign countries, especially in the Orient, the question of making a sale is not a question of going out and finding a man who needs a motor and then showing him that he needs this motor and asking him to buy it. It is not at all like that! The man who needs a motor would like to buy three motors if he could find a means to pay for them. He fully realizes his need, even overemphasizes it in many cases; so the problem with which engineers in these countries have to deal is not one of demonstrating a need and then inducing the one in need to satisfy that need, but rather, one of filling well-recognized needs under terms which can be met. In short, it is one of financing. In this country we very seldom realize that these foreign countries are pitifully weak financially. Perhaps I can illustrate this best by saying that there are towns in Asia, towns of 40,000 or 50,000 or even 100,000 population which do not have as much money in their banks as would be found in an average country bank in the United States, in a town of 1,000 inhabitants. Think seriously of what that means. The savings of these people are so pitifully small that a hundred of them cannot accumulate what we count as normal for a single man. Of course they can not buy our products on the terms that we are accustomed to, because these terms involve large reserves for banking purposes; so, no matter how badly they need a motor, no matter how badly they need machinery of whatever kind it may happen to be, no matter how badly they need transportation facilities, they are unable to get these things unless their installation can be so financed

that they can be paid for in very long-time payments. The engineers' problem then is not one of connecting the man who has something to sell with the man who has real use for it, but of developing a method of financing the proposition which will make it possible to effect a sale and secure payment from the ultimate profits to be derived from the use of the thing sold.

The promotion of railways, the promotion of power developments, the promotion of mills and factories and of all such undertakings must be accomplished with these facts in mind. Indeed, the one reason, if you please, why the English have been so successful in their foreign ventures in spite of the fact that they are not as polite as other foreigners is that they have understood the problems involved in financing foreign ventures and have gone into these countries with both money and machinery, and have erected their machinery and operated it and then taken the profits. In other words, they have to a very large extent owned, or at least controlled, the businesses which were based on their sales of machinery and equipment. If we will grasp this viewpoint in this country and will send our engineers out, not to try to sell something which people want but can not afford to buy, but on the other hand to put in the improvements that will be owned and operated, or at least controlled, by ourselves in the interests of the country where they are located as well as in our own interest, it will greatly help the development of our foreign trade.

Finally, the man who will gain success in a foreign land is the man who, knowing his business well and well grounded in the financial problems with which he must deal, will take his character there and adapt it to the conditions he finds, who will endeavor to understand the men with whom he deals, and who will, at all times, cultivate a diplomatic and a gracious approach.

Mr. Follows. Mr. Chairman and Gentlemen, I took my stand here yesterday, and I am afraid I am going to be guilty of false pretenses now, because I am not an active engineer at the present time, but I was for a number of years before I took up teaching work.

I just want to say something that was put into my mind by Dr. Jenks's splendid address.

I had in my mind yesterday morning the image of a canvas stretched over in front here, a large canvas; and on the desk was a program. At lunch to-day I was speaking of this image. I was the guest of one of the visitors whose son is in the room here and who goes to Pittsburgh to-morrow. He heard about this commercial engineering and wants to go over to Pittsburgh at once and see for himself what we are doing at Carnegie Tech.

The fact that the course in commercial engineering includes advertising and salesmanship must be my excuse for talking shop in this way. It is part of my duty to advertise Tech.

As to the canvas and the picture that I have had in my mind since yesterday morning, I have seen growing on that canvas a number of lines and quite a number of dabs of color. I put my own little dab of color there yesterday, but I do not know where it is now. Others have added their sketchy lines and dabs of color, and I have been wondering what the picture was going to be like when finished. To-day somebody who was apparently in the same state of mind asked, "Where are we at? What are we doing? Where are we going? What does it all mean?"

There have seemed to be so many colors on the canvas, and so many sketchy lines, no particular picture, and I have been very much puzzled as to what the picture was going to mean finally. So I am very glad indeed that Dr. Jenks was placed last on the program, because to me, absolutely, he has put all those sketchy lines in their right places. He has got all those colors harmonized. He has given me a most wonderful inspiration and encouragement with my own work, which, of course, I am only striving to do. I am not trying to finish anything; I am only trying to begin something worth while, but in a most wonderfully encouraging and inspiring way he has completed the picture; he has brought those colors together. There are dark places, as there should be in all pictures; there are bright places, and there are clear places that have stars scattered about, and they are still there to gaze at. Dr. Jenks talked about the humanities in a way that I wish I could talk myself, but I can not, the humanities of business! That is really what we mean, I think, by commercial engineering.

There I am, getting on to that advertising line again!

Commercial engineering at Tech differentiates between the materially technical and the humanly technical. That is our idea about it. I do not know whether I am right in putting it that way or not. I was trying to explain it to a man who came to Tech about three weeks ago because he thought possibly he wanted his son to come to Tech. I said that on one side we had the old-fashioned materially technically trained man, and we had enough of those; we ought to stop training men to do merely material things, to design machinery only or to design a bridge only; and we ought to train those men to design a bridge for use in its proper place, a *suitable* bridge.

The point I have been trying to make right along at Tech is this: It is not wise to try to train in four years or any number of years a man who is to be a designer or research man, to lead him along

for years as a designer or research man, and then make use of that man, not as a designer, not as a research man for which he was trained, but for business. It seems to me that is a great mistake. To my mind the commercial background which we should give to the technically trained man is one that should make him a better designer, a better research man, a more useful, rational, sensible man; should put more common sense into him; that is to say, give him a background which will be a common-sense background. The business college of the past and the smaller business colleges of to-day are trying to develop business men, but they can give no real background of the big things of life.

Is it not true that to-day we need in the business world men who are familiar with materials? Because materials and material things, material apparatus, wonderfully ingenious apparatus, the inventions of great engineers, these wonderful material devices are in use in every line of work. We do not go into any factory now and expect to find things made by hand.

At Tech we give a strong course in accountancy. It takes the better part of two years to go through that course; our accountant insists that we must enable our students to visualize industrial conditions before we begin to teach them accountancy. Otherwise, when we talk to them about overhead expense, distribution of expense, classification of expense, they do not know what we mean.

In Pittsburgh we have great natural advantages, that is, natural in this sense, that we have the factories, a great array of factories, and there we take our students as sophomores, those men who are to take the course in accounting and commercial engineering, so that they may see the manufacturing processes and conditions.

I was very much interested in the suggestions made by Dr. Mann in connection with changes in teaching methods, with reference to the backward plan, and I thought I would just give you an illustration of something I have tried out with very great success in the study of what we call economic production. This subject is listed in the course. What does it mean to the man who reads it? Very, very little. I have heard that sort of thing referred to to-day, and yesterday, too, as though it were almost unnecessary to have a chart or a list of subjects. You can not get along without our list; but the list does not mean much except to the man who makes it, or to the man who is engaged in the teaching of the subjects.

When I say "economic production," it can not mean to you what it means to me. At Tech to-day economic production means that every week the senior commercials go into an industrial plant for observational purposes and afterwards write a short paper. They are directed to go there not with the idea of merely gazing at things, but in order that they may really study things. Often I hand a

student over to a workman in the plant and say, "Stay with this man for two hours and find out all you can about him and tell him all you care to about yourself." A day or two later, an "experience" meeting proves interesting to us all. I have taken students through a plant where they make cold-drawn steel shafts up to 4½ inches in diameter. They would see the open-hearth process first, and I have noticed a peculiar lack of interest. They look at an open-hearth furnace, but they do not ask intelligent questions about it. So I reversed the operation and took the student first to the finished cold-drawn bar, and then took him to where the bar is drawn through the die, and from the moment he saw the finished bar he began asking intelligent questions. When he saw the bar being pulled through the die he said, "How much does it lengthen the bar?" And the foreman said "18 inches, and reduces the diameter one-sixteenth." "What is that white stuff?" "That is lime, to neutralize the acid in the pickle." "Oh, then there is a pickling process?" And so on. He sees the dipping in the lime immediately after the pickling process. We go to the next shop and we see the square bar being put through the rolls to make it round. By the time he gets to the open-hearth furnace he looks at it as a father might look at his own son. He is very much interested in that furnace. He knows what it is there for, because he has already seen all the processes between it and the finished article.

That experience helped me to appreciate more fully what is meant by Dr. Mann's idea—working back from the solution to the problem.

I do not know that there is anything more that I care to say except once more to thank Dr. Jenks for the wonderful inspiration his talk has been to me.

Chairman McLEAN. I would like to hear from Dean Hotchkiss, of the University of Minnesota.

Mr. HOTCHKISS. I do not really think I have very much to contribute to this subject, Mr. Chairman. I come from the fresh water. We get the foreign trade side of things last. I was very much interested, however, in addressing a group of business men at the Twin Cities last fall, a group of sales managers of some of the principal concerns in the Northwest. I was interested and somewhat surprised to find foreign trade appear rather early on the list of things about which they were thinking. I had never thought that we should particularly feature foreign trade in our business course. We are in a region where domestic distribution is a big problem. Of course we have our manufacturing; we have our flour mills and even steel mills, but the great factor in our business life is distribution, wholesaling and retailing merchandise to a large agricultural population.

But our business men are interested very distinctly in foreign trade. I doubt whether they have a very distinct idea of just what they are going to do in the way of foreign trade, but it is in their line of vision.

It occurs to me in this connection that possibly there is a danger in this conference, perhaps naturally, of thinking about foreign trade too exclusively in engineering terms. Not being an engineer, but being a teacher of business, located in an agricultural section, that danger, if it be a danger, appeals to me perhaps more strongly than it would to others.

It is very proper that the engineer should come in for a large share of the educational work in developing this subject. Among the great things America has to offer, the greatest thing, is machinery for the development of other parts of the world.

We can not afford, however, to think of foreign trade from the standpoint of one class of commodities. We need to approach the subject from the standpoint of a survey of the things we are bound to supply to the rest of the world, and the things we are bound to take in exchange.

I think it has been an inspiration to all of us to mix together and get each other's viewpoint. Although the business schools proper are somewhat less developed than the engineering schools, they are much younger; we feel we have something to contribute to the engineers, and I am sure we do right in being bold enough to make the assertion in public.

Mr. HIMES. I wish to add a bit of experience by way of developing a point that has been briefly mentioned this evening. Reference has been made to the conflicting views of educators on the place of the humanities in our courses of study, and the view has been advanced that engineering and commercial courses are not devoid of the values most prized in the humanities.

In 1910, the Louisiana State University offered a four-year course in commerce, leading to the degree of bachelor of arts. We took the position that such a course lacked none of the essential elements of a liberal college education. We took the position that the man who worked on a problem in accounting, or he who worked on some exercise in the mechanical laboratory, was doing a thing that was as humanistic as that of the fellow who toiled over the conjugation of a Greek verb. To illustrate, there stands in one of our office buildings a piece of ornamental iron furniture. It is a hat rack and umbrella stand combined. It was worked out by the boys in the mechanical laboratory. I have not seen or heard in 20 years a poem from our language departments comparable to this one in iron. It combines artistic grace and symmetry with the idea of service. The workman caught a vision of beauty, and he wrought his vision,

not in the language of words, but in a language of vivid reality that any human being of any race or tongue can read.

So the workman who is inspired by the ideals of his chosen life work will weave those ideals into the products of his hand, and he will thus serve not only the material but the spiritual welfare of the human race.

Mr. DIETZ. Mr. Chairman, I think my experience during the last six years might be of interest to you, but may I ask that the remarks that I am now about to make shall not be recorded?

Chairman MCLEAN. If you would rather not be reported, I will ask that no notes be taken of your remarks.

(Mr. Dietz thereupon addressed the conference, his remarks being unreported.)

Chairman MCLEAN. I wonder if anyone has a resolution or a recommendation that he would like to offer at this juncture. Are there any resolutions?

Mr. TURNEAURE. Mr. Chairman, it seems to me that this meeting ought not to adjourn without expressing itself relative to the importance of this subject of engineering and commerce; so that the following general resolutions are proposed:

It is the sense of the meeting that—

(1) Industrial and commercial development has created a demand for men with technical engineering training and business ability. Manufacturing industries are seeking engineers to qualify to serve in capacities requiring sound business training. Banks and brokers also need men with business training and the engineering point of view. This need is rapidly increasing and bids fair to demand a large number of technically trained men.

(2) In order to meet this demand the economic phases of engineering subjects should be emphasized wherever possible in engineering instruction. This may be done by emphasizing the problems of values and costs in the regular technical work, and by introducing or extending courses in general economics, cost accounting, business organization, and business law into the engineering curricula. These courses should be designed particularly to meet the needs of the engineering student.

(3) The engineering phases of economic subjects should be emphasized wherever possible in commercial instruction. Students in commercial courses should also be given opportunity to take special courses in the basic principles and practices of engineering so that they may understand in general terms the operation of power plants and transportation systems from the engineering point of view.

(4) It is also urged upon all institutions with departments in engineering and economics or commerce that they consider some plan of coordination to develop a course in preparation for those careers wherein training in the essentials of engineering and business theory and practice have been found to be both helpful and necessary.

These resolutions were drafted by the conference committee and are presented for your consideration. I hope they will be adopted.

Chairman McLEAN. Is there a second to the motion?

[The motion was duly seconded.]

Mr. NICHOLS. I take it, Mr. Chairman, that these resolutions have reference properly to the entire conference. I do not recall that there is any reference to the thought which I understood was made particularly this afternoon. It seems to me it is unfortunate. As I view the situation to-day, there is every probability that the United States will be a nation of foreign traders. For that reason it seems to me there ought to be some very definite reference to that fact. I tried to make clear—perhaps I did not do it—in the rather hasty presentation I made that that is a fact, and there are a great many people in the United States among the thinkers who accept it as a fact. The training of the engineer who is going to perform the function of prime importance to all American industry should have some reference to foreign trade.

For that reason, it seems to me, there should be a very definite reference in some resolution to these thoughts. The other thing I had much in mind in connection with this was the one subject to which I perhaps devoted most attention, namely, the subject of modern language. There is no reference whatever in these resolutions to the study of modern languages. I think it is exceedingly desirable.

Chairman McLEAN. Perhaps the author of the resolution and the speaker will agree upon the incorporation of this suggestion. Do you suggest any amendment to the resolutions?

Mr. HUGHES. The remarks of the last speaker, Mr. Chairman, lead me to suggest the possibility that the last clause might be modified in this way.

Mr. JONES. I have been a careful listener during the entire conference. I do not believe the resolutions will meet the present situation. I do not think any modification of our curricula will meet the present situation. It seems to me the better plan would be to follow the same system that we have had in preparation for the war, and that is to establish the short course. The short course was successful at cantonments and successful in the various training schools. It seems to me that for preparation of men to do this work abroad there should be established at convenient centers or in large manufacturing plants or schools the necessary trained practical engineers. This work can not be done by students of the class of 1920 or the class of 1919 or of 1917. That work will have to be done by more experienced men.

It seems to me the solution of it, for the present at least, is to establish short courses that will round out the engineers who may be picked out for this work.

Chairman McLEAN. I am going to suggest, if there is no objection, that the resolution be read again. I think some in the rear of the room did not hear it entirely.

Mr. TURNEAURE. [After again reading the resolution referred to.] I realize that there is nothing in here specifically taking account of the discussion of foreign commerce. I would be very glad to have the speakers on that subject suggest a resolution, or, possibly, it might be provided in a sufficiently adequate manner by inserting at the end of this first paragraph, right after the sentence reading "This need is rapidly increasing and bids fair to demand a large number of technically trained men," the words "for both domestic and foreign commerce."

Then make the last paragraph to read as follows:

It is also urged upon all institutions with departments in engineering and economics or commerce that they consider some plan of coordination to develop a course in preparation for those careers wherein practical training in modern languages, in the essentials of engineering and business theory and practice, have been found to be both helpful and necessary.

The author I am sure, will be glad to accept those amendments if satisfactory.

Mr. NICHOLS. It seems to me those amendments would be very pertinent to the discussion this afternoon. So far as I know, they are acceptable.

Chairman McLEAN. I think the suggestions are very good and that the amendment suggested will meet the whole situation. If there is no further discussion I will put the question on the resolution.

Mr. POTTER. I want to say in connection with the modifications of the resolutions that personally I am very much in favor of the resolutions as they were originally presented. The tendency at the present time seems to be to eliminate foreign language from engineering courses. I believe you will find that the majority of the engineering schools are considering very seriously the elimination of foreign languages, for the simple reason that we find that the amount of knowledge that is given in an engineering school in the matter of languages at the present time is of no value to the student in his future career; and, personally, from my own observation of the study of foreign languages, I am very much in favor of eliminating the required foreign language in engineering schools.

It seems to me, therefore, that it would be unfortunate if we should include in the resolutions a clause intimating that it is desirable to require the study of foreign languages in connection with engineering.

Mr. MARSTON. I would like to ask that the last clause be read again. I gained the impression in listening to it that it applied only to courses to be developed in a very few institutions, not ordi-

nary engineering courses at all, in preparation for foreign trade, which would be a different thing from that discussed by Mr. Potter just now.

[Mr. Turneaure read the resolutions referred to. On a viva voce vote the resolution was unanimously adopted. The resolution as amended and adopted is printed in this report as Appendix D.]

Mr. MARSTON. I have been requested by the special committee at whose request this conference was called to present a resolution expressing the thanks of the conference, including those of the committee, to the chairmen who have presided at our sessions and to the speakers outside of the committee who have conducted the discussion.

I therefore offer such a resolution, that the thanks of the conference and of the special committee be extended to the chairmen who have presided so efficiently at the four sessions and to those speakers not members of the committee who have so thoroughly and so ably discussed the various phases of the topics under consideration.

[The resolution was seconded, and on a viva voce vote was adopted.]

Mr. LANGSDORF. I wish to offer one more resolution, Mr. Chairman, if you please, namely, that the thanks of the members in attendance at this conference be tendered to the Commissioner of Education and to the conference committee for having arranged this interesting program.

[The resolution was duly seconded.]

Chairman MCLEAN. Before putting the motion I desire to say that I very heartily concur in the resolution. I think it was a very fine conception to have projected this conference. We have the evidence here of the importance of bringing together in conference business men and engineers as well as instructors in the various technical colleges of the country, and I feel that very great benefit will be derived from the conference.

[On a viva voce vote the resolution was adopted.]

Chairman MCLEAN. Are there any other resolutions or papers of any kind?

If not, I declare the conference adjourned.

[Whereupon, at 5 o'clock p. m. the conference adjourned sine die.]

APPENDIX A.

COURSES OF STUDY IN ENGINEERING AND COMMERCE IN VARIOUS UNIVERSITIES—BRIEF STATEMENT OF PRESENT PRACTICE AND OF CHANGES CONTEMPLATED.[a]

University of Alabama (President George H. Denny, Mar. 13, 1919). A committee consisting of the professor of economics and the dean of engineering have arranged to introduce a special course in industrial organization to be given in conjunction with the engineering work. Students are advised to elect special courses in the school of law or in the department of economics that will give to them business training.

University of Arkansas (W. N. Gladson, dean, college of engineering, Mar. 14, 1919). Present practice in the engineering college is to encourage and allow electives up to 8 hours in the department of economics.

Leland Standard Junior University, California (Chas. D. Marx, professor of civil engineering, Mar. 15, 1919). Owing to elective system, no definite curriculum in the engineering courses, which require, however, a common mathematical basis. Nothing to prevent a student in engineering from taking 15 to 30 units in business economics. The department of economics offers the following courses to meet the wants of engineering students: Accounting, bond values and capitalization, corporation finance, labor problems, water transportation, and banking. First curricula suggestion not likely to be adopted; second meets with approval, although not incorporated in engineering courses. Nothing to prevent a student from taking a five-year combined engineering and commercial course.

Throop College of Technology, California (H. C. Van Buskirk, recorder, Mar. 19, 1919). Offers a four-year course in engineering and economics, leading to the degree of B. S. Possible for a good student to complete in five years one of the regular engineering courses and the engineering and economics courses.

University of California (Lester C. Uren, assistant professor of mining, Mar. 17, 1919). College of mining has a minimum of six units of business training and economics. In metallurgy there are two units; in petroleum engineering, three; and in economic geology, none. A minimum of 8 or 10 units would be desirable for mining students. The grouping of selected lists of courses in economics as desirable electives for the stronger students seems easily possible. The engineering council may, within a year or so, favor the adoption of five-year curricula for all of the engineering colleges. If this is done, a combined five-year engineering and commercial course might well be considered as an addition to the present curricula.

University of Southern California (R. D. Hunt, department of economics, Mar. 14, 1919). Engineering students now take about 11 hours of work in economics and commercial subjects. In respect to the five-year combined course, tentatively recommends a four-year course, with suitable work in mathematics and science, leading to the A. B. degree, with the fifth year of work culminating in the degree bachelor of science in engineering.

[a] Universities arranged alphabetically according to States.

Sheffield Scientific School of Yale University, Connecticut (J. C. Tracy, professor of civil engineering and chairman of the committee on engineering, Mar. 21, 1919). Committee on engineering at work on a new engineering curriculum covering four years; undecided whether or not a prescribed course of study in commercial engineering shall be given. Practically certain, however, that courses in accounting, business administration, and similar courses will be offered to students in their junior and senior years and more advanced courses in business administration to students in the graduate school.

University of Florida (J. R. Benton, dean of the college of engineering, Mar. 11, 1919). Would look favorably upon introducing a certain number of hours of business training into all engineering courses. Would not regard the provision of electives in business economics as feasible in the four-year engineering curriculum. Would oppose having degrees including the name "engineering" given by any other branch of the university. Would gladly cooperate in giving a five-year combined engineering and commercial course.

Georgia School of Technology (J. M. Watters, dean, school of commerce, Mar. 11, 1919). Have already attempted something along the line suggested by the committee. Commercial students have excellent opportunities for receiving a practical working knowledge of mechanical, civil, electrical, chemical, and textile engineering, drawing and architecture.)

Armour Institute of Technology, Illinois (H. M. Raymond, dean, Mar. 21, 1919). The degree of bachelor of science is granted to graduates of the four-year courses in engineering. In addition to required political science, psychology, and economics, the following subjects are also given to seniors: Business law, engineering contracts and specifications, and economics of engineering. Particular attention is paid to specifications and contracts in all courses. A feature of the senior work in power-plant engineering is the emphasis given the financial study of the problems involved and the thorough grounding in cost accounting.

University of Illinois (President Edmund J. James, Mar. 14, 1919). The college of commerce and business administration offers curricula in railway transportation and in industrial administration, each requiring 130 hours for graduation, with degree of bachelor of science. One prepares men for work in the operating departments of railways and the other is intended to meet the needs of commerce students planning to enter the administrative or selling departments of industrial plants. In the third and fourth years there are four optional groups of technical courses. (Cf. catalogue of the institution for full description of these courses.)

University of Notre Dame, Indiana (Matthew Schumacher, director of of studies, Mar. 18, 1919.) All engineering students at present carry a five-hour course in principles of economics and also a brief course in business law. At a special meeting of the faculties in engineering and commerce, held on March 18, to consider the suggestions of the committee, it was decided to make the following offerings for the coming year: A four-year course in engineering administration, the student choosing a special line of engineering; a year in business administration to follow a four-year engineering course or to be taken in three summer sessions.

Iowa State College (Ansel Marston, dean, division of engineering, Mar. 27, 1919). Development of the group system of electives in commercial engineering, started shortly before the war, was interrupted by the war. Favors requiring a certain minimum amount of commercial engineering work

in all engineering courses. Favors introducing into the principal engineering courses an elective group in commercial engineering to the extent of at least two-thirds of a year. Thinks that a four-year course in commercial engineering must wait for later development. Does not think that many students will take a five-year combined course.

The State University of Iowa (William G. Raymond, dean, college of applied science, Mar. 12, 1919). Three semester hours in accounting or economics required in all engineering courses. In connection with school of commerce, institution offered for two years two courses, namely, chemistry and business and engineering and business, the latter made up of 61 hours of general subjects, 42 hours of engineering subjects, and 33 hours of business subjects. No demand for the course. Doubt if there is any call for a five-year combined course. A general engineering course now offered in connection with college of liberal arts. A student takes the regular engineering course for two years and in junior and senior years does 30 hours of prescribed engineering work, 4 hours of English, a varying amount of modern language, and the remainder of 66 hours as electives, preferably in the department of economics of the college of law. Not much demand for the course. (Norris A. Brisco, head, department of economics, sociology and commerce.) Believes desirable a four-year course in commercial engineering.

Kansas State Agricultural College (A. A. Potter, dean, division of engineering, Mar. 8, 1919). All engineering students take a three-unit semester course in economics and a one-unit course each in business law and business administration. Two units each in factory design and factory engineering are given to seniors in mechanical and electrical engineering. Total, nine semester units. Does not believe feasible provision of 15 to 30 units in business economics on an elective basis unless incorporated in five-year combined engineering and commercial course.

The University of Kansas (P. F. Walker, dean, school of engineering, Mar. 26, 1919). The minimum number of required hours in business training favored by the administrative committee of the school of engineering is six, to include three hours in principles of economics and three hours in industrial administration. Arrangements were made several years ago to allow students to elect 20 to 26 hours in business economics and other allied subjects. Just now steps are being taken to outline this plan so as to show what subjects would be cut from the engineering course to allow the introduction of business courses. Believes it is inappropriate for any school of commerce to offer a course in industrial or commercial engineering. A school of commerce or an academic department of economics might prepare outlines of work for students in the college of liberal arts whereby such students might receive training in a limited degree in engineering subjects to supplement their business training. Institution not yet ready to make a definite statement regarding a five-year combination engineering and commercial course. Believes that catalog should show a five-year course for men interested in business or industrial engineering.

The Johns Hopkins University, Maryland (A. G. Christie, department of engineering, Mar. 18, 1919). Offers three hours in political economy throughout junior year and three semester hours in industrial organization and contracts in senior year. Second half of machine design is devoted to plant layout and arrangement and manufacturing costs, and a part of course on power plants is given to rate making.

Massachusetts Institute of Technology, Massachusetts (Davis R. Dewey, professor of economics, Mar. 25, 1919). The course in engineering administration provides a training for men who expect to enter positions concerned with the management or administration of manufacturing, construction, and transportation enterprises which demand a knowledge of scientific and engineering principles. It combines with instruction in general engineering studies in the methods, economics, and law of business. The course includes (1) the instruction common to all courses, in literature, language, and history, and in chemistry, physics, and mathematics; (2) a choice of engineering studies classified under three options: Civil engineering, mechanical and electrical engineering, chemical engineering; and (3) a selected group of subjects in business and economics. While the amount of time assigned to engineering subjects is less than that prescribed in the other courses of the institute, the fundamental subjects have been retained which will enable graduates to fill many of the positions open to engineers.

Approximately one-fourth of the total time of the curriculum is given to business subjects which are primarily chosen so as to train students to analyze commercial and industrial problems. In this group special emphasis is placed upon accounting, business law, the industrial organization of society, and business management. The course in accounting is designed to be of service to administrative officers in the analysis of accounts and financial reports, rather than to make bookkeepers, auditors, or accountants in a technical sense. Business law treats of contracts, agency, negotiable instruments, sales, and patents. The two extended subjects of industrial organization and business management deal with the financial operations of corporations and the conduct of business from the standpoint of the individual employer. Among other subjects included in the group of business studies are banking, statistics, report writing, transportation, and securities and investments. (For more extended description, including options in the several engineering divisions, compare circular of information of the institute, 1918, pp. 70–73.)

Tufts College, Massachusetts (Gardner C. Anthony dean, engineering school, Mar. 26, 1919). In the fourth year a course in engineering economics and business law is offered. A large amount of time is allowed, however, for free election in other departments, so that especially during the senior year a student may intensify his specialty or broaden his course to a very just extent. (Cf. catalogue of 1919–20, which will give the recently adopted new curriculum, a radical departure from the older courses given in the engineering school.)

Worcester Polytechnic Institute, Massachusetts (President Ira N. Hollis, Mar. 22, 1919). Offers shop management and elements of business law.

Mississippi Agricultural and Mechanical College (B. M. Walker, director school of engineering. Mar. 11, 1919). Regular courses include in senior year a full term's work devoted to economics.

University of Missouri (Isidor Loeb, dean, school of business and public administration, Mar. 25, 1919). The school of engineering now requires of all students 5 hours in general economics. From 10 to 17 hours are now elective—may be taken in economics and commerce. The faculties in engineering and business administration are now considering a plan whereby engineering students will be required to take a minimum amount of electives in economics or commerce. The faculty of the school of business and public administration has had under consideration the offering of a curriculum

which would combine commercial and engineering subjects. Engineering and commerce students taking one of the five year curricula may take a combined engineering and commercial course.

Princeton University, New Jersey (F. H. Constant, head of the civil engineering department, Mar. 11, 1919). At present time offers no course in commercial engineering. (E. W. Kemmerer, department of economics and social institutions, Mar. 19, 1919). The departments of engineering and economics are considering the problem of adapting courses in economics to the needs of the engineering students and of offering such courses as electives to engineering students.

Rutgers College, New Jersey (A. A. Titsworth, dean of engineering, Mar. 11, 1919). Present practice does not include any course outlined in the committee's "curricula suggestions." The second may be considered favorably for adoption.

Stevens Institute of Technology, New Jersey (President Alex C. Humphreys, Mar. 7, 1919). Has been giving for over 20 years to its students instruction in the commercial or business side of engineering. (Cf. catalogue 1919–1920 for description of course in economics of engineering.)

Columbia University, New York (Geo. B. Pegram, dean of the schools of mines, engineering, and chemistry, Mar. 11, 1919). Does not require a minimum number of hours in business training in all engineering courses. Mining engineering students have a course in accounting, and one in mining law, and mechanical engineering students are to have a course in business law. Students are advised to study economics as part of the three years of college work required for admission to the engineering courses. Plans for next year, if possible, a course in manufacturing and industrial engineering (this course in line with third curricula suggestion of committee, but with degree offered in school of engineering rather than in school of business). This course will give more thorough training than the committee's suggested five-year combined course.

New York University (compare pp. 47–49 of Bulletin No. 7, Apr. 16, 1918, for details of course in business and engineering). The chancellor of New York University writes under date of July 11, 1919, that "there is in New York University a keen appreciation of the need of a closer integration of education for engineering and education for business."

University of Nevada (President Walter E. Clark, Mar. 17, 1919). Plans further extension of department of accounting and law, permitting larger election of commercial subjects by engineering students. Engineering division has been considering the possibility of offering a five-year course, the added year to be given to such projects as economics, commerce, English and modern languages.

Dartmouth College, New Hampshire (Charles A. Holden, director Thayer school of civil engineering). Has offered for four years a course in engineering management. A unique feature of this course is the large requirement in outside reading covering 30 or more books on the subject. (W. R. Gray, director Amos Tuck school of administration and finance, Mar. 24, 1919.) Compare latest published announcement of this school for courses in scientific management and outline of curriculum.

New Hampshire College (C. E. Hewitt, dean of engineering, Mar. 13, 1919). Students are advised to offer electives in commercial subjects.

North Dakota Agricultural College (E. S. Keene, dean, school of mechanic arts, Mar. 15, 1919). Offers a three-credit hour course in contracts and

specifications. Engineering faculty believes committee's second curricula suggestion best suited to local conditions.

Case School of Applied Science (President Charles S. Howe, Mar. 19, 1919). Offers to seniors a series of 10 or 12 lectures on business; has never given a course in business economics; does not give a course in commercial or industrial engineering; is willing to consider a five-year combined engineering and commercial course.

Municipal University of Akron, Ohio (Fred E. Ayer, dean, college of engineering, Mar. 8, 1919). Requires a minimum of 8 hours in commercial work in addition to 12 hours of economics. Requires further 3 hours of productive engineering and 3 or 4 hours of coordination, dealing largely with the business of production in the factories. Offers a four-year degree course in manufacturing production in cooperation with large local rubber factories. With this exception, all engineering courses are five-year part-time courses.

Oklahoma Agricultural and Mechanical College (H. W. Moorehouse, dean, school of commerce and marketing, Mar. 26, 1919). None of the students in this course elect work in engineering. Engineering students, however, are required to take principles of economics and laws of contracts; in addition to civil engineering, students take city economics.

The University of Oklahoma (T. Bruce Robb, acting director, school of public and private business, Mar. 28, 1919). After this year all engineers will be required to take five hours in elements of economics, including business administration and accounting. A two-hour elective course will be offered in cost accounting.

Lafayette College, Pennsylvania (Fred G. Allen, secretary of engineering council, Mar. 18, 1919). The policy of the engineering council, in revising the engineering curricula for 1919-20, has been in part to increase the number of elective hours and to remove the restrictions in the choice of elective subjects. This elective system fully meets the committee's second curricula suggestion. There is a minimum requirement of 9 credit hours in business economics for civil engineers and 15 credit hours for electrical and mechanical engineers. By the use of the elective system, these minimum requirements may be increased to 21 and 27 credit hours, respectively.

Lehigh University, Pennsylvania (President H. S. Drinker, Mar., 14, 1919). The new schedules show a marked increase in the required number of term-hours devoted to business subjects.

Swarthmore College, Pennsylvania (G. F. Blessing, professor in charge of engineering, Mar. 8, 1919). Six-hour requirement in economics for all engineering students, who may, however, elect further hours in this department. At present interested in outlining a course in industrial engineering.

Brown University (James A. Hall, assistant professor of mechanical engineering, Mar. 11, 1919). All students take a fundamental course in economics in sophomore year and engineering economics in senior year. In addition, students may elect accounting and advanced economics. The committee's second curricula suggestion could be adopted by arranging special courses.

Agricultural and Mechanical College of Texas (J. C. Nagle, dean of engineering Mar. 17, 1919.) With next year only one three-hour semester course in fundamentals of economics will be required in most of the technical degree courses; business organization to be offered as an elective. Offers also a two-hour semester course in contract law and specification writing and devotes some time in one or two courses to management engineering.

University of Utah (Joseph F. Merrill, director schools of mines and engineering). All the courses in engineering to be changed this year in order to permit the introduction of a two-hour course for juniors in spring term in engineering economics, and a three-hour course in business in spring term of senior year. A four-year course in commercial engineering will be offered whenever there is sufficient demand for it.

Virginia Polytechnic Institute (S. R. Pritchard, dean of the engineering department, Mar. 22, 1919). No course is offered in either commercial or industrial engineering.

Norwich University, Vermont (Arthur E. Winslow, department of civil engineering, Mar. 24, 1919). Believes that committee's first curricula suggestion should be adopted. At present offers six semester credits in sophomore year, three in junior, and three in senior, covering economics, business finance, administration and management, and cost accounting and estimating.

West Virginia University (C. R. Jones, dean, college of engineering, Mar. 7, 1919). Course in industrial engineering, with emphasis on the commercial side, has been in contemplation for some time. Has been taking care of the situation in regular mechanical engineering curriculum by allowing substitution for those who expect to enter commercial work and also through a five and six year combined engineering and science course.

Marquette University, Wisconsin (J. C. Pinney, jr., dean, college of applied science and engineering, Mar. 20, 1919). Offers a required course in business administration. Provides for a minimum of six units in economics and is contemplating more on elective basis. Offers a fifth-year elective course in industrial engineering, including corporation finance, business administration, accounting, etc.

University of Washington (E. B. Stevens, executive secretary, Mar. 10, 1919). Provision is made for business law, and for a certain amount of electives. A large number of students elect courses in economics.

Howard University, District of Columbia (Harold D. Hatfield, director, school of applied sciences, Mar. 22, 1919). Students are receiving in senior year courses in commercial law, business management. Follows the committee's fourth curricula suggestion.

Letters from the following were received subsequent to the committee conference of March 31:

Massachusetts Institute of Technology (President Richard Maclaurin, Apr. 28, 1919). The institute is much interested in the problem of commercial engineering and after the war the faculty showed its appreciation of the growing importance of economics in the field of engineering by doubling the amount of time formerly given to economics in all the engineering curricula.

University of Colorado (Frederick A. Bushee, director, college of commerce, Apr. 12, 1919). No courses in economics or business training are required of students in engineering school. The possibility of a combined course in engineering and economics for the training of city managers has been discussed.

Maryland State College of Agriculture (T. H. Taliaferro, dean, division of engineering, Apr. 4, 1919). Offers a three-hour course for one year in economics and the law of contracts and also some incidental lectures pertaining to business matters connected with the practice of engineering.

University of South Dakota (L. E. Akeley, dean, college of engineering, Mar. 31, 1919). Requires one term of economics in sophomore year and specifications and contracts in senior year. Considers of vital significance the proposition to construct a course in commercial engineering for the preparation of engineers with business training.

University of North Dakota (E. J. Babcock, dean of the engineering colleges, Apr. 5, 1919). Has offered for three years a course in general engineering, providing about 60 per cent of the work along fundamental subjects in sciences, mathematics and technical engineering, and about 40 per cent in subjects relating to both business and engineering careers. Can give a five-year combined course in engineering and commerce, which would embody likewise the committee's first and second curricula suggestions.

University of North Carolina (P. H. Daggett, professor of electrical engineering, April 21, 1919). Contemplates a course somewhat along the lines suggested in the committee's report.

University of Wisconsin (F. E. Turneaure, dean, college of mechanics and engineering, Apr. 2, 1919). The only required study is a four-hour course in elementary economics in the civil and electrical engineering courses. Many engineering students elect courses in departments of economics and commerce.

College of the City of New York (President S. E. Mezes, July 7, 1919). Has had under consideration for a long time a more coherent arrangement of the courses now offered in business and engineering, so that they may lead to a distinctive degree.

Massachusetts Institute of Technology (Davis R. Dewey, July 8, 1919). Demands for the graduates in our course in engineering administration are increasing. This is an index of the current interest in the subject.

The Tulane University of Louisiana (President A. B. Dinwiddie, July 3, 1919). May count on full cooperation in promoting the proper business training for engineers. We have now under consideration a revision of our engineering curriculum with this end in view and the new curriculum will be put into effect as soon as we can finance the new course.

APPENDIX B.

LIST OF UNIVERSITIES AND COLLEGES WITH COLLEGES OR SCHOOLS OF ENGINEERING.[1]

Alabama Polytechnic Institute.
University of Alabama.
University of Arizona.
University of Arkansas.
University of California.
University of Southern California.
Throop College of Technology, California.
University of Santa Clara, California.
Leland Stanford Junior University, California.
University of Colorado.
Colorado College.
Colorado Agricultural College.
State School of Mines, Colorado.
Sheffield Scientific School (Yale University), Connecticut.
Delaware College.
Catholic University of America, District of Columbia.
George Washington University, District of Columbia.
Howard University (colored), District of Columbia.
University of Florida.
University of Georgia.
Georgia School of Technology.
University of Idaho.
Armour Institute of Technology, Illinois.
Lewis Institute, Illinois.
Northwestern University, Illinois.
University of Illinois.
Purdue University, Indiana.
Rose Polytechnic Institute, Indiana.
University of Notre Dame, Indiana.
Valparaiso University, Indiana.
Iowa State College of Agriculture and Mechanic Arts.
State University of Iowa.
University of Kansas.
Kansas State Agricultural College.
University of Kentucky.
Louisiana State University and Agricultural and Mechanical College.
Tulane University of Louisiana.
University of Maine.
Johns Hopkins University, Maryland.
Maryland State College of Agriculture.
Harvard University, Massachusetts.
Massachusetts Institute of Technology.

[1] With additions taken from Bulletin, 1918, No. 36, U. S. Bureau of Education, pp. 110–111, Educational Directory.

Lowell Textile School, Massachusetts.
Tufts College, Massachusetts.
Worcester Polytechnic Institute, Massachusetts.
University of Michigan.
University of Detroit, Michigan.
Michigan Agricultural College.
Michigan College of Mines.
University of Minnesota.
Mississippi Agricultural and Mechanical College.
University of Mississippi.
University of Missouri.
Washington University, Missouri.
Montana College of Agriculture and Mechanic Arts.
University of Nebraska.
State University of Nevada.
New Hampshire College of Agriculture and Mechanic Arts.
Dartmouth College, New Hampshire.
Rutgers College, New Jersey.
Princeton University, New Jersey.
Stevens Institute of Technology, New Jersey.
University of New Mexico.
New Mexico College of Agriculture and Mechanic Arts.
New Mexico School of Mines.
Polytechnic Institute of Brooklyn, New York.
Cornell University, New York.
College of the City of New York, New York.
Columbia University, New York.
Clarkson College of Technology, New York.
Manhattan College, New York.
New York University, New York.
Syracuse University, New York.
Rensselaer Polytechnic Institute, New York.
University of Rochester, New York.
Union College, New York.
University of North Carolina.
North Carolina State College of Agriculture and Engineering.
North Dakota Agricultural College.
University of North Dakota.
University of Cincinnati, Ohio.
Case School of Applied Science, Ohio.
Ohio State University.
Ohio Northern University.
Municipal University of Akron, Ohio.
St. Mary's College, Ohio.
Toledo University, Ohio.
University of Oklahoma.
Oklahoma Agricultural and Mechanical College.
Oregon State Agricultural College.
Lafayette College, Pennsylvania.
Pennsylvania College.
Bucknell University, Pennsylvania.
Drexel Institute, Pennsylvania.
University of Pennsylvania.

Carnegie Institute of Technology, Pennsylvania.
University of Pittsburgh, Pennsylvania.
Lehigh University, Pennsylvania.
Pennsylvania State College.
Pennsylvania Military College.
Swarthmore College, Pennsylvania.
Villanova College, Pennsylvania.
Rhode Island State College.
Brown University, Rhode Island.
The Citadel, the Military College of South Carolina.
Clemson Agricultural College, South Carolina.
South Dakota State College of Agriculture and Mechanic Arts.
South Dakota State School of Mines.
University of South Dakota.
University of Tennessee.
Vanderbilt University, Tennessee.
Agricultural and Mechanical College of Texas.
Rice Institute, Texas.
University of Texas.
University of Utah.
University of Vermont and State Agricultural College.
Norwich University, Vermont.
Virginia Agricultural and Mechanical College and Polytechnic Institute.
University of Virginia.
Virginia Military Institute.
Washington and Lee University, Virginia.
State College of Washington.
University of Washington.
West Virginia University.
University of Wisconsin.
Marquette University, Wisconsin.
University of Wyoming.

APPENDIX C.

LIST OF DELEGATES.

Baker, Van K., Supervising Engineer of Construction, Dupont Circle, Washington, D. C.

Baldwin, Albert L., General Agent, Northwestern Mutual Life Insurance Co., Washington, D. C. Representing Washington Society of Engineers.

Bawles, A. F., Dean of Engineering, New Mexico College of Agriculture and Mechanic Arts, State College, N. Mex. Representing same.

Bawden, W. T., Specialist in Industrial Education, Bureau of Education, Washington, D. C.

Bell, Spurgeon, Department of Business Administration, University of Texas, Austin, Tex. Representing same.

Bennis, Charles P., Assistant Manager, Underwriters' Association of District of Columbia, Washington, D. C. Representing National Fire Protection Association.

Berg, Ernest J., Professor of Electrical Engineering, Union College of Schenectady, N. Y. Representing same.

Betts, Philander, Chief Engineer, State of New Jersey Board of Public Utility Commissioners, Newark, N. J. Representing same.

Bishop, F. L. Dean, School of Engineering, University of Pittsburgh, Pittsburgh, Pa.

Black, W. M., Major General, Chief of Engineers, United States Army, Washington, D. C.

Bliss, Collins P., Professor of Mechanical Engineering, New York University, N. Y. Representing same.

Bogart, Ernest L., Professor of Economics, University of Illinois, Urbana, Ill. Representing Department of State, Foreign Trade Adviser's Office.

Bowman, Charles H., Mechanical Engineer, Langhorne, Pa. Representing Montana Society of Engineers.

Boyd, Alfred, Dean of Engineering, Agricultural and Mechanical College, Stillwater, Okla. Representing Oklahoma Society of Engineers.

Bozell, Harold, Assistant Professor of Electrical Engineering, Yale University, New Haven, Conn. Representing same.

Brown, H. H. Chemist, Department of Agriculture, Washington, D. C. Representing Bureau of Chemistry, Department of Agriculture.

Brower, Irving C., Major, Construction Division, Washington, D. C. Representing American Society of Municipal Improvement.

Browne, Arthur B., Major, Chief Motors and Vehicles Division, Ordnance Department, Washington, D. C. Representing Society Automobile Engineers.

Browne, William Hand, jr., Professor of Electrical Engineering, North Carolina State College of Agriculture and Engineering, West Raleigh, N. C. Representing same.

Bruner, Warren D., Investigator, United States Bureau of Efficiency, Washington, D. C.

Burden, Harry P., Engineer in Forest Products, Forest Service, United States Department of Agriculture. Representing same.

Burks, Jesse D., Manager Washington Office, National Industrial Conference Board, Washington, D. C.

Butler, G. M., Dean, College of Mines and Engineering; Director, Arizona Bureau of Mines, University of Arizona, Tucson, Ariz. Representing same.

Capen, Samuel P., Specialist in Higher Education, United States Bureau of Education, Washington, D. C. Representing same.

Carothers, Neil, Economist, Department of State, Washington, D. C. Representing Office of Foreign Trade Adviser, Department of State.

Carpenter, Dan E., Dean of Faculty, International Correspondence Schools, Scranton, Pa. Representing same.

Chamberlain, J. A., Supervisor of Manual Training, Franklin School, Washington, D. C. Representing Worcester Polytechnic Institute.

Chase, Charles P., Chief Engineer, United States Housing Corporation, Washington, D. C. Representing Iowa Engineering Society in Washington, D. C.

Chase, Leon Wilson, Chairman, Agricultural and Mechanical Engineering Department, University of Nebraska, Lincoln, Nebr. Representing same.

Child, Stephen, District Town Planner, United States Housing Corporation, Washington, D. C. Representing School of Landscape Architecture and City Planning of Harvard University, and American Society of Landscape Architecture.

Clark, Howard F., Major of Engineers, Office of Chief of Engineers, Washington, D. C.

Claxton, P. P., Commissioner of Education, Washington, D. C.

Coddington, E. F., Dean of Engineering, Ohio State University, Columbus, Ohio. Representing same.

Coe, Frank W., Major General, Charge of Coast Artillery, Washington, D. C. Representing Coast Artillery.

Coggeshall, George W., Institute of Industrial Research, Washington, D. C. Representing Society of Automotive Engineers, New York City.

Cohen, Louis, Consulting Engineer, Washington, D. C.

Collier, Frank W., Director of Research, American University, Washington, D. C. Representing same.

Conner, Samuel L., Professor Railroad Engineering, Tufts College, Mass. Representing same.

Covell, Grant A., Dean of School of Engineering, Oregon Agricultural College, Corvallis, Ore. Representing same.

Cummings, Elmore D., United States Assistant Engineer, Office Chief of Engineers, Washington, D. C.

Dachnowski, Alfred P., Bureau of Plant Industry, United States Department of Agriculture, Washington, D. C.

Daggett, Parker Huyward, Professor of Electrical Engineering, University of North Carolina, Chapel Hill, N. C. Representing same.

Davison, Charles M., First Lieutenant of Engineers, Camp A. A. Humphreys, Va. Representing Edwards Manufacturing Co., Cincinnati, O.

DeLaMater, Stephen T., Major, Quartermaster Corps, Washington, D. C.

Dennis, E. J., Washington, D. C.

De Yarnett, Harry J., Superintendent of Trades, Hampton Institute, Va.

Dietz, I. W., Educational Director, Western Electric Co., New York City. Representing same.

Drinker, Henry Sturgis, President, Lehigh University, South Bethlehem, Pa. Representing same.

Dodge, H. L., Assistant Professor of Physics, State University of Iowa, Iowa City, Iowa. Representing same.

Duckering, William E., First Lieutenant, Engineers, United States Army, Camp Humphreys, Va.

Du Brul, Ernest F., President, Pyro Clay Products Co., Cincinnati, Ohio.

Earl, Samuel Broodus, Director of Engineering Department, Clemson Agricultural College, Clemson, S. C. Representing same.

Emery, Natt M., Vice President, Lehigh University, South Bethlehem, Pa. Representing same.

Emory, Frederick L., Professor of Mechanics and Applied Mathematics, West Virginia University, Morgantown, W. Va. Representing same.

Evans, Frederick H., Dean, Toledo University, Toledo, Ohio.

Feiser, M. L., Associate Editor, Iron Trade Review, Cleveland Ohio. Representing same.

Felgar, J. H., Dean, College of Engineering, University of Oklahoma, Norman, Okla. Representing University of Oklahoma and Oklahoma Society of Engineers.

Fernald, Robert H., Professor of Dynamical Engineering, University of Pennsylvania, Philadelphia, Pa. Representing same.

Flather, John J., Professor of Mechanical Engineering, University of Minnesota, Minneapolis, Minn. Representing same.

Follows, George H., Professor of Commercial Engineering, Carnegie Institute of Technology, Pittsburgh, Pa. Representing same.

Gardner, Carroll H., Engineer, American International Corporation, New York, N. Y. Representing same.

Glading, Frank W., Bureau of Standards, Washington, D. C. Representing National Fire Protection Association.

Glazer, Morris H., McGraw-Hill Co., Washington, D. C. Representing same.

Griswold, Robert G., Chief Technologist, Henry L. Doherty & Co., New York, N. Y. Representing same.

Halsey, W. D., Assistant Professor of Mechanical Engineering, George Washington University, Washington, D. C. Representing same.

Hamilton, E. P., Secretary, John Wiley & Sons, Inc., New York, N. Y. Representing same.

Hanline, Simon M., Paint Manufacturer, Baltimore, Md. Representing Paint Manufacturers' Association of the United States.

Harding, Edward J., Field Secretary, Association of General Contractors of America, Washington, D. C. Representing same.

Harrison, John L., Civil Engineer, Washington, D. C. Representing Ohio Engineering Society.

Hatfield, Henry R., Dean, College of Commerce University of California, Berkeley, Calif. Representing same.

Hatt, William Kendrick, Professor of Civil Engineering, Purdue University, Lafayette, Ind.

Henderson, William E., Professor of Inorganic Chemistry, Ohio State University, Columbus, Ohio. Representing same.

Henry, P. W., Vice President, American International Corporation, New York City. Representing same.

Henry, S. M., Captain, C. C., United States Navy, Navy Department, Washington, D. C. Representing Bureau of Construction and Repair, Navy Department.

Herbert, Edith G. Editorial Assistant, the Ronald Press, New York, N. Y. Representing same.

Himes, R. L., Professor of Commerce, Louisiana State University, Baton Rouge, La. Representing same.

Hodgins, Howard L., Dean, College of Engineering, George Washington University, Washington, D. C. Representing same.

Hoffman, J. M., Captain of Engineers, Washington, D. C.

Hofmann, Adam, Dean of Engineering College, St. Mary College, Dayton, Ohio. Representing same.

Holden, Charles A., Director, Thayer School of Civil Engineering, Dartmouth College, Hanover, N. H. Representing same.

Holton, E. L., Professor of Education, Kansas State College, Manhattan, Kans. Representing same.

Holmes, W. Goode, Professor of Civil Engineering, University of South Carolina, Columbia, S. C. Representing same.

Hoover, Frank R., Civil Engineer, Washington, D. C.

Hotchkiss, W. E., Director, Business Education, University of Minnesota, Minneapolis, Minn. Representing same.

Hughes, Hector James, Chairman of the Administrative Board and Professor of Civil Engineering, Harvard Engineering School, Harvard University, Cambridge, Mass. Representing same.

Hustvedt, Olaf M., Lieut. Commander, United States Navy, Bureau of Ordnance, Navy Department, Washington, D. C. Representing same.

Jarvis, Chester R., Specialist in Agricultural Education, Bureau of Education, Washington, D. C.

Jenkins, C. F., Past President, Society of Motion Picture Engineers, Washington, D. C.

Jenks, Jeremiah W., Research Professor of Government, New York University; Chairman of Board, Alexander Hamilton Institute, 13 Astor Place, New York, N. Y. Representing same.

Jones, C. R., Dean, College of Engineering, West Virginia University, Morgantown, W. Va. Representing same.

Jones, John W., International Correspondence Schools, Scranton, Pa. Representing same.

Kapa, Stanley J., Engineer, University of Pennsylvania, Philadelphia, Pa.

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APPENDIX D.

RESOLUTION ADOPTED AT THE FOURTH SESSION OF THE CONFERENCE WITH REFERENCE TO ENGINEERING AND COMMERCE.

(See p. 155.)

It is the sense of the meeting that—

1. Industrial and commercial development has created a demand for men with technical engineering training and business ability. Manufacturing industries are seeking engineers to qualify to serve in capacities requiring sound business training. Banks and brokers also need men with business training and the engineering point of view. This need is rapidly increasing and bids fair to demand a large number of technically trained men for both domestic and foreign commerce.

2. In order to meet this demand the economic phases of engineering subjects should be emphasized wherever possible in engineering instruction. This may be done by emphasizing the problems of values and costs in the regular technical work and by introducing or extending courses in general economics, cost accounting, business organization and business law into the engineering curricula. These courses should be designed particularly to meet the needs of the engineering student.

3. The engineering phases of economic subjects should be emphasized wherever possible in commercial instruction. Students in commercial courses should also be given opportunity to take special courses in the basic principles and practices of engineering so that they may understand in general terms the operation of power plants and transportation systems from the engineering point of view.

4. It is also urged upon all institutions with departments in engineering and economics or commerce that they consider some plan of coordination to develop a course in preparation for those careers wherein practical training in modern languages, in the essentials of engineering and business theory and practice have been found to be both helpful and necessary.

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