ADMINISTRATIVE ENGINEERING FOR MICHIGAN STATE COLLEGE

THESIS FOR THE DEGREE OF B. S.

Victor Merdler

1933

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Study + Teaching

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"Administrative Engineering"
for
Michigan State College

A Thesis Submitted to
The Faculty of
MICHIGAN STATE COLLEGE
of
AGRICULTRE and APPLIED SCIENCE

BY

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Candidate for the Degree of
Bachelor of Science

June 1933

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Sources of Information and Data

1. Engineering Office
2. Dean of Engineering
3. Members of Faculty
4. Students

5. Proceedings of Society for Promotion of Engineering Education, 1917 to 1932

6. Catalogues, Bulletins and Correspondence from the following Universities and Colleges:
   Stanford University
   Northwestern University
   Marquette University
   Cornell University
   Columbia University
   Yale University
   Harvard University
   Princeton University
   Purdue University
   New York University
   Massachusetts Institute of Technology
   Armour Institute of Technology
   Carnegie Institute of Technology
   University of Maine

University of Southern California

University of Illinois

University of Michigan

Rensselaer Polytechnic Institute

Alabama Polytechnic Institute

Georgia School of Technology

Clarkson College

Michigan State College

Iowa State College

Pennsylvania State College

Rutgers College

Lehigh University

The essential purpose of this thesis is to present to the Faculty of Michigan State College a carefully planned curriculum for a course in Administrative Engineering especially adapted for this institution.

A course which can, at the discretion of the Board of Agriculture, be introduced into the college of Engineering. A definite and well devised program of study will be laid out consisting only of subjects already available in the various departments of the college as a whole.

The procedure followed in this thesis will be:

I. The purpose of a course as proposed.

II. The demand for such a course.

III. History and Trend.

IV. The development, layout and analysis of the curriculum.

V. The conclusion.

PURPOSE

The purpose of this course is to educate young men in the fundamentals which underlie the administration of technical enterprises. Successful administration in industry demands technical aptitude, business acumen and natural ability for leadership. These attributes are enhanced by training which provides a background of science and engineering, and at the same time develops a facility in the analysis and solution of business problems. A definite technique of administration now in process of development is proving unusually effective in the hands of those who are fitted to apply the scientific method to business management.

From the beginning of the factory system, scientifically trained men have served industry in planning, building, equipping and operating physical plants. In recent years there has been a growing appreciation of the value of their services in purchasing, selling, accounting, and financing. It has been found that careful analysis, rigid logic and painstaking adjustment of means to ends are almost indispensable in every phase of business management under modern conditions of large production, keen competition, and narrow margins of profit.

Since both scientific training and instruction in economics and business technique are essential to the

all-round development of the business executive, it seems the part of wisdom to combine them in one course.

Between the mere conception of a community need and the actual engineering service supplying the need there comes the following sequence of activities: research, design, construction, and operation.

Engineering problems arising in this sequence are of two sorts; namely, material and human, giving rise to engineering technology and engineering administration, respectively.

The technical problems of one branch of engineering are in part characteristic of that branch and in each field there are the technical problems which are characteristic of that field. On the contrary, the administrative problems are essentially similar in all branches and fields, therefore they should be embodied in a more general course.

Engineering education may be regarded from two points of view: It is an education in a profession upon which the demands are constantly increasing; it is, also, a preparation for business and for professions other than engineering. A course of study which combines with abstract science a study of its applications is valuable, even though divested of all professional idea and selected simply for the training given. An increasing number of young men find the study of engineering an excellent preparation for business responsibilities.

An engineer to achieve success in satisfying measure, needs both technical ability and the attainments of a broadly educated man. The study of engineering is necessarily concentrated and highly specialized. It should, therefore, be preceded by preparation designed not only to train the student in mathematics and the sciences specifically required for technical instruction, but also to give him an adequate background of general knowledge. Even further than this, the underlying purpose of the engineering course is to teach fundamental principles with just so much of the technique as may be necessary to show the applications of these principles and to illustrate engineering methods. These principles are clearly brought out at Northwestern University. The catalog of this university states that the motto of the school of Engineering is "Culture for Usefulness". This motto calls for an effort to obtain for the student the broadest culture attainable in order to equip him, as a man and as an engineer, for the greatest possible usefulness in the world in the united struggle of man for progress.

The purpose of the School of Engineering of Northwestern University is to furnish to each student a thorough training for the profession of engineering, combined with a general training of the man. The School aims to train engineers for the greatest average effectiveness in a lifetime rather than for the greatest effectiveness in the first few years after graduation. It aims to

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develop a capacity for unlimited growth. Hence strong emphasis is laid on those studies which tend to develop the man as well as on those which furnish training in engineering.

**"Through the accumulated experience of a century, the administration at Rensselaer Polytechnic Institute has learned that a student who has enjoyed a wide training in a major field is more likely to find an opening commensurate with his ability than is one who has specialized unduly. Since an undergraduate knows little or nothing about the opportunities which will exist when he completes his work, a background that will enable him to meet the demands of many positions is always the most practical as well as the most satisfying from a purely cultural point of view.

Since the foundation of the Institute, students have come to it from all parts of the world and have left it to become pioneers in the scientific thought and physical development of many countries. Its graduates have been successful not only as investigators and teachers in many branches of pure science and designers and constructors of many notable engineering works but also as organizers and executives of many great industrial enterprises as well as leaders in the other learned professions.

When the catalogue of 1926 was issued, one hundred years after the first class was graduated, the number

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of graduates was 3,351. At that time, or at the time of their deaths, 195 were presidents of corporations; 148 were vice presidents, secretaries, or treasurers; 246 were managers or superintendents, and 111 were chief engineers,--in all seven hundred holding high executive positions. Consulting engineers numbered 110; architects and contractors, seventy-seven; and sales engineers, forty-two. Many other graduates also held important positions in engineering, industry, or business. Among the ninety-six who were officers in the Army and Navy of the United States, two were brigadier-generals and four, rear-admirals. Of the 177 connected with institutions of higher learning, ninety-one were professors and eighty-six, instructors. The number of physicials, lawyers, and clergymen was ninety-two. Not included in these groups were four state geologists; two members of state boards of regents; two state supreme court justices; a state surveyor, and a United States senator. Of the 2,201 alumni graduated before 1916, a striking number have achieved distinction in their chosen fields. Although the 1,150 alumni graduated during the next ten years are still young, over one hundred had attained to high executive positions by 1926."

The course in Administrative Engineering is designed for students who wish to combine a knowledge of engineering principles with business studies. There is a great

" Rensselaer Polytechnic Institute, Bulletin 1933 Catalogue.

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need for technically trained executives. As the survey of the activities of graduates shows a large number of engineers have today become administrators and executives of industrial, public service, and similar business enterprises. This indicates that in many men technical aptitude and inclination are associated with commercial aptitude, natural ability for leadership, personal force, and other recognized qualities of the administrator. But while modern industry is calling for the special managerial ability that comes from habits of thought developed by training in the field of engineering, there is also a constantly increasing appreciation of the importance of definite technique in business administration.

The older courses are chiefly concerned with the physical and natural sciences and their application. They contribute to the discovery and use of new forms of wealth and new methods of production. But with this increase in productive power new problems in the conduct of business have arisen. The internal organization of both large and small business establishments has become more complex, often unwieldy and inefficient. Production has outrun efficient administration. Some colleges have recognized these new problems and have established departments of business education; but in only a few institutions has there been an attempt to combine a training in business economics with engineering instruction.

The object of this course is to prepare for those executive and managerial positions which require a knowledge of engineering principles and methods. The course is not intended for students who expect to become professional engineers in the field of design and construction or for those who expect to fill executive positions in which a knowledge of engineering is required equivalent to that ordinarily gained in any one of the other engineering courses.

The course prepares the student to enter industrial organization in positions leading to superintendence, financing, scientific management, and business administration. It prepares the graduate for the competent handling of such subjects as departmental management in factories, determination of costs, costs engineering, depreciation, appraising, manufacturing statistics, proper distribution of expense, economic production, personnel, production planning, efficiency, transportation, marketing, sales administration, etc.--and allied work, leading ultimately to superintendence, works management, and general management.

Engineering includes the science not only of utilizing the forces and materials of nature, but also of organizing and directing human efforts to that end. Executives whose work involves both administrative and technical functions far outnumber those who are in purely technical work. The administrative engineering course aims to prepare the student for this executive work.

Engineering courses are not designed to cover the whole field of technical thought and achievement. At best they can impress upon the student only basic principles. Students who pursue successfully the course in Administrative Engineering, or any other engineering course, can not hope to be experts in all its varied and useful fields, but on joining the great army of workers in the commercial world, they will inevitably drift into some particular line of work in which the productive period of their lives will be passed.

A normal career in engineering administration will carry the young graduate to an executive position in industry, either on the technical or business side. Before attaining to such a position, however, he will ordinarily have gained experience in a number of specialized activities which will have been both of technical and commercial character. It follows that training in engineering administration must provide both a satisfactory technical education and a background of economic and business principles thus laying the foundation for engineering and business judgment which are needed in later years growth into the larger executive responsibilities.

DEMAND

**"Since the aim of all engineering is intelligent production, the function of the engineering school is to develop men for intelligent production. The factors of production at the present time are men, materials, and organization; and each of these factors has to be considered in every engineering project from the point of view of science, of practice, and of costs. That is, we must first consider whether a structure is scientifically possible; second, if it is scientifically correct, can it be built; and third, is the value to be obtained from the structure worth the cost?

In solving an engineering problem science is absolutely essential. A structure cannot be properly designed without knowledge of science. An understanding of shop practice is also absolutely essential. A scientifically correct structure that cannot be built is useless. But the controlling factor in production is the question of the appraisement of values and costs. Somebody must decide that the value to be obtained from a structure warrants the cost of producing it. Somebody has to be willing to pay the price, or the structure will not be built. Hence, the controlling element in production,--the act that determines whether science and application shall serve men,--is the appraisement of values and costs."

*1917 proceedings S. P. E. E. Page 204.

In engineering schools at present, the question of materials is treated very fully from the points of view of science and of practice. The student learns the properties of materials, and the laws of science with a reasonable degree of success. But the appraisement of values and costs, which is the controlling element, is treated slightly. Some schools ignore it altogether, while in others it is recognized to a certain extent, but nowhere does it receive anything like the emphasis and importance which it has in real life. It is the controlling element in engineering, and it is not treated so in the schools. To make the school true to life, the appraisement of values and costs must be included in all of the instruction much more fully than is done at the present time.

Two thoughts are frequently expressed by the engineers; One the belief, apparently based on general grounds, that a broad training is the best preparation for the present day needs of the engineer; and the other that the college students are seldom able to predict the lines which their future endeavors will take and consequently should not be obliged to follow a program designed to fit them for some particular field.

Until recently the field of the engineer was a comparatively narrow one, comprising a little more than design, construction, and operation. As industry has developed, however, many technically trained men have

entered the field of manufacturing, selling, and administration.

This is a natural and increasing tendency, since industrial development rests mainly upon a scientific basis. There are few lines of human activity today that are not connected in some way with applied science, and this is particularly true of those lines known by the general term of engineering.

The success of the engineer in times past in meeting these commercial requirements, for which he had received no special training, was probably due to the method of attack characteristic of the engineer and to superior knowledge of the technical side of the work. But the commercial demands upon the engineer are now becoming so great that special training is necessary to equip him more completely for this larger field. This becomes more evident when it is considered that a large number of the graduates of engineering colleges go into the commercial side of engineering.

*"Considering the fact that in most engineering schools some two-thirds of the graduates gravitate into executive and commercial rather than into strictly technical pursuits, it would seem that these subjects should be given fully as serious attention as the technical and scientific subjects."

*Page 541, 1931 proceedings S. P. E. E.

It is a well established fact that the majority of the graduates of engineering colleges eventually find their way into administrative positions in engineering and manufacturing enterprises. Several reasons for this tendency has been advanced. Industry is becoming increasingly scientific in its background and practices, in many cases so much so as to require technical training for an understanding of its problems. Scientific and engineering methods of thought have invaded the fields of plant location, design and operation reaching now into the personnel problems of management.

But engineers as a rule are lacking in certain qualities and accomplishments which often prevent them from attaining as high a place in industry as their opportunities afford. Many graduates who have been successful in administrative positions have complained that their college course did not contain certain non-technical subjects that would have been of marked value to them in industry.

The recent investigation of engineering college curricula by the society for the Promotion of Engineering Education revealed the fact that from the view point of many alumni the courses are lacking in economic and historic content. On the other hand, there is an increasing demand for more thorough scientific training for the smaller group of graduates who are to engage in engineering design and construction; and there is, there-

fore, greater need for retaining the present engineering degrees and making them even more significant technically, so far at least, as some options are concerned. If, therefore, a more liberal course is offered, the degree to which it leads should be differentiated from the present degrees of Civil Engineer, mechanical engineer, or chem. engr.

The problem can, of course, be solved in a fairly satisfactory manner by five and six year courses such as are now offered by many of the leading colleges and universities as optional program to the regular four year courses in which there is little room for liberal studies. Experience indicates that such lengthy courses do not attract students. If for no other than economic reasons, a compulsory five or six year course in engineering seems to be expedient at this time.

The solution of the problem and the usual answer to this demand, as offered by most colleges, is a four year course in engineering with a senior option in industrial engineering, or with the system of the optional administrative course in conjunction with the regular courses in Civil, Mechanical, Electriaal, and Chemical engineering, as employed here at the Michigan State College. These courses are librealized with English, Economics, etc., as far as the faculties of engineering are willing to go, and yet confer an engineering degree. However these are weak and inharmonious efforts to solve this problem and will not meet this demand.

Of late, however, a few colleges elsewhere, have introduced broader courses, such as the one here proposed and no doubt the tendency is in this direction. To justify the need for such a course herewith is an account from the catalog of the Massachusetts Institute of Technology in which they defend their engineering administrative course. The article reads as follows:

*"The establishment of the Course was due to an inquiry made in 1913 by a committee of Institute alumni at the request of the Alumni Council. It was recognized that a considerable number of students did not, after graduation, follow an engineering or technical profession, but were drafted into commercial or managerial positions in industry. This committee first made a survey of instruction given at that time in American colleges in business administration, commerce, finance, accounting, and kindred subjects, but found no curriculum already in force which combined these studies with engineering and applied science. As a result of this investigation it was recommended that a new course be established whose aim shall be to furnish a broad foundation for ultimate administrative positions in commerce and industry by combining with a general engineering training instruction in business methods, business economics, and business law." In accordance with this report, the Faculty, at the request of the Corporation, established the course, then called

Engineering Administration, which graduated its first class in 1917.

The conviction of this committee that such a combination of studies would meet a genuine demand has been more than justified. Within a few years this course developed into one of the largest at the Institute. Between 1917 and June 1931, 1,076 men have been graduated by the Institute in all courses in the same period. That the curriculum is meeting a need is evidenced by the fact that over eighty-five per cent of the graduates of the first class undertaking Engineering Administration (1917) are now holding executive positions in industrial establishments.

HISTORY AND TREND

The designer and builder of fortifications or of roads and bridges that facilitated the movement of troops, many centuries ago, was called a "military engineer". By contrast, the designer and builder of civil works, such as highways, railroads, and canals, lighthouses, and harbor works, and bridges and buildings to be used in the peaceful development of a country, was called a "civil engineer".

The training of civilian engineers, as distinct from military engineers is of comparatively recent origin. Until 1826 the only institutions in the United States where students could prepare for engineering of any kind were the United States Military Academy at West Point and Rensselaer Polytechnic Institute at Troy. The first degree in civil engineering conferred in any English-speaking country was given during 1835 by the last-named institution; in England, the degree of civil engineer was not conferred until several years later.

On April 21, 1885, the Board of Agriculture of Michigan State College announced the establishment of a Department of Mechanic Arts. This was the beginning of the present Division of Engineering in this college which was created November 13, 1909.

In 1922 under the influence of Doctor Friday, who was then President of the college, the optional course in administrative engineering was introduced into the

college in the form as it is today. The purpose of this course, as taken from the catalog, is*"to meet the requirements of students who, in addition to a natural aptitude and liking for engineering careers, feel that the business side of the engineering industries has a stronger appeal than the technical side, and who sense in themselves the business, executive, or administrative ability which could be developed by a college course, differing from the usual type of engineering course."

"To this end the course offered in Engineering Administration is constructed by omitting from the technical engineering courses some of the advanced technical and professional subjects, and by substituting therefor a series of subjects in economics as related to the engineering industries, viz: general economics, accounting, banking, statistics, industrial management, corporation finance, contracts and specifications, labor problems and public utility economics."

The first senior class graduated from this course in the spring of 1924. The course as originally introduced under the influence of Dr. Friday contained thirty-one credits in economics, accounting, and statistics, which were, as mentioned before, substituted for some of the more advanced technical subjects. However, these optional credits were later reduced to twenty-one in number and so the course has remained to the present time.

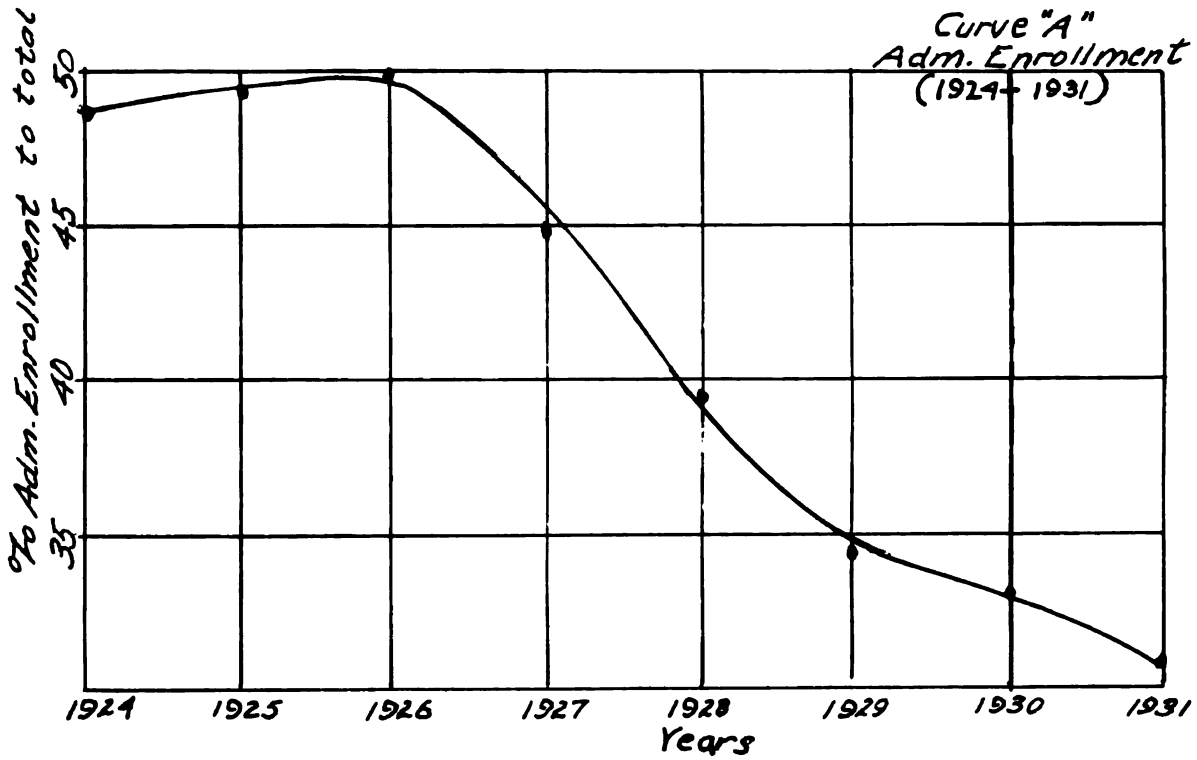
*MichiganState College Catalog.

The trend at this institution, then, has been toward a greater restriction of these economic subjects which seems to be in direct opposition to the policies of some of the best engineering institutions. The present trend of engineering education seems to be toward a cultural, administrative, and business training including, of course, fundamentals of professional subjects, as opposed to the purely narrow technical training.

There are three important developments which have taken place in the best engineering education: the establishment of sound scientific training as a foundation, the requirements of a broader general education for engineers and the enlargement of the scope of instruction.

On the following chart is listed the enrollment in the engineering division of Michigan State College for both the technical and administrative courses since the inauguration of the administrative option to 1931. From this data the graphs "A" and "B" have been constructed to determine, if possible, the reaction of the students to this type of training. The conclusion drawn is logical but, of course, a personal view point of the conditions.

Year		Senior Year	Junior Year	Soph Year	Total	Per cent of Adm. to Total
1924	Tech.	33	49	54	136	48%
	Adm.	44	39	42	125	
1925	Tech.	47	54	34	135	49%
	Adm.	35	42	54	131	
1926	Tech.	51	36	42	129	50%
	Adm.	37	38	55	130	
1927	Tech.	33	54	71	158	44%
	Adm.	35	42	50	127	
1928	Tech.	46	59	86	191	38%
	Adm.	41	39	36	119	
1929	Tech.	56	74	89	219	33.5%
	Adm.	33	37	40	110	
1930	Tech.	74	77	96	247	32%
	Adm.	36	39	42	117	
1931	Tech.	66	81	115	250	31.5%
	Adm.	40	33	43	116	
Average Tech.		50.8	60.5	73.4		
Average Adm.		37.8	38.6	45.3		


Curve "A"
Adm. Enrollment
(1924 - 1931)
% Adm. Enrollment to total
50
45
40
35
1924
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1929
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1931
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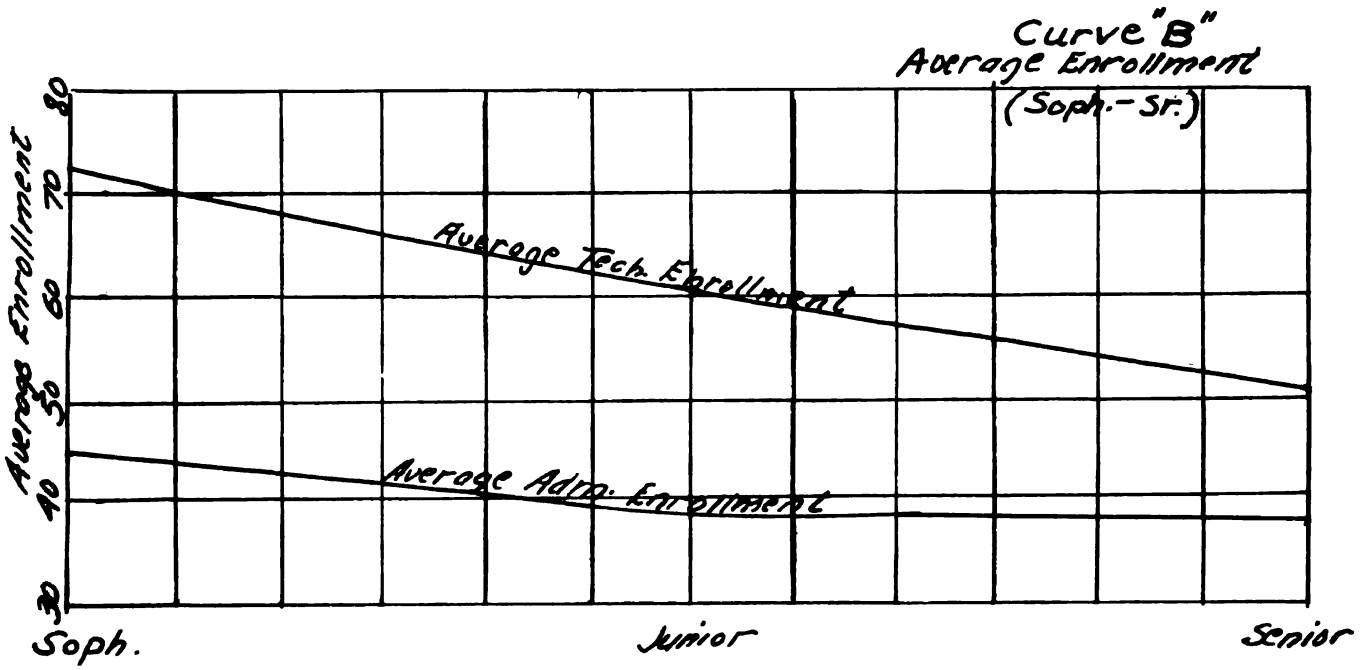

Curve "B"
Average Enrollment
(Soph. - Sr.)
Average Tech. Enrollment
Average Adm. Enrollment
Soph.
Junior
Senior

From this curve, curve A, it is clearly seen that the popularity of the administrative course has waned from 1926 to 1931, the drop being from 50% to 31.5% during this period. Bearing in mind that the number of credits in economics was decreased from 31 to 21 it can be construed that the value of the course was greatly decreased by this action. also that an increase in economics courses would be more favorable in the eyes of the student and, therefore, more popular.

It is noted in this curve, curbe B, that the drop in enrollment in the technical course is very sharp from the sophomore to the senior year, this drop being from 73.4 to 60.5 in the sophomore to the junior year and then to 50.8 in the senior year. On the other hand in the administrative course the drop is from 45.3 to 38.6 in the first year and then a drop of only .8 to the senior year. The significance of this is that the engineering student becomes more aware as he progresses of the value of economics as a necessary part of his training. The fact that the drop in the technical course enrollment between the junior and senior year and the almost insignificant drop in the administrative course during the same period clearly shows the tendency of the students to abandon the former for the latter course.

INVESTIGATION, ANALYSIS, AND DEVELOPMENT OF CURRICULUM

The major problems of this investigation to which all detail studies are subsidiary is that of the Administrative Engineering curriculum. In so controversial a field it is an advantage to begin with some point of agreement. The verdict of all parties consulted, teachers, graduates, students, and the opinion gained from all material read is definitely against specialized training for undergraduates.

As to the normal length of the curriculum, the four year course seems to be most universal. It is long enough to afford a reasonable general training without specialization or a narrow training with specialization. Looking at the question practically a longer course is a great added burden of expense on the student. A longer course is not justified on either economic or cultural grounds. It is clear from the experience of leading institutions that a sound general training can be given in four years' time through a relatively simple program.

As to admission into this engineering course, it need be no different from the admission requirements of the other engineering courses. However high school preparation in commercial law, economics, bookkeeping, typewriting, public speaking, etc. will be of distinct advantage to the student entering this course. The admission requirements into the engineering course as taken

from the college catalog is as follows:

**"Graduates of approved high schools who meet the requirements as set forth and are recommended are admitted to our four-year courses without examination. A certificate of recommendation, which may be obtained from the principal of the high school, should be sent to the Registrar of the College as early as possible after the close of the school year.

The College requires that all such applicants present fifteen acceptable units for admission--a unit meaning a subject pursued throughout a school year, with not less than four recitation periods each week.

For admission to the courses in Engineering the applicant must offer the following:

English	3 units
Algebra	1½ units
Geometry (Plane and Solid including Spherical)	1½ unite
Physics	1 unit
Group I	4 units or more
Group II	4 units or less
Total	15

Group I

From this group four units must be chosen, the number of credits accepted being shown.

English, 1 unit	Botany, ½ or 1 unit
Mathematics, 1 or 2 units	Physiography, ½ or 1 unit

Physics, 1 unit	General Science, ½ or 1 unit
Chemistry, 1 unit	Geology, ½ or 1 unit
Zoology, ½ or 1 unit	History, 1, 2, 3, or 4 units
Physiology, ½ or 1 unit	Language, 2, 3, or 4 units

Group II

Six units may be taken from this group for all courses except Engineering. In the Engineering Course four units may be taken from this group.

This group is made up of subjects not included in Group I which are accepted for graduation by accredited high schools, except that not less than two units of any one language will be accepted,, nor does the College accept physical training, penmanship, military training or spelling.

ADMISSION BY EXAMINATION

Candidates for admission who have not graduated from an approved high school or an approved preparatory school are required to pass examinations in fifteen units as follows:

For admission to the courses in Engineering:

English	3 units
Algebra	1½ units
Geometry (Plane and Solid, including Spherical)	1½ units
Physics	1 unit
Additional subjects, at least	8 units
Total	15

*Michigan State College Catalogue 1931.

As to the curriculum, it will be characterized as a combination of academic and professional study with adequate training in the fundamental sciences necessary to engineering, enough English and Speech to enhance correct speaking and writing, a thorough grounding in economics and a command of the essential technique of engineering.

In order that personal prejudice may not enter into the choice of subjects for this course, a definite method of attack has been adopted for the development of this curriculum. First, the all important basic fundamental subjects will be brought out from the most reliable source that could be obtained i.e. the study made by the "Society for the Promotion of Engineering Education" on this subject of fundamentals. Second, the curricula of ten institutions, which have already considered and adopted such a course and which most nearly resemble the objective course will be given. Third, charts will be constructed from the data obtained from these ten case courses. From these charts the curriculum of this administrative engineering course for Michigan State College will be developed. The only restriction in this procedure for development will be that the subjects included will be only those which are already existing in the various departments of this institution.

**"Of late years there has been a gradually increasing tendency in engineering education to concentrate on fundamental principles and methods and a corresponding swing away from instruction in the more specialized subjects. It is a proven fact that this movement has the endorsement of engineers and instructors alike. It is, therefore, natural that the question shall be raised as to what subjects should constitute the common core of the engineering curriculum.

The resulting information gathered which is based upon the replies of over five hundred teachers of extended experience and more than eight hundred of the leading engineers of the country is probably a good indication of present opinion on this matter.

The list of subjects indicated by a majority of the teachers as of primary importance is as follows:

Mathematics--through Calculus

General Physics

English--Composition and Speech

Inorganic Chemistry

General Economics

Graphics--Mechanical Drawing and Descriptive Geometry

Mechanics of Materials

Analytical Mechanics

Elements of Electrical Engineering

*Pages 363,365 1926 proceeding S. P. E. E.

Hydraulics

Elements of Thermodynamics

Surveying

The practicing engineers indicated all the foregoing and the following in addition:

Business Law

Accounting

Shop Work

The second step in the development of this course of study is to analyze the curricula of other institutions which have already adopted this course and thereby profit from the experiences already gained in this type of instruction. After delving into the catalogs of eighty-four engineering institutions of this country ten case curricula were selected as most nearly resembling the objective sought. The institutions chosen are:

University of Illinois

University of Southern California

Carnegie Institute of Technology

Alabama Polytechnic Institute

Clarkson Institute of Technology

Massachusetts Institute of Technology

Rensselaer Polytechnic Institute

Cornell University

University of Maine

Iowa State College

These chosen institutions represent every section of the nation. Seven of the ten are probably the leading engineering schools of the country and their presence in this study lends great weight to the importance of such a course. Another feature of this selected group is that it represents State Colleges, State Universities, strictly technical colleges, and a private institute. The choice, then, represents the biased opinions of the different localities as well as the different types of governing bodies.

On the following pages is presented these ten curricula which were chosen as a basis for this development. From this data charts "C" and "D" were constructed to bring out the relative importance of the various subjects.

Iowa State College of Agriculture and Mechanic Arts

General Engineering

Freshman Year
Fall Term

General Chemistry	4 units
Algebra	5 "
English Composition	3 "
Drawing	2 "
Engineering Problems	1 "
Military Science	1 "
Physical Education	R
Technical Lectures	R

Winter Term

General Chemistry.	4	units
Trigonometry	4	"
English Exp.	3	"
Ind. History	3	"
Engineering Problems	1	"
Military Science	1	"
Physical Education	R	
Lectures.	R	

Spring Term

Qual. Chemistry.	4	units
Analitical Chemistry	5	"
English.	3	"
Industrial History	3	"
Military Science.	1	"
Physical Education	R	
Lectures.	R	

Sophomore Year

Fall Term

Calculus.	4	units
Physics.	5	"
Descriptive Geometry.	2	"
Economics.	3	"
Public Speaking.	3	"
Military Science.	1	"
Physical Education.	R	

Winter Term

Calculus	4 units
Physics	5 "
Drawing	2 "
Economics	3 "
Psychology	3 "
Military Science	1 "
Physical Education	R

Spring Term

Calculus	4 units
Physics	5 "
Statistics of Mechanics	3 "
Business Management	3 "
Engineering Problems	1 "
Military Science	1 "
Physical Education	R

Junior Year

Fall Term

Mechanics	5 units
Mathematics of Construction	3 "
Mechanical Lab.	1 "
Direct Currents Electrical Engineering	3 "
Accounting	4 "
Seminar	R
Elective	2 units

Winter Term

Mechanics.	4 units
Mechanical Lab	1 "
D. C. E. E. Lab.	3 "
Laboratory	1 "
Business Correspondence.	1 "
Cost Accounting.	4 "
Seminar.	R
Elective	3 units

Spring Term

Hydraulics.	4 units
Mechanical Laboratory	1 "
American Government	3 "
English.	2 "
Electrical Engineering, Alternating Currents. . . .	3 "
Laboratory	1 "
Business Correspondence.	1 "
Seminar.	R
Elective	3 units

Senior Year

Fall Term

Engineering Valuation.	3 units
Electrical Engineering, Alternating Currents. . .	3 "

Laboratory . . . . . 1 unit

Surveying. . . . . 3 "

Industrial Organization. . . . . 3 "

Seminar. . . . . R

Electives. . . . . 5 units

Winter Term

Money, Banking . . . . . .3 units

Labor, American . . . . . .3 "

Industrial Engineering. . . . . .3 "

Elements of Structures. . . . . .5 "

Seminar. . . . . R

Electives. . . . . 3 units

Spring Term

Corporation Finance. . . . . 3 units

Contracts. . . . . 2 "

Scientific Management. . . . . 3 "

Water Power. . . . . 3 "
or or
Time Studies . . . . . 2 "

Electives. . . . . 8 "

Carnegie Institute of Technology

Commercial Engineering

Freshman Year

First Semester

Mathematics	3 units
English	3 "
Industrial History	3 "
Engr. Drawing and Descriptive Geometry	3 "
Hygiene (or in 2nd Semester)	1 "
Physical Education	1 "
General Chemistry	3 "
Shops	2 "
Reserve Officers' Training Corps	2 "

Second Semester

Mathematics	3 units
English	3 "
Industrial History	3 "
Engineering Drawing and Descriptive Geometry	3 "
Physical Education	1 "
General Chemistry	3 "
Shops	2 "
Reserve Officers' Training Corps	2 "

Sophomore Year

First Semester

Mathematics	3 units
Introductory Psychology	3 "
Economics	3 "
Economic Districts	3 "
Physical Education	1 "
Physics	4 "
Specifications and Letters	2 "
Reserve Officers' Training Corps	2 "

Second Semester

Mathematics	3 units
Economics	3 "
Modern Industries	3 "
Physical Education	1 "
Mechanics	3 "
Physics	4 "
Typewriting	1 "
Reserve Officers' Training Corps	2 "

Summer Session

Surveying	2 units

Junior Year

First Semester

Mathematics	2 units
Mechanics	3 "
Physics	4 "
Materials	2 "
Advertising and Selling	3 "
Power Plants	2 "
General Matallurgy	2 "
Reserve Officers' Training Corps	3 "

Second Semester

Statistics	2 units
Mechanics	3 "
Accounting	5 "
Power Plants	4 "
Machine Design	4 "
Reserve Officers' Training Corps	3 "

Senior Year

First Semester

Markets and Marketing.	3 units
Hydraulics.	3 "
Production and Distribution	3 "
Industrial Management.	3 "
Cost Accounting.	3 "
Electrical Engineering.	3 "
Reserve Officers' Training Corps.	3 "

Second Semester

Commercial Law.	3 units
Banking and Credit.	3 "
Production and Distribution	3 "
Transportation.	3 "
Commercial Engineering Reports.	3 "
Electrical Engineering.	3 "
Reserve Officers' Training Corps.	3 "

University of Southern California

General Engineering

Freshman Year

Inorganic Chemistry and Qualitative Analysis.	4	units
Introductory Course.	3	"
Introduction to the Practice of Engineering	1	"
General Engineering Drawing.	2	"
Algebra.	3	"
Advanced Trigonometry.	2	"
General Activities	1	"

Second Semester

Inorganic Chemistry and Qualitative Analysis.	4	units
Introductory Course.	3	"
Introduction to the Practice of Engineering	1	"
General Engineering Drawing.	2	"
Algebra.	2	"
Plane Analytic Geometry.	3	"
General Activities	1	"

Sophomore Year

First Semester

Differential Calculus.	3	units
Mechanics.	3	"
Heat.	3	"
Specialized Activities.	1	"
Health Education.	2	"

General Psychology. . . . . 3 units

Man and Civilization. . . . . 3 "

Second Semester

Surveying. . . . . 3 units

Integral Calculus. . . . . 3 "

Electricity. . . . . 3 "

Light. . . . . 3 "

Specialized Activities . . . . . 1 "

Man and Civilization . . . . . 3 "

Electives. . . . . 2 "

Junior Year

First Semester

Accounting for Engineers. . . . . 2 units

Analytical Mechanics. . . . . 3 "

Materials and Mechanics . . . . . 3 "

Graphical Methods. . . . . 2 "

U. S. Constitutional History . . . . . 2 "

Heat Engines. . . . . 3 "

Public Speaking II. . . . . 2 "

Electives. . . . . 1 "

Second Semester

Accounting for Engineers. . . . . 2 units

Fundamentals of Economics. . . . . 3 "

Elements of Electrical Engineering . . . . 2 "

Analytical

Hydraulics

Electives

Elements

Electrica

Principle

Seminar.

Electives

Contracts

Engineeri

Corporat

Seminar.

Elective

Total un

Analytical Mechanics. . . . . 3 units

Hydraulics. . . . . 3 "

Electives . . . . . 5 "

Senior Year

First Semester

Elements of Electrical Engineering. . . . 2 units

Electrical Apparatus Testing. . . . . 2 "

Principles of Industrial Management . . . 3 "

Seminar. . . . . 1 "

Electives. . . . . 10 "

Second Semester

Contracts in Engineering. . . . . 3 units

Engineering Economics. . . . . 3 "

Corporation Finance. . . . . 3 "

Seminar. . . . . 1 "

Electives. . . . . 8 "

Total units required, 140

University of Illinois

General Engineering

Freshman Year

First Semester

Inorganic Chemistry	3 or 4 units
Elements of Drafting	4 "
Advanced Algebra	3 "
Trigonometry	2 "
Rhetoric and Themes	3 "
Physical Education	1/2 "
Military Drill and Theory	1 "
English Lecture	0 "
Total	16 1/2 or 17 1/2

Second Semester

Qualitative Analysis	4 units
Descriptive Geometry	4 "
Analytic Geometry	4 "
Rhetoric and Themes	3 "
Physical Education	1/2 "
Hygiene (men)	2 "
Military Drill and Theory	1 "
English Lecture	0 "
Total	18 1/2

Sophomore Year

First Semester

Principles of Economics	3 units
Differential Calculus	5 "
Pattern and Foundry Laboratory or General Surveying	3 "
General Physics	3 "
Physics Laboratory	2 "
Physical Education	1/2 "
Military Drill and Theory	1 "
Total	17 1/2

Second Semester

Money, Credit, and Banking	3 units
Integral Calculus	3 "
General Surveying or Pattern and Foundry Laboratory	3 "
General Physics	3 "
Physics Laboratory	2 "
Analytical Mechanics (statistics)	2 "
Physical Education	1/2 "
Military Drill and Theory	1 "
Total	17 1/2

Junior Year

First Semester

Corporations	3 units
Direct Current Apparatus	3 "
Direct Current Laboratory	1 "
Machine Laboratory	3 "
Resistance of Materials	3 "
Resistance of Materials--Laboratory	1 "
Analytical Mechanics	3 "
Total	17

Second Semester

Structural Stresses	4 units
Alternating Current Apparatus	3 "
Alternating Current Laboratory	1 "
Thermodynamics	3 "
Hydraulics	2 "
Hydraulics Laboratory	1 "
Approved Elective	4 "
Total	18

Senior Year

First Semester

Metallurgy	3 units
Structural Design	4 "
Labor Problems	3 "
Steam Engineering	3 "
Inspection Trip	0 "
Approved Elective	4 "
Total	17

Second Semester

Business Law--Contracts, etc.	3 units
Structural Design	4 "
Engineering Geology	3 "
Mechanical Engineering Laboratory	3 "
Approved Elective	4 or 5
Total	17 or 18

Alabama Polytechnic Institute

Engineering Administration

Freshman Year

First Semester

English Composition	3 units
History and Government of the United States	2 "
Algebra	3 "
General Chemistry	3 2/3
Mechanical Drawing	1 1/3
Economic Organization	2 "
Industrial Engineering--Wood Shop	1 "
Reserve Officers' Training Corps	2 "
Physical Training	1/3
Total	18 1/3

Second Semester

English Composition	3 units
History and Government of the United States	2 "
Trigonometry	3 "
General Chemistry	3 2/3
Descriptive Geometry	1 1/3
Economic Geography	3
R. O. T. C.	2
Physical Training	1/3
Total	18 1/3

Sophomore Year

First Semester

Public Speaking	2 units
Dif. Calculus	3 "
Mechanics and Heat	3 "
Physics Laboratory	1 "
Industrial Engineering--Machine Shop	2 "
Principles of Economics	3 "
Accounting	3 "
R. O. T. C.	2 "
Total	19

Second Semester

Public Speaking	2 units
Int. Calculus	3 "
Physics--Elec., Sound and Light	3 "
Physics Laboratory	1 "
Accounting	3 "
Industrial Engineering, Machine Shop	2 "
Time Study	3 "
R. O. T. C.	2 "
Total	19

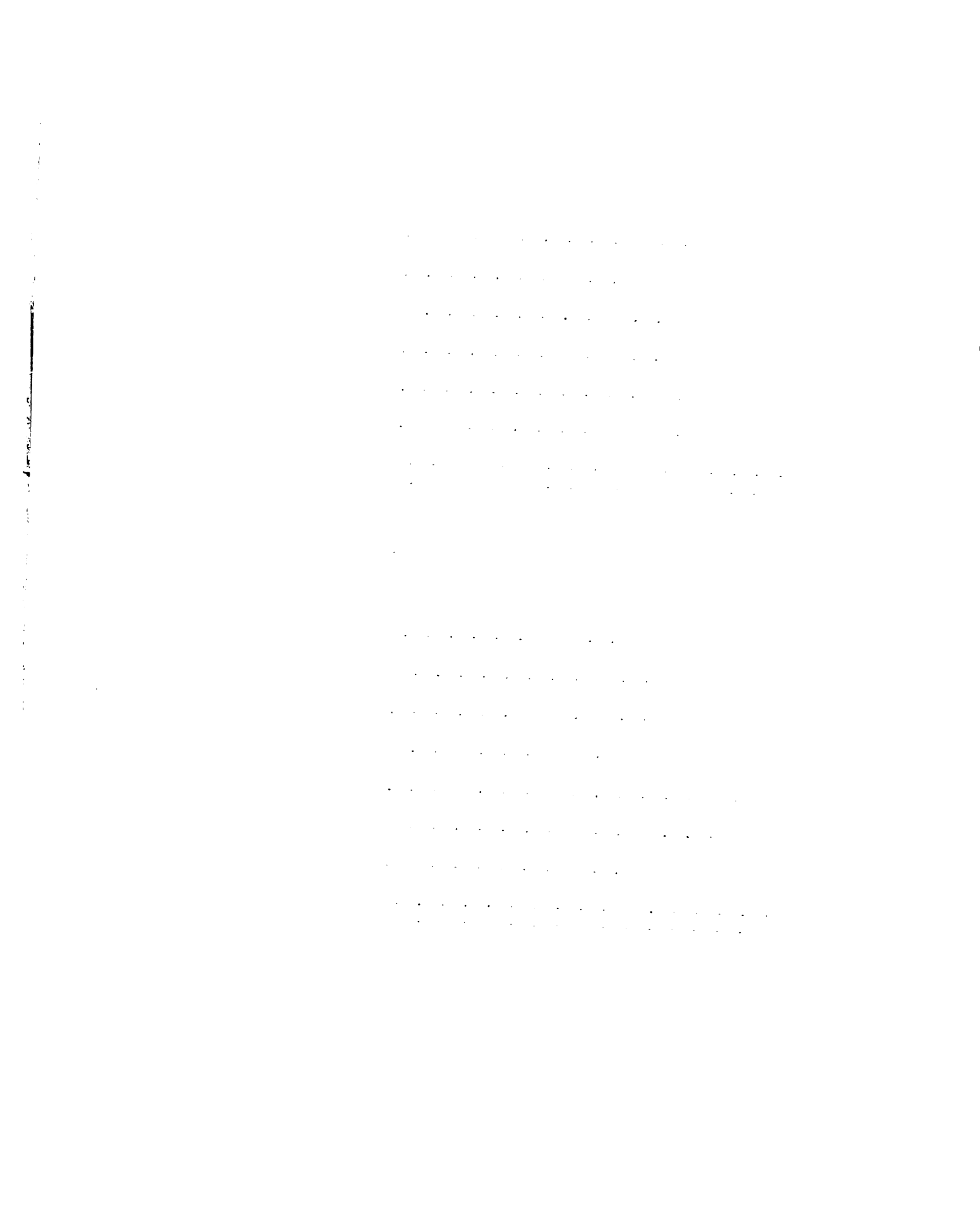
Junior Year

First Semester

Applied Mechanics	3 units
Materials of Engineering	2 "
Theory of Electricity	3 "
Electrical Laboratory	1 "
Business Law	3 "
Business Finance	3 "
Electives	3 "
Total	18

Second Semester

Strength of Materials	3 units
Electrical Machinery	3 "
Electrical Laboratory	1 "
Manufacturing Processes	1 "
Business Law	3 "
Economic Cycles	3 "
Machine and Tool Design	2 "
Electives	3 "
Total	19



Senior Year

First Semester

Thermodynamics	3	units
Accounting	3	"
Factory Planning	1	"
Contracts and Specifications	1	"
Salesmanship	3	"
Statistics	3	"
Personnel Administration	2	"
Electives	3	"
Total	19	

Second Semester

Power Plant	3	units
Industrial Management	2	"
Labor Problems	3	"
Advertising	3	"
Public Utilities	2	"
Cost Accounting	3	"
Electives	3	"
Total	19	

Cornell University

General Engineering as proposed by Dexter S. Kimball, Dean of Engineering at Cornell University.

Freshman Year

First Semester

Mathematics	5	units
Chemistry	3	"
Physics	3	"
Elementary Drawing	3	"
Introductory Lectures	1	"
Economics (Econ., Hist., Geog.)	3	"
Hygiene	1	"
Total	19	

Second Semester

Mathematics	6	units
Chemistry	3	"
Physics	3	"
Introductory Engineering Laboratory	2	"
Economics	3	"
Hygiene	1	"
Total	18	

Sophomore Year

First Semester

Mechanics	5 units
Empirical Design	2 "
English	3 "
Materials	2 "
Engineering, Chemistry	2 "
Wood Shop	2 "
Business and Industrial Organization	2 "
Total	18

Second Semester

Mechanics	3 units
Hydraulics	2 "
Kinematics Recitation	2 "
Kinematics Drawing	1 "
English	3 "
Materials	2 "
Foundry	1 "
Business and Industrial Organization	2 "
Machine Shop	2 "
Total	18

Junior Year

First Semester

Mechanical Laboratory	3 units
Machine Design Recitation	2 "
Machine Design Drawing	2 "
Heat, Power	3 "
Industrial Relations	2 "
Accounting	3 "
Money and Banking	3 "
Total	18

Second Semester

Mechanical Laboratory	3 units
Heat, Power	3 "
Accounting	3 "
Corporation Finance	3 "
Business Statistics and Forecasts	3 "
Public Speaking	3 "
Total	18

Senior Year

First Semester

Mechanical Laboratory	2	units
Industrial Engineering Lectures	1	"
Industrial Engineering Problems	2	"
Corporation and Investment Finance	2	"
Business Law	2	"
Marketing	3	"
Electives	7	"
Total	19	

Second Semester

Electrical Laboratory	4	units
Industrial Engineering Lectures	1	"
Industrial Engineering Problems	2	"
Cost Accounting	2	"
Business Law	2	"
Marketing	3	"
Lectures	1	"
Electives	4	"
Total	19	

University of Maine

General Engineering

Freshman Year

First Semester

Chemistry	4 units
English	3 "
Drafting	2 "
Trigonometry	2 "
Algebra	2 "
Military Science	1 ½
Physics	5
Physical Education	0
Total	19 ½

Second Semester

Chemistry	4 units
English	3 "
Machine Drawing	2 "
Analytical Geometry	4 "
Military Science	1 ½
Physics	5 "
Physical Education	0
Total	19 ½

Sophomore Year

First Semester

Chemistry	5	units
Geology	3	"
Economics	2	"
Descriptive Geometry	2	"
Calculus	5	"
Military Science	2	"
Physical Education	0	"
Total	19	

Second Semester

Biology	2	units
Chemistry	5	"
Metallurgy	3	"
Economics	2	"
Calculus	5	"
Military Science	2	"
Physical Education	0	"
Total	19	

Junior Year

First Semester

Electrical Engineering	4 units
Mechanics	5 "
Heat Engineering	3 "
Electives	6 "
Total	18

Second Semester

Electrical Engineering	4 units
Heat Engineering	3 "
Mechanics	5 "
Electives	6 "
Total	18

Senior Year

First Semester

Electives	19

Second Semester

Thesis

Electives	18

Electives are to be applied in economics, engineering, history, mathematics, physics, and psychology.

Clarkson College of Technology

General Engineering

Freshman Year

First Semester

English	3 units
Mathematics	4 "
Chemistry	4 "
Physics	4 "
Drawing	2 "
Shop	1 "
Physical Education	1 "
Total	19

Second Semester

English	3 units
Mathematics	4 "
Chemistry	4 "
Physics	4 "
Drawing	2 "
Shop	1 "
Physical Education	1 "
Total	19

Sophomore Year

First Semester

Calculus	3 units
Mechanics	3 "
Kinematics	2 "
Empirical Design	1 "
Principals of Economics	3 "
Accounting	2 "
Electrical. Engineering	4 "
Physical Education	1 "
Total	19

Second Semester

Calculus	3 units
Mechanics	3 "
Thermodynamics	3 "
Kinematics	2 "
Business Finance	3 "
Accounting	4 "
Physical Education	1 "
Total	19

Junior Year

First Semester

Mechanics	3 units
Thermodynamics	3 "
Electrical Engineering	3 "
Marketing	3 "
Statistics	3 "
Manufacturing Industries	2 "
Total	17

Second Semester

Mechanics	3 units
Thermodynamics	2 "
Electrical Engineering	3 "
Marketing	3 "
Statistics	3 "
Manufacturing Industries	2 "
Total	18

Senior Year

First Semester

Engineering Laboratory	1 unit
Power Plants	2 "
Labor Problems	3 "
Cost Accounting	2 "
Industrial Management	3 "
Business Law	2 "
Electrical Engineering	3 "
Surveying	1 "
Total	17

Second Semester

Engineering Laboratory	2 units
Power Plants	3 "
Personnel	3 "
Cost Accounting	2 "
Industrial Management	3 "
Business Law	2 "
Electives	2 "
Total	17

Massachusetts Institute of Technology

Commercial Engineering

Freshman Year

First Semester

Mathematics	3	units
English	3	"
Industrial History	3	"
Drawing and Descriptive Geometry	3	"
Hygiene	1	"
Physical Education		2/3
General Chemistry	4	"
Shop	2	"
Reserve Officers' Training Corps	2	"
Total	21	2/3

Second Semester

Mathematics	3	units
English	3	"
Industrial History	3	"
Engineering, Drawing and Descriptive Geometry	3	"
Physical Education	1	"
General Chemistry	4	"
Shop	2	"
Reserve Officers' Training Corps	2	"
Total	21	

Sophomore Year

First Semester

Mathematics	3	units
Psychology	3	"
Economics	3	"
Economic Districts	3	"
Physical Education	1	"
Physics	4	"
Specifications and Letters	2	"
Reserve Officers' Training Corps	2	"
Total	21	

Second Semester

Mathematics	3	units
Economics	3	"
Modern Industrial Economics	3	"
Physical Education	1	"
Mechanics	3	"
Physics	4	"
Typwriting	1	"
Reserve Officers' Training Corps	2	"
Total	20	

Junior Year

First Semester

Mathematics	2 units
Mechanics	3 "
Physics	4 "
Materials	2 "
Advertising and Selling	3 "
Power Plants	2 "
Metallurgy	2 "
Reserve Officers' Training Corps (advanced)	0 "
Total	18

Second Semester

Statistics	2 units
Mechanics	3 "
Accounting	5 "
Power Plants	3 "
Machine Design	4 "
Reserve Officers' Training Corps	0
Total	17

Senior Year

First Semester

Markets and Marketing.	3	units
Hydraulics.	3	"
Production and Distribution	3	"
Industrial Management.	3	"
Cost Accounting.	3	"
Electrical Engineering.	3	"
R. O. T. C.	0	"
Total	18	

Second Semester

Commercial Law.	3	units
Banking and Credit.	3	"
Production and Distribution	3	"
Transportation.	3	"
Commercial Engineering Reports.	3	"
Electrical Engineering.	3	"
R. O. T. C.	0	
Total	18	

Rensselaer Polytechnic Institute

Industrial Engineering

Freshman Year

First Semester

(Credits assigned by author)

Accounting	3 units
Chemistry	4 "
English	3 "
Geology	3 "
Mathematics	4 "
Physical Education	1 "
Total	18

Second Semester

Economics	3 units
Chemistry	4 "
Physics	5 "
Mathematics	4 "
Physical Education	1 "
Total	17

Summer Session

Shop and Thesis

Sophomore Year

First Semester

Drawing	3 units
Economic Geography	3 "
English	2 "
Economic History	3 "
Mathematics	4 "
Projections	3 "
Total	18

Second Semester

Electricity	4 units
Industrial History	3 "
Metallurgy	2 "
Industrial Architecture	2 "
Mathematics	4 "
Physics	4 "
Total	19

Summer Session

Shop and Thesis

Junior Year

First Semester

Qualitative Chemistry	3	units
Business Economics	3	"
Electrical Engineering, A. C.	3	"
Mechanics	4	"
Kinematics	2	"
Mechanical and Hydraulic Laboratory	1	"
Organic Chemistry	3	"
Total	19	

Second Semester

Quanitative Chemistry	3	units
Marketing	3	"
Thermodynamics	3	"
Mechanics	4	"
Industrial Management	3	"
Structures	3	"
Total	19	

Summer Session

Thesis

Senior Year

First Semester

Banking and Finance	3	units
Statistics	3	"
Chemistry Technology	3	"
Electrical Engineering Laboratory	1	"
English (letters)	3	"
Industrial Accounting	3	"
Transportation	3	"
Total	19	

Second Semester

Banking and Finance	3	units
Productive Engineering	3	"
Thesis		
Hydraulics	3	"
English (speech)	3	"
Industrial Management	3	"
Law	3	"
Total	18	

CHART C

X indicates course contained in the curriculum.

O indicates course optional in the curriculum.

	U. of Ill.	U. of So. Cal.	Carnegie Tech.	Alabama Polytech.	Clarkson Inst.	Mass. Inst. of Tech.	Rensselaer	Cornell U.	U. of Maine	Iowa State
Chemistry	X	X	X	X	X	X	X	X	X	X
Drawing	X	X	X	X	X	X	X	X	X	X
Des. Geom.	X		X	X		X	X		X	X
Math.	X	X	X	X	X	X	X	X	X	X
English	X	X	X	X	X	X	X	X	X	X
Phys. Ed.	X	X	X	X	X	X	X	X	X	X
Mil. Sci.	X		X	X		X			X	X
Eng'g Lectures	X	X				X		X		X
Foreign Language	O	O		O				O	O	
Physics	X	X	X	X	X	X	X	X	X	X
Mechanics	X	X	X	X	X	X	X	X	X	X
Economics	X	X	X	X	X	X	X	X	X	X
Shop	X		X	X	X	X	X	X		
Surveying	X	X		X	X			X	X	X
Elec. Eng'g D. C.	X	X	X	X	X	X	X	X	X	X
Machine Lab.	X				X			X		
Structural Theory	X						X			X
Elec. Eng'g A. C.	X	X	X	X	X	X	X	X	X	X
Thermodynamics	X			X	X		X			

CHART C (CONT'D)

	U. of Ill.	U. of So. Cal.	Carnegie Tech.	Alabama Polytech.	Clarkson Inst.	Mass. Inst. of Tech.	Rensselaer	Cornell U.	U. of Maine	Iowa State
Hydraulics	X	X	X	X	X		X	X	X	X
Electives	X	X		X	X	X		X	X	X
Metallurgy	X	X	X			X	X		X	
Steam Lab.	X									
Law	X	X	X	X	X	X	X	X	X	X
Materials		X	X			X		X		
Geology	X						X		X	
Mechanical Laboratory	X									X
Introd. to Engineering		X						X		
Psychology		X	X			X			X	X
Accounting		X	X	X	X	X	X	X	X	X
Graphics	X	X								
History		X	X	X	X		X		X	X
Heat Engines		X						X	X	
Public Speaking		X		X			X	X	X	X
Industrial Management		X	X	X	X	X	X	X	O	X
Seminar	X	X	X	X	X	X	X	X	X	X
Business Writing			X		X	X	X			X
Typing			X		X					

CHART C (CONT'D)

	U. of Ill	U. of So. Cal.	Carnegie Tech.	Alabama Polytech.	Clarkson Inst.	Mass. Inst. of Tech.	Rensselaer	Cornell U.	U. of Maine	Iowa State
Machine Design			X	X		X		X		
Thesis	X	X	X	X	X	X	X	X		
Industrial Architecture						X				
Production Eng'g.							X			
Eng'g Lab								X		
Empirical Design								X		
Engineering Valuation									X	
American Government									X	
Biology									X	

CHART D

Credits converted into equivalent Mich. State credits.

	U. of Ill	U. of So. Cal.	Carnegie Tech.	Alabama Polytech.	Clarkson Inst.	Mass. Inst. of Tech.	Rensselaer	Cornell U.	U. of Maine	Iowa State	No. of Colleges having subject	Av. credits of subjects	Modal credits
Chemistry	12	12	12	12	12	12	30	12	27	17	10	15.8	12
Drawing	6	6	4.5	2	6	4.5	4.5	4.5	6	4	10	4.8	4.5
Des. Geom.	6		4.5	2		4.5	4.5		3	2	7	3.8	4.5
Math.	25.5	24	21	18	22.5	21	24	21	27	29	10	23.3	21
English	9	9	9	9	9	9	12	9	9	11	10	9.5	9
Physics	15	18	18	12	12	18	13.5	9	15	15	10	14.5	15
Mechanics	13.5	13.5	12	12	24	16.5	15	18	15	9	10	14.8	15
Economics	31.5	42	45	41	36	45	36	44	24.5	42	10	38.7	—
Shop	4.5		6	7.5	6	6	R	7.5			7	5.4	6
Surveying	4.5	4.5		4	1.5			4.5	4.5	3	7	3.8	4.5
Elec. Eng'g	12	9	9	12	20	9	12	6	12	15	10	11.6	12
Hydraulics	4.5	4.5	4.5	4.5	4.5		6	3	4.5	4	9	4.4	4.5
Matallurgy	4.5	3	3			3	3		4.5		6	3.5	3
Law	4.5	4.5	4.5	10.5	6	4.5	4.5	6	9	2	10	5.6	4.5
Accounting	4.5	6	12	18	15	12	9	12	4.5	8	10	10.1	12
History		3	9	9	9		9			6	6	7.5	9
Public Speaking		3		6			4.5	4.5	4.5	3	6	4.3	4.5
Industrial Management		4.5	4.5	10.5	9	4.5	9	9		11	8	8.7	9
Business Writing		3	3		3		R	3		2	6	2.3	3
Statistics		4.5	3	4.5	9	3	4.5		4.5	3	8	4.5	4.5
Psychology		4.5	4.5			4.5			4.5	3	5	4.2	4.5

As previously stated, Chart "C" was developed from the ten case curricula for the purpose of showing the relative importance of the individual subjects. Chart "D" was developed from Chart "C" by listing the subjects of greater importance and the number of credit hours (converted into equivalent Michigan State College credits) assigned to these, thereby affording a method of determining the amount of time that should properly be assigned to each of these subjects. These two charts can now be used as a basis for the development of the objective curriculum.

From a close observation of charts "C" and "D" it is at once apparent that the most important and outstanding subjects are: chemistry, drawing, and descriptive geometry, mathematics, english, physics, mechanics, economics, principals of electrical engineering, commercial law, accounting, physical education, and military science. These subjects being present, in most cases, in all ten of the case curricula, it is apparent that they must be included in the proposed course.

Chemistry being one of the fundamental sciences upon which engineering has been built is, of course, essential. Seven of the example courses allot twelve credit hours to this subject. This seems to fit in very well with the system as applied in this college in that all of the present engineering

departments, in their freshman year, require the courses in general chemistry for the entire year which amount to nine or twelve hours depending on whether the student has had chemistry in high school or not. It is proper therefore that chemistry 101, 102, and 103 be assigned for the freshman year in the course.

Drawing is another of the fundamental requisites of the engineers' education. In most cases one semester has been alloted to this subject. Where more time has been given it appears to have been taken at the expense of descriptive geometry. The choice most nearly in keeping with chart "D" is mechanical drawing D&D 104a. This course coupled with Descriptive Geometry D&D 1052 and 105b allocates nine credit hours to this department which is sufficient in such a general course.

Mathematics beginning with trigonometry and followed through calculus is the present day method of preparing the engineering student for this most important branch of study upon which the entire engineering profession hinges. The regular series of mathematics courses for all engineering students of this school; i.e. mathematics 101, 102, 103, 204, 205, and 206, totaling 24 credits, furnish this requirement and therefore have been selected. This choice is entirely in keeping with chart "D" which brings out the fact that the average time alloted is twenty-three and a fraction credit hours as compared to the twenty-four credit hours of this series.

The most universal practice in regards to english for engineering courses is to devote three hours a week throughout the entire freshman year. In accordance with this plan, english 102e and 102f and 102g have been chosen. These three courses total nine credit hours which agrees with the model figure on the chart.

Physics being another of the fundamental sciences upon which engineering is based is, of course, of prime importance. The average number of credits assigned by the ten example curricula is fourteen and one half. The regular engineering physics section composed of Physics 202d, 202f and 202e taken throughout the sophomore year would allot fifteen credits to this subject which compares favorably with the average. This series will afford a thorough grounding in physics which serves as the prerequisite and basis for so many of the advanced technical courses.

Mechanics is the course which truly trains the student to attack the problem from a scientific and engineering point of view. Mechanics is engineering. It is the course which teaches the student to apply the fundamental laws of science to the practical problem. In natural sequence following the sophomore year of physics it is most fitting that the junior year be devoted to a thorough course in mechanics. With this in view the courses in mechanics CE304a, 304b, and 304c

are chosen to be taken throughout the junior year. This series in mechanics totals fifteen credits which agrees nicely with chart "D".

The importance of economics in such a course as this has been fully explained. The selection of the proper and most beneficial subjects in economics for a course of this nature requires the experience of an educator. The responsibility of such a selection must be with a person of far more knowledge of educational problems than mine. Therefore, I have consulted with Professor William Haber of the economics department on this matter. His choice of subjects is as follows: Economics 210a, 210b, 217, 305a, 307, 316, 318, 330, 320, 419, 442, 452 and accounting 203a, and 325a. With the exception of Economics 320, the above mentioned have been embodied in the curriculum. The inclusion of this series of subjects will afford a knowledge of the principles of economics, of organization and management of business, of labor and its problem to society, of banking and finance, of transportation, of investments, and of forecasting. It is the purpose of this instruction not only to deal with commercial, financial, and industrial problems, but also to stimulate the spirit of inquiry into the many social problems, the solution of which is so urgently needed.

To supplant the theory of electricity gained from physics it is necessary that a more practical course in the elements of electrical engineering be included in the curriculum. A knowledge of direct and alternating current apparatus and installation is necessary to every engineer. From chart "D" it is to be noted that an average of eleven and a fraction credit hours have been assigned to electrical engineering which also includes laboratory instruction. Electrical engineering courses E. E. 306a, 306ab, 306b, and 306bc have been chosen to fill this requirement. This series affords a complete survey of direct and alternating current theory plus laboratory practive in both despite the fact that it falls short of the comparison chart in regards to credit hours.

*"The field of practice of engineering and architecture is no longer confined to designing and supervising the construction of works; engineers and architects have become counselors and advisers in the investigation and promotion of enterprises, and the main reliance of the building owner for the knowledge he must have as to the requirements demanded by law relating to his project. It follows that the professional man, engaged in building and construction, is constantly being confronted with legal problems relating thereto.

*Preface-Simpson and Dillavou-Law for Engineers and Architects.

In increasing numbers universities and colleges are responding to this need by installing courses designed to teach certain of the legal principles applicable to the engineering profession. Since the time alloted to this study is in most cases relatively short, clearly such a course cannot enable one to become his own attorney; rather it should be designed to give such knowledge of the fundamental legal principles as will assist him in avoiding unpleasant and expensive pitfalls and to aid him in protecting his employers and his own rights and interests." To this end the courses in business law: economics 445a and 445b, have been selected. From chart "D" it is seen that an average of five and a fraction credit hours have been allocated to this preparation. The courses selected total six credit hours which compares favorably with the chart.

Military science and physical education requirements are fixed at this college and therefor no deviations from the present layout can be made. In accordance with these requirements military science 101, 102, 103, 204, 205, and 206 are prescribed for the freshman and sophomore years and physical education must be taken throughout the freshman year.

Now that the most essential courses have been alloted their respective places and weights in the curriculum, it is time to concentrate on these subjects

which are of lesser importance but still vital to the well rounded curriculum that is to be developed. The problem still to be solved is which of these lesser subjects shall be added and which can be overlooked and still retain a course having those qualities for which this study has been devoted. Bearing in mind that this curriculum is definitely limited to four years, the proceedure now is to choose those subjects which are most essential. With the aid of charts "C" and "D" and a careful application of means to an end the subjects considered as most essential have been chosen to complete this curriculum. These subjects selected are: business letter writing, thesis writing psychology, seminar, industrial management, statistics, hydraulics, history, sand, cement, and concrete, metallurgy, public speaking, surveying, engineering lectures, and shop work.

A preparation for positions in business certainly requires that training be given in business letter writing. Correspondence is the most important means of transacting business. Its popular position in this type of course is evidenced in chart "D". Journalism 303 has been selected as the course in business writing to fill this requirement.

It appears that the thesis for the bachelor's degree is required in most cases. In analyzing the value of the thesis as an instrument for student training it can be shown that there are some distinctive benefits to be derived from such a requirement. It is the one opportunity the student has to show some individuality and initiative. Some advantages of such a requirement are as follows: (1) student becomes familiar with literature of some special field (2) reveals latent capacity of student for research and develops this capacity (3) provedes good practice for important expository writing (4) acquaints instructing staff with students' ability to attack the problem. It is considered the best policy to include thesis work in the curriculum at least to the extent of six credit hours.

As previously stated, the engineering course must also serve the purpose of a general education. It is a great wrong on the part of the institution that the individual should graduate from the college or university without having had some contact with the cultural courses. The college graduate must have more than a superficial knowledge of the history and current problems of the significant countries and races. It is also desirable that he take at least an introductory course in psychology for subsequent value in making contacts with associates. These aspects of a student's preparation cannot

be neglected if he is to be adequately prepared for a position of leadership in his profession and is to avoid the danger of becoming a narrow technician. It is probably attributed to these facts that history and psychology stand out so prominently popular on the charts and in accordance with this fact history 101a, 101b, 101c, and psychology 201 have been selected.

Some time toward the end of the student's four year struggle to attain the elements of a profession it becomes desirable that he come in contact with the class for the purpose of discussing current topics of the profession. Further than this a seminar class can become of inestimable value in speech training in expressing oneself effectively. For these reasons it is probable that seminar classes are present in the senior year of most courses and so it seems wise to include such training in this curriculum.

The industrial management course is the one opportunity of the student to obtain practice in actual problems in plant management. In fact it is almost the only course in the entire curriculum devoted to practical training. This entire phase of engineering is based on industrial management. To discuss the advantages of such a course would be merely repetition of what has been said before in regards to the purpose of the entire curriculum. Industrial management 405a, 405b, and 405c have been selected to be pursued throughout the entire senior year.

Hydraulics, like mechanics, is of fundamental importance to the profession. In fact, one branch of engineering is based wholly on hydraulics. Its popularity is evident from an inspection of chart "D" it seems proper, at this point, to include at least one course in hydraulics; to this end the course CE305 has been selected.

Both engineering problems, scientific research, and financial analyses require a knowledge of statistical methods to enhance their solution. Compliation of data for statistical analysis is the most effective method of attaining facts. It is indispensable for a training of this nature. In most of the example cases one semester has been devoted to statistics, therefore the selection has been limited to one course, i.e. Mathematics 318.

The engineer must be acquainted with the properties of materials used for construction. In most cases a course in materials has been introduced to provide this knowledge, however at this institution there is no course of this nature in existence. To fill this requirement, then, there has been selected the course in metallurgy M. E. 211a and the course in sand, cement, and concrete C. E. 316a. It is felt that these two courses plus the course in strength of materials, which has already been included, will satisfactorily fill this requirement.

Surveying stands out rather prominently in the charts. Evidently it is considered as a necessity in a course of this nature. Practical application of engineering technique, at least, to this extent seems to be advisable. In accordance with this surveying C. E. 201b has been selected.

In many schools it is considered necessary that the student just coming from high school be exposed to a series of lectures for the purpose of orienting the student to the new surroundings, new methods of doing things, and the peculiar characteristics of the course which he has chosen to follow for at least another four years. To this end it is highly desirable that attendance be required of freshman students to the engineering lecture course as is now the case in the present engineering courses.

It is essential to the man who is to promote anything of consequence to acquire the ability to express himself in correct and effective English. The ability to speak forcibly and persuasively is decidedly advantageous, in fact, essentially necessary to the man climbing the ladder to success. Public speaking has been included in six of the example courses. The average time alloted to this training being four and a fraction credit hours, this in most cases is sufficient. In view of the conditions here, that is, the

type of speech as exemplified by the senior engineering students on this campus this does not seem to be sufficient training. It has been suggested by instructors that more time be put on speech training, therefore, two courses speech 203a and 215d have been selected for this curriculum.

In the technical schools shop work occupies a rather uncertain position. There is no agreement as to the real purpose of it. At any rate, shop work requirements are rapidly declining. In view of the fact that seven of the schools are still clinging to this course, it is probable that there is some value to be gained from such a course, therefore shop courses M. E. 131, 151, and 161 have been introduced into the freshman year. This series totals six credits which coincides exactly with chart "D".

An interesting feature which I ran across in studying the various catalogs is the personnel service at Purdue. Although this is not of direct bearing on the subject, it is not entirely irrelevant and I quote it from the catalog--

**"The Personnel Service assists the engineering students in developing their personalities; provides occupational information; helps the seniors to secure employment after graduation; aids the juniors and underclassmen in obtaining summer work; keeps cumulative personnel records up to date for all students; assists graduates in personnel matters and employment problems;

*1933 catalog of Purdue University.

performs personnel research; and is responsible for instruction in Personnel Administration.

The Personnel Service endeavors to assist the student in improving his personality. This is accomplished by means of ratings, interviews, special counseling, lectures, and individual analysis. Every effort is made to improve the student's address and manner, attitude, disposition, industriousness, leadership, and the other personal traits which are necessary for success in the engineering profession."

All subjects which are to be embodied in the proposed curriculum have now been discussed generally. Of course there are many more subjects which because of the limited schedule have been omitted from the curriculum. However the choice has, in every case, been guided by the charts and with this guide it is felt that the best selection, under the circumstances, has been made. On the following pages is given the curriculum as proposed for this college. Following this is given a description of the various subjects as taken from the catalog.

(1st yr. Identical for all engineering courses)

FRESHMAN YEAR
FALL TERM

Chem. 101a or 101	Gen. Chemistry	3 or 4
D. & D. 104a	Mech. Drawing.	3
Eng. Comp. 102e	Composition.	3
Math. 102 or 102	Algebra or Trigonometry. . . .	3
M. E. 131,151,or 161	Shop-work.	2
M. E. 101	Engineering Lectures	0
Mil. Sci. 101	Military Science	1½
Phys. Ed. 102	. . . . .	1

WINTER TERM

Chem. 102a or 102	General Chemistry.	3 or 4
D. & D. 105a	Descriptive Geometry	3
Engl Comp. 102f	Composition.	3
Math. 101 or 103	Algebra or Analytic Geom.. . .	3
M. E. 131,151,or 161	Shop-work.	2
Mil. Sci. 102	Military Science	1½
Phys. Ed. 101	. . . . .	1

SPRING TERM

Chem. 103a or 103	General Chemistry.	3 or 4
D. & D. 105b	Descriptive Geometry	3
Eng Comp. 102g	Composition.	3
Math. 103 or 204	Analytic Geometry or Calculus.	3 or 5
M. E. 131,151,or 161	Shop-work.	2
Mil. Sci. 103	Military Science	1½
Phys. Ed. 103a or 103b	. . . . .	1

SOPHOMORE YEAR

Fall term

C. E. 201b	Surveying.	3
Math. 204	Calculus	5
Phys. 302D	Mechanics and Heat	5
Econ. 332	Accounting for engineers . .	3
Mil. Sci. 204	Military Science	1½

Winter term

Speech 203a	Fundamentals of Speech . . .	3
Math. 205	Calculus.	5
Phys. 202f	Heat, Elec., & Magnetism. .	5
Econ 210a	General Economics	3
Mil. Sci. 205	Military Science.	1½

Spring term

Speech 215d	Advanced speech.	3
Math. 206	Calculus.	5
Phys. 202e	Light and Sound.	5
Econ. 210b	General Economics.	3
Mil. Sci. 206	Military Science.	1½

JUNIOR YEAR

Fall term

C. E. 304a	Mechanics of Engineering. . .	5
E. E. 306a & ab	D. C. Machinery.	3
M. E. 211a	Metallurgy.	2
Econ. 308	Money, Credit, & Banking. . . .	5
Hist. 101a	History.	3

Winter term

C. E.304b	Mechanics of Engineering. . .	5
C. E. 305	Hydraulics.	3
E. E. 306b & bc	A. C. Machinery	4
Hist. 101b	History.	3
Econ. 307	Personnel Management	3

Spring term

C. E. 304c	Resistance of Materials. . .	5
Math. 318	Statistics.	3
Hist. 101c	History.	3
Econ. 316	Corporation Finance.	3
Econ. 217	Business Org. and Mgmt.. . .	4

SENIOR YEAR

Fall term

M. E. 405a	Industrial Management. . . .	3
Econ. 419	Econ. of Transportation. . .	5
Econ. 305a	Labor Economics.	4
Acct. 325a	Cost Accounting.	3
Econ. 445a	Business Law.	3

Winter term

M. E. 405b	Industrial Management. . . .	2
C. E. 430a	Seminar.	2
C. E. 316a	Sand, Cement, & Concrete . .	3
Psych. 201	General Psychology.	4
Econ. 445b	Business Law.	3
Econ. 442	Public Utility Economics. . .	3

Spring term

M. E. 405c	Industrial Management. . . .	3
C. E. 411	Thesis.	6
Econ. 330	Investments.	3
Journ. 302	Business Writing.	3
Econ. 452	Business Cycles.	3

101. General Chemistry. (Non-metallic elements.) 4(3-6)

The lectures are illustrated by appropriate experiments and embrace the history of chemistry, the laws of chemical combination, elementary substances, their geographical distribution, properties, combinations, and technical uses. The practical relations of chemistry are made prominent.

101a. General Chemistry. (Non-metallic elements.) 3(2-6)

Prerquisite: One year of high school chemistry.

Similar to Course 101, but assuming a knowledge of certain fundamentals.

102. General Chemistry. (Metals). 4(3-6)

Prerequisite: 101.

A continuation of Course 101. The lectures are devoted to further discussion of fundamental theories of chemistry, and the laboratory work to a study of the chemistry of the metallic elements.

102a. General Chemistry (Metals). 3(2-6)

Prerequisite: 101a.

Similar to Course 102.

103. General Chemistry. (Carbon compounds.) 4(3-6)

Prerequisite: 102.

A course in which the student becomes familiar with the chemistry of the carbon compounds, particularly those of the aliphatic series. In the laboratory the student prepares a number of typical organic compounds and makes some determinations of their physical constants.

103a. General Chemistry. (Carbon compounds.) 3(2-6)

Prerequisite: 102a.

Similar to course 103.

C. E. 201b. Surveying and Leveling. 3(2-3)

Prerequisite: Math. 102 or 102a.

A course in elementary surveying, covering the use of the tape, compass, level, and transit with practice in making simple maps.

C. E. 304a. Mechanics of Engineering. 5(5-0)

Prerequisite: Math. 206.

Elementary statics and dynamics, theory of center of gravity, friction and moment of inertia comprise principally the first term's work. Analytic methods are more generally employed, supplemented by graphic constructions and numbrous examples of practical application.

C. E. 304b. Mechanics of Engineering. 5(5-0)

Prerequisite: 304a.

A continuation of the study as outlined under Course 304a, using the same textbook in class. Kinetics, kinematics, work and impulse are some of the divisions of this study.

C. E. 304c. Resistance of Materials. 5(5-0)
Prerequisite 304a.

Among other considerations dealt with are simple tension, compression and shear; moment and shear in flexure of beams, with diagrams, long columns and reinforced concrete beams.

C. E. 305. Hydraulics. 3(3-0)
Prerequisites: 304a, and 304b taken concurrently.

This course is studied as an application of our courses in mechanics of engineering. Subdivision of the course includes hydrostatics, hydrodynamics, water supply, water power, water sheels, and turbines. Special attention is given to the flow of water in pipes as preparatory to the economic design of a distributing system of a municipal water supply.

C. E. 316a. Sand, Cement, and Concrete. 3(2-3)
Prerequisite: Junior classification.

A study of the properties of concrete aggregates and concrete, including their manipulation in construction together with laboratory exercises in making the standard acceptance tests and others.

C. E. 430a. Seminar. 2(2-0)
Prerequisite: Senior classification.

A course in reading and discussion of current engineering magazines and literature.

D. & D. 104a. Mechanical Drawing. 3(0-9)

Lettering and the making of name plates. Theory of orthographic projection and its application in working drawings. Textbook used.

D. & D. 105a. Descriptive Geometry. 3(2-4)
Prerequisite: 104a.

Problems in point, line, and plane and practical applications of same. Textbook used.

D. & D. 105b. Descriptive Geometry. 3(1-6)
Prerequisite: 105a.

A continuation of Course 105a, including surfaces of revolution with practical applications of the same.

Econ. 210a. General Economics. 3(3-0)

This course is designed as a general introduction to Economics for students in the divisions of Engineering, Agriculture, and Home Economics. Beginning with a brief description of present-day industrial organization, it deals with the fundamental principles of the production, exchange and distribution of economic wealth and the relation of these principles to current industrial and financial problems.

Econ. 210b. General Economics. 3(3-0)

Continuation of Course 210a with special attention to application of principles to current economic problems.

Econ. 307. Personnel Management. 3(3-0)

Personnel management is a study of the employer's methods in administering human relations in industry. This course is concerned with two aspects of the problem. First, with an examination of the symptoms of inefficient organization such as labor turnover, absenteeism and restriction of output; and second, the organization of the personnel department to supervise such matters as labor supply, selection and placement, training, discharge, safety and health, wages, welfare activities and joint relations with employees. The course is designed both for students specializing in personnel work and those who wish only to secure a better grasp of human relations problems in industry.

Econ. 318. Money, Credit and Banking. 5(5-0)
Prerequisite: 209b or 210b.

A survey course of the financial organization of society. After consideration of monetary standards, foreign exchange and the social uses of credit, a study is made in turn of the principal types of modern financial and credit institutions and of their relations to each other. Special attention is given to commercial banking, and to relation of national and state banks to Federal Reserve System.

Econ. 316. Corporation Finance. 3(3-0)
Prerequisites: 209b or 210b, 203a or 333.

This course is a study of corporate form of business organization with reference to its financial administration. It treats of promotion, types of stocks and bonds and conditions under which each type is issued, management of income, receivership and reorganization.

Econ. 217. Business Organization and Management. 4(4-0)
Prerequisites: 209b or 210b, 203b.

Study of organization and management of business enterprise from point of view of executive control. The course stresses the managerial functions of production, finance, credit, sales and traffic. Case problems are studied.

Econ. 305. Labor Economics. 3(3-0)
Prerequisite: 209b or 210b.

As an introduction to the field of labor and industry this course examines the economic, legal and social position of the wage earner and of the wage earning groups in modern society. It surveys the evolution and character of present-day labor problems; the causes of industrial unrest, wages, hours of work, unemployment, industrial accidents, standards of living and similar problems. It analyzes the aims, policies and tactics adopted by various economic groups such as trade unions, cooperative societies and employers' associations.

Econ. 330. Investment Banking and Security Markets. 3(3-0)
Prerequisite: 318.

Examines organization and operations of investment banks, underwriting syndicates, bond houses, trust companies and investment trusts, security exchanges and brokers, etc. Includes study of principles of investment and investment characteristics of various types of corporate securities.

Econ. 419. Economics of Transportation. 5(5-0)
Prerequisite: 209b or 210b.

This course is a study of the technical organization and services of railroads, highways, waterways and airways. The problems of integration and coordination of the several branches of transportation and of governmental regulation are considered. Business practices and principles, as an outgrowth of the interdependency of carriers and shippers, are stressed.

Econ. 442. Public Utility Economics. 3(3-0)
Prerequisite: 209b or 210b.

This course deals with public utilities other than railroads from the double standpoint of management and public policy. The relations of public utility holding and operating companies, franchises and problems of financing, valuation, rate-making and service regulation are given special consideration.

Econ. 445a. Business Law. 3(3-0)

This course attempts to give an understanding of the part which law and legal institutions play in the economic organization; and a working knowledge of essential legal concepts and instruments. Attention is then given to the law of contracts, and agency, sales, and negotiable paper.

Econ. 445b. Business Law. 3(3-0)
Prerequisite: 445a.

This course covers the ownershipand transfer of real property; and the law of business associations and incorporations, with special attention to Michigan laws governing corporations and sale of securities. Consideration is also given to commercial arbitration.

Econ. 452. Business Cycles and Forecasting. 3(3-0)
Prerequisites: 318, 320.

The characteristics of the periods of good and bad business with their episodes of "Tight money", crises and possibly, panics are described. Various explanations for these cycles are examined. Study is made of the problem of interpreting current business conditions. The methods of forecasting general business and of developments in particular lines are examined. The principal forecasting services (Babson, Harvard, Brookmire, etc.) and some typical current forecasts are discussed. Finally the problems of business stabilization and control are given attention.

Econ. 332. Accounting for Engineers. 3(3-0)

A survey course in accounting emphasizing interpretation of financial statements, valuation of property assets and ownership problems.

Econ. 325a. Cost Accounting. 3(3-0)

Prerequisite: 203c.

This course applies the principles of accounting to the problems of scientific accumulation of manufacturing costs to determine unit and job costs. The construction and interpretation of manufacturing statements is emphasized. Practice work will be required.

E. E. 306a. Direct Current Circuits and Apparatus. 2(2-0)

Prerequisites: Physics 202f, Math. 206.

Laws of direct current circuits and magnetic circuits. Theory of operation and characteristics of direct current motors and generators, control systems and protective equipment.

E. E. 306ab. Direct Current Circuits and Apparatus Lab. 1(0-3)

Prerequisites: Physics 202f, Math. 206.

A laboratory course for Course 306a.

E. E. 306b. Alternating Current Circuits and Apparatus. 3(3-0)

Prerequisites: 306a and 306ab.

Theory of operation and characteristics of alternating current apparatus and transmission lines.

E. E. 306bc. Alternating Current Circuits and Apparatus Laboratory. 1(0-3)

Prerequisites: 306a and 306ab.

A laboratory course for Course 306b.

Eng. 102e. Composition. 3(3-0)

This course gives, through study of models and frequent writing of themes, careful training in composition.

Eng. 102f. Composition. 3(3-0)

Prerequisite: 102e.

A continuation of the work of the fall term, together with practice in the use of the library and the preparation of long papers.

Eng. 102g. Composition. 3(3-0).

Prerequisite: 102f.

Continuation of Course 102f.

Speech 203a. Elementary Public Speaking. 3(3-0)

Prerequisite: Eng. Comp. 102b.

An elementary course combining theory and practice. It is designed for students who pursue but one course in public speaking.

Speech. 215d. Advanced Public Speaking. 3(3-0)

Prerequisite: 215b.

A course in speech psychology, advanced study of speech

composition, and platform technique. One section will be reserved for advanced students in engineering, and for these 203a serves as prerequisite.

Hist. 101a. General History of Europe from the Peace of Westphalia (1648) through the French Revolution. 3(3-0)

Hist. 101b. General History of Europe from the Napoleonic Era through 1871. 3(3-0)

Hist. 101c. General History of Europe from 1871 to the Present Time. 3(3-0).

Math. 102. Trigonometry. 3(3-0)
Prerequisites: Two and one-half entrance units in Algebra and Plane Geometry of two entrance units in Algebra and Geometry and Mathematics 100a. (Students in Engineering must furnish one and one-half units each of Algebra and Geometry.)

Math. 103. Analytic Geometry. 3(3-0)
Prerequisites: 101 or 100a, and 102.

Math. 204. Calculus. 5(5-0)
Prerequisite: 103 or 103b.

Math. 205. Calculus. 5(5-0)
Prerequisites: 204.

Math. 206. Calculus. 5(5-0)

Prerequisite: 205.

This course is a continuation of Course 205.

Math. Statistics. 3(3-0)

Prerequisite: 206.

This is a course in the elementary principles of the scientific methods of interpretation of statistical data. The course will include as many of the following topics in the order named as the time allotted will permit: Sources of statistical data, graphical methods, statistical terms and units, frequency of distribution, averages, dispersion, correlation, error, curve fitting, Applications of the various topics to industrial statistics will be made in connection with the discussion of these topics.

M. E. 101. Elements of Engineering.

This course is designed to give the student a general view of the field of engineering achievement and to interest him in his work.

M. E. 131. Pattern Work. 2(1-3)

Instruction and practice in the use of wood-working tools, followed by exercises in joinery, wood turning, and simple pattern making.

M. E. 151. Foundry. 2(1-3)

Instruction and practice in hand and machine mould-

ing; melting, cleaning, and trimming castings in iron, brass, bronze, and aluminum; and in core making.

M. E. 161. Machine Shop. 2(1-3)

Machine tool construction and operation, tool shapes cutting speeds and feeds, bench work, and pipe cutting.

M. E. 211a. Metallurgy. 2(2-0)

Prerequisite: Physics 202d.

A study of the methods of manufacture of iron and steel. The following subjects are covered: Iron and carbon; the manufacture and purification of pig iron; the manufacture of wrought iron and crucible steel; the Bessemer process; the open hearth process; defects in ingots and castings; mechanical treatment of steel; constitution of steel and cast iron; malleable iron.

M. E. 405a. Industrial Management. 3(3-0)

Prerequisite: Senior classification.

A study of the methods of correlation and control of materials, methods, money, and men, in a modern industrial organization. The effect of improvements, of product, method, and working conditions, is viewed from standpoints of all concerned. Problems dealing with power, scientific determination of lot sizes, expense burden, etc., are especially emphasized.

M. E. 405b. Industrial Management. 2(1-3)
Prerequisite: 405a.

Individual problems repeatedly met in industry and calling for an exact solution are segregated and studied in the environment under which they occur. Some examples are the design, operation, and cost finding of tooling a specific piece, time and motion study, problem of installing special, automatic or semi-automatic machinery with the resultant cost and saving.

M. E. 405c. Industrial Management. 3(2-3)
Prerequisite: 405b.

A course designed to show the procedure adopted by an industrial engineer in making a survey as to location of a plant and selection of factory site, type of factory construction, heating, ventilation and sanitation, processing of work, selection and arrangement of equipment development of organization chart, introducing a factory cost system and predetermining cost of product.

Mil. Sci. 101-103. Freshman Training 1½(3-0)

Infantry, cavalry or artillery close and extended order drills to include the school of the company, troop or battery; physical drill, ceremonies, rifle marksmanship, military courtesy and discipline, military hygiene and first aid, and the National Defense Act. In addition to the above infantry sections receive instruction in scouting and patrolling; the cavalry instruction in scouting, patrolling,

and equitation; and the artillery sections receive second class gunner's instruction.

Mil. Sci. 204-206. Sophomore Training. 1½(3-0)

Drill and command to qualify the student to perform the duties of corporal in the drills listed under the freshman training. In addition to the above the infantry sections receive training in musketry, automatic rifle, scouting, and patrolling and combat principles; cavalry sections instruction in musketry, cavalry weapons, employment of cavalry and equitation; and artillery sections first class gunner's instruction.

Phys. 202d. Mechanics and Heat. 5(5-4)

This course together with Courses 202e and 202f constitute a physics series which covers the whole field of general physics, introducing the student to the method and practice of combining mathematics and experimental data in the solution of elementary problems in engineering and applied science.

Phys. 202e. Sound and Light. 5(5-4)

Prerequisite: 202d, and 202f.

A continuation of Course 202d, and 202f.

Phys. 202f. Heat, Magnetism, and Electricity. 5(5-4)

Prerequisite: 202d.

A continuation of Course 202d.

Phys. Ed. 101. Swimming. 1(1-2)

Phys. Ed. 102. Calisthenics, Apparatus and Games. 1(1-2)

Phys. Ed. 103a. Boxing. 1(1-2)

Psych. 201. General Psychology. 4(4-0)

An introductory course providing the student an opportunity to study the mental processes. Principles of instinct, emotion, feeling, sensation, perception, memory, thought, conditioned response, motivation, and the nature of intelligence will receive careful consideration. As the project method will be used to a large extent the class sections will be limited.

C. E. 411 Technical Problems and Reports. 6(0-18)

Original investigations and analyses are carried on by the students, for which a definite assignment of hours is made in the spring term. Two typewritten copies of each report must be deposited with the department.

Journ. 302. Business Writing. 3(3-0)

A course in the general principles of business correspondence with training in the composition of effective business letters. Some time is devoted to other forms of business writing and the principles involved.

As to graduation requirements the following chart is produced to show the term credit hours required by the case schools for graduation. The credits have been transferred to equivalent credits at Michigan State College.

COLLEGES	TOTAL TERM HOURS REQD. FOR GRADUATION
University of Illinois	210
University of Southern California	210
Carnegie Institute of Technology	222
Alabama Polytechnic Institute	205
Clarkson Institute of Technology	207
Massachusetts Institute of Technology	221
Rensselaer Polytechnic Institute	220
Cornell University	217
University of Maine	205
Iowa State College	203
Average	212

The results bring out the fact that a normal graduation requirements for this course should be 212. It has been designed requiring 212 hours.

CONCLUSION

It should be noted that no attempt is made to provide specialized training in any of the major phases of management or engineering, and the student should bear in mind that this course is but an introduction to the period of practical experience with supplementary study which is necessary even for those who possess the highest potential capacity for leadership. The successful completion of this course should, however, materially shorten this training period and produce better ultimate results.

For many students the attainment of the Bachelor of Science degree marks a proper stopping place in their formal engineering education. From this course they will have received a sound general education and a training in the fundamentals of the engineering profession and may enter practice equipped to undertake the work usually open to the young engineer. Indeed, many employers prefer to engage young men who have completed only such a program of studies and to have them secure, through a period of apprenticeship in actual practice, the more advanced and professional applications of their training.

At the Massachusetts Institute of Technology it was found that the graduates of this course, who are naturally interested in the business aspects of industry rather than technical engineering, enter upon a great variety of industrial activities. The majority engage in manu-

facturing; but many are employed in merchandising and marketing aaalysis, and a considerable number are associated with financial establishments and investment houses, particularly in the field of investigation and analysis.

A survey of graduates of the Course in Engineering Administration at Massachusetts Institute showed that outstanding later success resulted from business and engineering training.

*"Not all engineering teachers are progressive. Too often older deans and department heads are excessively conservative, feeling that the processes that have seemed to work for many years should be amply satisfactory and should not be disturbed. Thus we find that radical experimentation in engineering education is exceedingly rare. But the world moves on at a fast pace. Not only are rapid changes in material things occurring, but in these times, deep underlying foundations of the social structure are being subjected to severe scrutiny. Is engineering education keeping pace? Is it training for the best citizenship? Is it training for leadership in industry? Is it even training for the most effective service to society? These are all q uestions of tremendous import to America. They are so vital that if an unequivocal "yes!" could be given as the answer to each of them, it would afford boundless gratification to every

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conscientious engineering teacher."

Engineering is a diversified profession, with constantly widening boundaries. There are many places in its field for young men of fair ability and limited training, a smaller number of commanding positions for men whose inherent superior ability has been developed through an educational process of the highest order. It has been the aim in presenting this course that it be a source of supply for the potential leaders in engineering and business.

THE END.