PAPERS

TO

SIR A. W. CURRIE, PRINCIPAL

McGILL UNIVERSITY

FROM

FACULTY OF APPLIED SCIENCE

(122)

APRIL 1931

Engineering Survey Key

So direct is bearing of articles prepared by late Dean H.M.MacKay that they are given intact, following are topics discussed:-

A. Results international survey of engineering education by S.P.E.E.

B. General objective and curriculum of engineering courses; preliminary training

C. Provision of new or increased laboratory facilitiesin hydraulics, mechanical engineering, electrical engineering, municipal engineering.

D. Changes in curriculum including: abolition of shopwork; requirements regarding engineering experience before graduation; new courses in communications, preparation of reports, public speaking.

E. Special emphasis laid on need new building for Mining, Metallurgy and Geology, and on development of graduate work, requiring both staff and scholarships of adequate amount.

And, compiled from a questionnaire then sent out(1927-28) this is opinion of graduates on such questions as:-

A. Extent to which college training provided a proper scientific and technical training for future work.

B. Quality or sufficiency of relationship between subjects studied in college and the problems and procedure of engineering practice.

C. Objectives of an engineering course; subjects of greatest professional value; desirable subjects for study not included in curriculum.

D. Relative values of academic attainment, personal qualities such as initiative, leadership, etc; and value of college training in developing qualities looked for in engineers in practice.

It was found that our general policy and aims were in harmony with recommendations resulting from the International Survey.

Re Mathematics and Cultural Subjects.

The whole question of matriculation is under review now by the Matriculation Board. The pre-engineering year course should be made more suitable to engineering needs by being made a part of their own curriculum, but for present there can be no change.

Specialized courses

Such as Industrial, Ceramic, Marine, Radio, Textile, etc. engineering. The best opinion is opposed to over specialisation. Legitimate needs of specialization can usually be made by providing options in the fourth year courses. This Faculty holds tenaciously to the view that the curriculum should be the same in the first 2 years of all engineering courses. Some 25 years ago a dept. of railroad engineering was established here. It was found that graduates in civil or mechanical engineering were well qualified to go into rr. work. Experience proved that a sepparate organisation was not necessary.

Fuel Engineering

has not been a successful venture.

Survey Camp

Suggests establishment permanent survey camp in the mountains, perhaps could use Y.M.C.A. or Boy Scouts' existing summer camps. Ste.Annes no longer suitable.

English Course

There is necessity for revising course in English for 1st year Arts and senior matriculation English for engineering students.

Engineering Physics

There is really little to justify the term "E ngineering" unless students take the 5th year in Electrical Engineering. With that 5th year the course is practically an honours course in Mathematics and Physics in the Faculty of Arts and Science.

Budget

Attention is drawn to the lack of fellowships and scholarships sufficient in amount to attract students from elsewhere or to encourage our best students to remain for a year after graduation and engage in a combined course of teaching and research. The provision of open fellowships of substantial amount in the graduate school would attract an increasing number of men here from other universities and would aid us in making junior appointments.

Salaries should be adequate in the teaching staff to attract outside new blood. We should not become ingrown. Our graduates have been chosen for engineering professorships in most of the leading universities and colleges in this country.

Registration

A chart showing registration in the ten years.

A chart showing that Toronto since 1925 has risen rapidly in engineering registration and McGill has not risen at all.

Graduates going to U.S.

An impression that large numbers of our graduates were lost to this country because of better opportunities elsewhere was not supported by the facts and figures of incomes of men of 5 to 20 years standing were almost same in both countries. 10.7% of our graduates reside in U.S. Almost 40% in Montreal and district.

Needs.

A.) Provision of new buildings: 1. Mining and Metallurgy. Geology.

B. Provision of funds for maintenance of equipment and purchase new.

C. Provision of staff to carry on undergraduate and graduate teaching.

D. Open fellowships or scholarships to attract able students from elsewhere.

Budget

Dr.J.B.Phillips, Chemical Engineering, is expected to be appointed next year. p.38.

Conclusion.

The committee as a whole or a smaller group might consider some of the general ~~xxpxxxxxxixx~~ questions in more detail when funds are available or might formulate desirable schemes on which an appeal for fundsmight be based.

The report is signed by Brown only, not by the members of the committee.

The future prestige of the Faculty in the view of the late Dean MacKay was bound up with graduate work, and for this we urgently need not one but several research professors and a system of scholarships.

122

McGILL UNIVERSITY
MONTREAL

FACULTY OF APPLIED SCIENCE
OFFICE OF THE DEAN

April 15th, 1931.

Sir Arthur W. Currie, G.C.M.G.,LL.D.,
Principal and Vice-Chancellor,
McGill University.

Dear Sir Arthur,

I have pleasure in transmitting the findings of the committee which you named to prepare a report on the Faculty of Applied Science.

Appended to the report you will find articles prepared by the late Dean H. M. MacKay on the development of the Faculty, and on professional training in the Faculty. Reports on the Departments of Chemical, Civil, Electrical, Mechanical, Metallurgical and Mining Engineering, and on the School of Architecture, are also appended, dealing with the organization, aims and needs of each of these divisions of the Faculty, and commenting on various phases of their work.

The report itself deals broadly with the question of training of engineers, and does not attempt to classify the contents of the departmental reports. It aims rather to present a picture of the work and policy of the Faculty as a whole; to define our objective and the means adopted to attain it; to discuss some of our difficulties; to explain our relations to industry, technical organizations and research, and to indicate how our resources are utilized in meeting the varied demands made upon us.

The vital questions of teaching personnel and equipment are discussed, and the broad lines of future policy which we believe to be in the best interests of the Faculty, are laid down.

The statements of the various departments outlining specific needs are an essential feature of the report, but the committee deemed it best to deal with our problems more broadly in the general report.

A separate report dealing with graduate work in the engineering departments was submitted to Dean Eve, for inclusion in the Report of the Faculty of Graduate Studies and Research.

On behalf of the Committee,
Yours faithfully,

E. Brown.

Chairman of the Faculty of Applied Science.

REPORT

to

SIR A. W. CURRIE, PRINCIPAL,

McGILL UNIVERSITY,

from

FACULTY OF APPLIED SCIENCE.

April, 1931.

TABLE OF CONTENTS.

Set Development of the Faculty of Applied Science.) H.M.MacKay, June 1930
Professional Training in Applied Science.) "McGill News".

Reports of Departments of Chemistry, Civil, Electrical, Mechanical, Metallurgical and Mining Engineering and of the School of Architecture.

REPORT

ON

THE FACULTY OF APPLIED SCIENCE

McGILL UNIVERSITY.

DEVELOPMENT AND PROFESSIONAL TRAINING.

Shortly before his death, the late Dean H.M. MacKay wrote an account of the development of the Faculty of Applied Science. The article appeared in the "McGill News" for June 1930, and dealt with many matters which would otherwise have claimed a place in a report on the work of the Faculty such as you ask for in your letter of November 26th, 1930. An earlier report, also from the pen of our late Dean, and published in the "McGill News", contains summaries of the replies of graduates of the Faculty to questionnaires designed to secure information regarding their activities, and to obtain their views on the question of the college training of engineers and on their own course in particular. The inquiry was sent to all graduates of the Faculty prior to and including the year 1924, whose addresses were known.

Similar inquiries were made at the same time by the leading engineering schools of the United States. It is believed that the large number of replies represents fairly the experience and opinion of our graduates. The survey was made under the auspices of the Carnegie Foundation and the Society for Promotion of Engineering Education, and furnished us with experience and opinions of the principal institutions on the continent. It was found that our general policy and aims were in harmony with recommendations resulting from the international survey.

This inquiry among our graduates was made at a time when changes in our curriculum were being discussed, and additions made to the laboratories of the departments of civil, electrical and mechanical engineering. The general trend of opinion, criticisms of weakness, and ideas regarding development proved most useful and stimulating. There can be no doubt but that the broad general changes of recent years discussed in the article referred to, are in line with the well-considered judgment of the graduate body.

The reports referred to contain a narrative of events, and a statistical and general commentary on the aims and accomplishments of our Faculty. The committee appointed recently to report on the work of the Faculty regards them as constituting, in large measure, an answer to the questions raised in your letter as to how we are moving, and whether we are adapting ourselves to new conceptions of our purpose, and to changing ideals. They believe that close contact with graduate opinion should be maintained, and that it will provide both needful criticism and helpful suggestion. Too frequent recourse to organized inquiry by questionnaire is, however, undesirable and, indeed, likely to defeat the purpose in view. The effect of changes in courses of study, or in standards required of those entering the Faculty, cannot be judged hastily. Furthermore, graduates of some two or three years standing, except in unusual circumstances, have not had a sufficiently wide experience to enable them to appraise accurately the full value of their university training. The committee believe, however, that the opinion of graduates of 1925 and later, should be sought at some future date, and that the views of the personnel departments of organizations employing large numbers of engineering graduates would afford some useful criticism.

So direct is the bearing of the articles prepared by our late Dean on the development and work of the Faculty, that they are submitted as a part of the present report. The articles on the development of the Faculty should be read at this point, if not wholly at least in part, and commencing with the post-war conditions of 1919. (See page 8. "McGill News", appended to report.) The following topics are discussed:-

(a) Results of international survey of engineering education by the Society for the Promotion of Engineering Education.

(b) General objective and curriculum of engineering courses; preliminary training.

(c) Provision of new or increased laboratory facilities in hydraulics, mechanical engineering, electrical engineering, municipal engineering (highways).

(d) Changes in curriculum including: abolition of shopwork; requirements regarding engineering experience before graduation; new courses in communications, preparation of reports, public speaking, etc.

Special emphasis was laid on the need for a new building to house the Departments of Mining, Metallurgy and Geology, and on the development of graduate work, the latter requiring both additional staff and scholarships of adequate amount.

The article on "Professional Training in Applied Science" requires more detailed study, being presented in graphical or statistical form rather than as narrative. If not read in full, the section summarizing the opinion of graduates on the quality of our training and of the product turned out, should be read. (See pages 6 to 9 of article appended to report.) It indicates the opinion of our graduates on such questions as the following:-

(a) The extent to which college training provided a proper scientific and technical training for future work.

(b) The quality or sufficiency of the relationship between subjects studied in college, and the problems and procedure of engineering practice.

(c) The objectives of an engineering course; subjects found to be of greatest professional value; desirable subjects for study, not included in curriculum.

(d) The relative values of academic attainment, personal qualities such as initiative, leadership, etc.; and the value of college training in developing in students the qualities looked for in engineers in practice.

As a further contribution of material for the preparation of the present report, the heads of the various departments in the Faculty and of the School of Architecture, have prepared statements covering the work carried on under their direction. These reports were not prepared according to any set form, and represent unfettered opinion on many phases of our work. The School of Architecture is a self-contained unit, within this Faculty, and the report of Professor Traquair is submitted separately. The reports of the other departments deal with changes of courses, additions to equipment, relations with the public, research, future development, criticism of results of teaching efforts including the shortcomings of both teachers and students, the demands of employers, aims and objects of courses, etc.

Many of these reports deal in considerable detail with the problems of teaching, for engineering instructors are self-critical, and are constantly reminded of what is required of them by their contact with engineering practice through graduates or employers. A recital of individual opinions would be tiresome, and an attempt is made in what follows to crystallize general opinion both of our own heads of departments and of others interested in engineering education, to focus attention on what is required of us, to state how we attempt to meet the demands made upon us, to discuss some recent trends, and to outline in a general way the pressing needs and lines of development. A copy of the report of each department is submitted herewith.

WHAT KIND OF MEN ARE NEEDED IN ENGINEERING INDUSTRIES?

An admirable summary of the needs of the industries was given in a recent address by the chief engineer of one of the largest organizations on this continent, - the American Telephone and Telegraph Company- which maintains a manufacturing plant, large research laboratories and engineering and operating departments. The requirements are similar, in a general way, in smaller industries. A few quotations are given below:-

> "What we want are men who can recognize the problems with which they are confronted; study the problems; determine the appropriate action, and then take such action in the right way ...... Understanding of the problem needs perception...... There can be but little perception without broad knowledge of the business, as things must be seen in their proper relation to each other, and to the business as a whole. There must be imagination, intelligence, judgment, intellectual honesty and high aims."

Other qualities named were a willingness, even an eagerness, to face difficulties; skill in persuading to enable inertia and opposition to be overcome; sympathetic understanding of people and of the world at large; ability to carry on several projects simultaneously without being over-whelmed or confused by varied activities. Skill in judgment of people was considered as being usually found along with the qualities named. Maintenance of co-operation and good morale by enthusiasm, sincerity of purpose, and by just and fair dealing were mentioned in considering the question of tact, and the view was expressed that over-emphasis of tact may result in the selection of colourless individuals, and those lacking in force.

The following quotations from the same address illustrate clearly the opinions held concerning the methods of training:-

> "In the relatively short time available for the professional training of the student, it is not possible to teach everything in science and engineering which might be useful in his profession ..... The important thing is that the engineering student should have discipline in the methods of solving engineering problems, and a general foundation in mathematics, physics and materials which will enable him to solve the special problems by getting the facts and then interpreting the facts and reasoning from them correctly. .... I am not suggesting that his education should teach him the facts beyond the fundamental ones..... I do not feel that the school training of a man for communication engineering should be essentially different from that given to electrical and mechanical engineers in general. The communication engineer is, after all, confronted by problems which are underlain by the common basis of

these branches of engineering; he deals with the same materials and the same physical laws; and his problem is to accomplish the most satisfactory results in the most economical manner, and so that the product of his work will meet not only the conditions of to-day, but those of the future....... I do not know how much it is possible within the scope of technical education to emphasize the importance of arriving at the most economical solution of a given problem. Correct engineering is the determination of the most economical way of arriving at a desired result. It is not sufficient to find a way to accomplish a result; it should be the most desirable way. I can appreciate the difficulties of emphasizing this point of view in a college education, but whatever can be done along these lines will be helpful."

"One of my strongest convictions is that unusual effort may well be made to teach every engineering student to speak and to write a report in clear and convincing English, setting forth the facts and arguments and conclusions pertaining to the question before him. "

These opinions are fully endorsed by this Faculty, particularly in regard to the limitation of studies to the fundamentals. Our experience indicates that the difficulty of handling adequately the question of relative merits of alternative schemes in connection with an engineering project is a very real one, having in mind the fact that in most cases the student is attacking a new problem through which he is endeavouring to apply for the first time, fundamental ideas of design. His attention and his difficulties are necessarily centred on these fundamental technical ideas, as distinct from considerations of the economy of his design, and the methods available in practice for achieving the desired result. The situation can be illustrated by the case of a student designing a structure such as a bridge or a roof. The following considerations are involved in the order named:-

(a) The estimation of the loads to be carried.

(b) The determination by some fundamental theory, of the effects of the loads on the structure.

(c) The proportioning of the various parts of the structure so that they will sustain safely, and for an indefinite period, the forces which come upon them. This involves a knowledge of the properties of materials used in construction.

(d) The economic study of different designs, which is only possible after fundamental processes outlined above, have been thoroughly assimilated.

While item (d) is never completely ignored and is stressed as strongly as possible in the working out of problems, it is our experience that undergraduates must centre their attention mainly on items (a), (b) and (c). The economic aspect of a project requires a broad experience which, in general, can only be acquired in practice after the college course is completed. Such considerations arise quite apart from the broad general question of training engineers in economics, engineering law, accountancy, etc. to which further reference is made on page 20 .

STUDENTS ENTERING OUR COURSES.

Our students are drawn mainly from the high schools of this country, and therefore their preliminary training is by no means uniform. The average age at entry is from 18 to 19, and while methods of education and content of courses in the schools have changed, the student of to-day does not appear to be better equipped to undertake an engineering course than were his predecessors of the past twenty years. On the other hand, the wide ramifications of present-day engineering and commercial life in general, provide many new outlets for the engineering graduate. This means that the sum total of our technical knowledge is much greater than it was twenty years ago, and a greater variety of demands is now made on the technical equipment of our graduates than heretofore. Having this in mind, and with a view also to broadening the cultural horizon of our students, the entrance standard was changed in the session 1928-29 to that of Senior Matriculation, or Junior Matriculation followed by the First Year in Arts. This change provides us with students averaging one year older at entrance to our Faculty, which by reason of some greater maturity should be an advantage to the technical student. It also affords an opportunity for broadening their education in important subjects not bearing directly on many phases of their technical work, such as English and languages. Our experience does not convince us that the course in English, either in Senior Matriculation or First Year Arts, is well adapted to the needs of students entering our Faculty. In view of the importance of the ability of an engineer to express his arguments and conclusions in a terse and logical manner, this is a serious defect. We believe that it should be possible to alter the requirements without lowering the standards in English, and we urge that proper consideration be given to this question.

We are likewise not convinced that the entrance requirements in mathematics are equal to those of Junior Matriculation (including advanced mathematics), which applied formerly. Although we recommend that advanced mathematics be offered in Junior Matriculation into Arts by those students who intend to enter this Faculty, it is evident that this course is not followed in all cases, and less ground is now covered in some branches of mathematics, such as trigonometry, than was covered under the former plan by those entering our Faculty direct from the schools, with Junior Matriculation.

It is to be feared that the interest of engineering students in cultural subjects is not great at the outset of their studies, but gains strength as they come to perceive more clearly the relations of such studies to technology, industry and professional life. It is possible that in an effort to reach the substance, we have caught only the shadow. The careers of students entering our Faculty under different qualifications are being followed closely, and while the new system has not been in effect long enough to enable us to judge fully of its effects, there appears to be reason to believe that the possible gain due to cultural studies has been offset to some extent by less satisfactory preparation in the vital subject of mathematics.

The whole question of matriculation requirements is under review by the Matriculation Board, and their recommendations must be studied carefully in the light of experience of our changed requirements of entrance. The suggestion has been made in informal discussion, and is referred to in the report on the Department of Mining, that some of the cramping influences which appear in our third year courses might be relieved if the present so-called "pre-year" course were controlled by this Faculty. It is probably true that, given proper teaching personnel, a course could be devised better adapted to the needs of the engineering student than the present First Year in Arts. Such a course, while distinctly cultural in some of its aspects, might well contain work in engineering drawing, which would relieve some of the pressure in the work of the later years. It is recognized, however, that the schools could not give an equivalent training, such as they can now provide as the equivalent of First Year Arts, and the change would virtually amount to the adoption of a five-year college course. The general weight of opinion is not yet favourable to such a change. The Faculty must, however, continue to study all factors which affect the preliminary training of our students, as this determines largely the extent to which knowledge, judgment and character can be developed by the professional training afforded in an engineering school.

COURSES OF STUDY.

General Notes - Courses offered.

Degrees are granted in the major divisions of Engineering:- chemical, civil, electrical, mechanical, mining and metallurgical,- the course extending over four years in each case. In recent years, many colleges have granted degrees in other divisions such as agricultural, illuminating, industrial, ceramic, marine, radio, textile, etc. No doubt this represents an effort to satisfy vocational aim, but the best opinion is opposed to over-specialization along such lines. The advantage of highly specialized teaching is doubtful, inasmuch as a student rarely knows definitely what his work will be after graduation. It may be an advantage financially at the outset of a graduate's career, but in the long run it is much less valuable than a more thorough training in one of the broader general divisions. Even if such specialization were desirable, there would still remain the financial burden imposed by the necessity of providing a teaching staff properly qualified to handle such diversified work. Such a burden would be especially heavy in engineering schools in which the number of students is relatively small, resulting in a small number of students per teacher.

The legitimate needs of specialization can usually be met by providing options in the fourth year courses of the major divisions. This avoids diversion of funds which can be applied to better educational advantage by strengthening the work in the main fundamental divisions. Apart, however, from such financial considerations, we feel that the restriction of degree granting departments to the main branches of engineering is the sounder educational policy. This Faculty has held tenaciously to the opinion that the curriculum should be the same in the first two years of all engineering courses. This view has not always been endorsed by all the large engineering schools, some of which have provided for specialization almost from the outset of the course. At least one of the largest and most widely known schools is abandoning this policy in favour of one similar to our own. It has been suggested that students intending to enter chemical, mining or metallurgical engineering might take more chemistry than other students during the first two years, but no action has yet been taken. The argument in favour of such a change is stronger than heretofore in that entrance standards have been raised, and chemistry will become a compulsory subject in 1932.

The division of the curriculum into the six main branches of engineering named above, takes place at the beginning of the third year, and such options as are desirable and possible within existing resources,are offered in the fourth year courses. These options might be extended in some cases if funds were available,- for example, in providing facilities for study of aeronautics. Conversely, subjects first introduced as options in certain branches of engineering may eventually increase in importance to such an extent that they come to be regarded as essential for all students in those particular branches. This has happened recently in the case of an optional subject,- "Communications" - in the fourth year course in electrical engineering, and it would seem to be a logical process of adaptation of courses to the changing conditions of engineering practice. Other examples of options now offered are found in courses in industrial engineering and municipal engineering, in the departments of mechanical and civil engineering respectively.

Some twenty-five years ago a department of railway engineering was established in the Faculty. The work of students in the department included courses in the departments of civil and mechanical engineering, with lectures on special phases of railway work by lecturers employed by the railroads. After several years, the department was abolished. Had it fulfilled a distinct purpose, not capable of being served by other departments, means to continue it would probably have been found, as it was backed for a period of years by grants from the two large Canadian railroad companies. It was found, however, that graduates in civil or mechanical engineering were well qualified to go into railroad work, and acquire after graduation such specialized knowledge as had been included in the course of study of the department of railway engineering. The course was distinctly "vocational" in aim, and experience proved that a separate organization was not necessary to train men adequately for railroad work.

More recently, provision was made for the establishment, for a period of years, of a special course in fuel engineering within the department of mechanical engineering. The primary intention was to provide for post-graduate study by a combination of lecture and laboratory work, along with supervised work in industrial plants. The course has not functioned along these lines, as graduates in chemical, mining or mechanical engineering, for whom it was intended, have not been attracted to it. It is proposed to offer a series of six public lectures in the fall, each to be given by an expert in some phase of the fuel problem. The lectures will be printed as a symposium on the fuel situation. It is hoped that a definite service will be rendered in this way, and that the lectures will attract the attention not only of those within the University, but of business and professional men. The course as now offered to graduate students will probably be discontinued.

Direct contact with industries is, and should be maintained through the employment of students and staff, and by special lectures arranged from time to time, either through the Faculty or the Undergraduates' Society. The Faculty is not, however, enthusiastic about "vocational" or "utility" courses as such.

Broadly speaking, it can be said that fundamental principles remain unchanging in spite of the increasing ramifications of modern engineering. New and improved methods of attacking fundamental problems are devised as a development in the art of teaching, but there is no short cut towards an understanding of these fundamental principles. Students of to-day have substantially the same preparation and mental capacity as their predecessors, and while they must be prepared to deal with a wider range of subjects in the practice of their profession, we feel that the content of the courses of the first three years cannot be expanded to an appreciable extent. Adaptations of our courses will therefore occur logically in the fourth year. Our feeling is that at present the opportunities so afforded can be used to meet legitimate demands.

Groups for Selected Students.

It has been suggested that the standard of work done might be raised, in the case of selected students, if the classes in mathematics, mechanics, etc. were divided in the first year, so as to segregate into a special group those whose mathematical and scientific abilities appear to be high. Such a proposal appears seductive, and to require only the provision of additional staff to carry such a group along at a greater pace than that of groups in which all grades of students are represented. There are, however, some practical difficulties, and we must look not merely at the start of the race, but at all stages up to the finish. A sound knowledge of mathematics and mechanics is unquestionably essential to the engineering student. It enables him to grasp quickly the underlying principles in engineering science: But much time is devoted in an engineering course to the application of such principles to specific problems of design, in the working out of which many other qualities and perceptions are required than those which are developed by a study of mathematics and mechanics. It is by no means certain that the most brilliant student in mathematics will be able to make a better design for a bridge than a student less well equipped mathematically. Not infrequently he has less flair for a construction problem than a student who would be rated as average in mathematical ability. Our courses are sufficiently comprehensive and difficult to ensure that all types of student will find that high general standing calls for hard work. The student who combines high mathematical attainments with a flair for engineering can find an outlet for his abilities in the design problems encountered, by carrying them to a fuller development and by having opportunity to view them from broader standpoints. It does not appear probable that brilliant mathematical students are being held back or sacrificed, if one considers that the ultimate object of our course is to train students to be engineers. Examination of the records of students entering first year some few years ago, when the possible effect of such segregation of classes was being considered, showed that about 15% at the most would be in the select group. The withdrawal of all such men from the other groups would remove the pace-setters, and to that extent would be harmful to a large number in our classes. The general feeling at the moment is that such pace-setters are not being sacrificed by being included in the general group, and that taking our course as a whole they find in it a sufficient outlet for their abilities. Unusual ability is not hampered, because much of the work in our fourth year courses affords opportunity for the exercise of special talents.

Economics, accountancy, business law.

The necessity for the inclusion of these subjects in the undergraduate programme of study, is strongly emphasised in the opinions sought from our graduates in regard to the nature and content of our courses. The difficulty of making economic studies of different designs for a given project has been referred to above. It is recognized that such studies require a background of experience in engineering practice, and call for the exercise of judgment in matters entirely distinct from the fundamental scientific principles of engineering science. Yet it is essential that an attempt be made to include in the curriculum some instruction designed to equip the undergraduate with sound ideas to guide him when dealing with business matters in the practice of his profession. For these reasons courses are given in engineering law, accountancy and economics. The aim is to explain in a general way the law governing contracts, and the forms of legal procedure which arise in handling engineering projects. The principles of accountancy are considered in their application to the financing of projects, the preparation of balance sheets, and the operation of cost systems in industrial plants. In economics, the broad principles of currency, the banking system, operation of tariffs, and special Canadian economic problems are discussed.

The provision of such a course has engaged the serious attention of the Faculty from time to time. There is room for some doubt as to the value and general effectiveness of such courses unless they are presented from a very definite standpoint, which, while specially adapted to the needs of engineering students, must not be narrow. Extended business training would seem to call for a special programme of study after graduation. A student adequately prepared in his undergraduate course for self-direction of his education after leaving college, could pursue such studies to advantage while dealing actively with the business aspects of engineering. It is not sufficient merely to displace from the engineering curriculum certain technological or scientific courses and substitute therefor subjects from a business curriculum. Engineering training emphasises principles capable of experimental verification, and the processes of teaching and study are fairly rigorous and logical. Training of engineers in general economics and the principles of law and accountancy should, as far as possible, be interwoven with technical training, but without sacrificing fundamental soundness of the instruction given.

To borrow an analogy from the teaching of law, much of the best "case material" lies in the records of studies of particular projects by engineering corporations or consulting engineers. It is a question whether the undergraduate, with his restricted outlook and technical limitations, could appreciate fully all that might be discussed by the "case method". It may be that the sounder policy is to try to impart the general fundamental ideas underlying economic studies by using simpler illustrations from engineering practice, leaving fuller development to the future, as the horizon of the graduate widens by direct contact with engineering work. The problem is a very difficult one which demands continued study. The requirements create a highly important and specialized problem in engineering education, not the least of which is the provision of an effective teaching force and the choice of teaching material.

Mathematics, Physics, Chemistry and Geology.

All the departments teaching the subjects named are represented on the Faculty, and general courses for engineering students are arranged directly with them. Reports were submitted dealing generally with the work of each department in relation to the university as a whole. The report on chemistry, including chemical engineering, is appended as it deals specifically with a branch of engineering in which a degree is granted. No detailed reference is made to the other reports.

Attention should, however, be directed to a long-standing arrangement, which has existed between the Department of Mathematics and the Department of Civil Engineering and Applied Mechanics, and has proved to be of great value in our teaching. Under this plan, some of the members of the staff in the latter department, have also given instruction in mathematical subjects, particularly in the courses of the first year. Experienced teachers have thus been available in the most fundamental work, and the introductory course in mechanics, for example, has been so developed as to form a sure groundwork for the courses in mechanics given in the second and third years. Other subjects, such as algebra, trigonometry, geometry and calculus have been similarly handled to the satisfaction of all departments in the Faculty. Quite apart from the important consideration of the economy of this arrangement, distinct benefits have resulted from the scholastic standpoint, and long experience has demonstrated its value and efficiency. It is important that these advantages be retained.

Geodesy and Surveying.

Attention is directed to the problem of providing adequately for the course in fieldwork. For many years past the work has been done at Ste Anne de Bellevue during the month of May, dormitory and dining-room facilities being provided at Macdonald College. The annual influx of a new body of students unaccustomed to this form of college life has given rise at times to some opposition on the part of the college authorities. But apart from such domestic matters, which ought to be capable of adjustment, the facilities for teaching work are becoming less satisfactory year by year . The resident community is growing in numbers, and the restrictions on the use of land formerly available are increasing. The country is too flat for satisfactory contour work, and the question of providing a permanent camp elsewhere must be faced.

Preliminary inquiries have been made regarding the possibility of utilizing the accommodation provided at the Y.M.C.A camp, Boy Scouts' camp, or elsewhere in the Laurentians. Many sites admirably suited for such work are available, and as the existing arrangement cannot be regarded as a proper solution of the problem of providing a satisfactory field course in surveying, steps should be taken towards the establishment of a permanent camp where the work can be carried on efficiently.

Engineering Reports.

Special mention may be made of a course introduced into the curriculum of the second year after the raising of our entrance standard. Although our students had gone through the First Year in Arts, or had passed Senior Matriculation, the need for further practice in English was very evident. A course in essay writing and preparation of reports was instituted, and conducted in such a manner as to be more likely to appeal to them than a conventional course in English. At the suggestion of the class, practice in public speaking has been encouraged by arranging periods during which each member speaks for a few minutes on a topic in which he is personally interested. This is followed by discussion and criticism, and the experiment has shown encouraging results. Great credit is due to Professors French, Wood and Weir, who have been responsible for the organization and conduct of this work, and we believe that much more may be accomplished by extending it. Reference is made elsewhere in this report (see page 10) to the need of revising the course in English of First Year Arts and Senior Matriculation for students entering this Faculty. There is evidence for the need of continuing work in English during our First Year course, and it may be found desirable to plan a course which will run throughout the full four years of study. This matter will require the earnest attention of the Faculty, as the necessity for instruction in English is apparent to all.

Drawing and Descriptive Geometry.

All the work in drawing in the first and second years is now directed by one Department. It includes descriptive geometry, freehand drawing and lettering, and mechanical drawing, the last-named being formerly under the direction of the Department of Mechanical Engineering. The change was made about four years ago, and has proved satisfactory in every way.

Engineering Physics.

A course in Engineering Physics has been in operation for many years past. It is open to undergraduates in the Faculty of Arts and Science, and also to undergraduates who have completed the work of the first two years in the Faculty of Applied Science and have shown special ability in mathematics and physics. The aim of the course is to provide an intensive training in these subjects, and thus prepare students for work in industrial or scientific laboratories, or for an academic career. The degree of B.Sc. in the Faculty of Arts and Science is granted at the end of four years of study. Graduates who completed the first two years in the Faculty of Applied Science are then permitted to proceed to the degree in Electrical Engineering by spending a fifth year in additional work of the regular third and fourth year courses leading to that degree. Experience shows that only a small proportion of students follow this procedure, and the full purpose of the course is therefore not attained. Those graduates who do not complete the work of the course in Electrical Engineering have had very little real engineering training, and their course differs from that of other graduates in Engineering Physics mainly in that they had their preliminary training in mathematics and the fundamental sciences in this Faculty rather than in the Faculty of Arts and Science. Their training in mechanical and geometrical drawing and surveying is no doubt of definite value, but broadly speaking when students taking high standing in our first two years leave us to take Engineering Physics and do not return to complete the Electrical Engineering course, there is a distinct loss so far as engineering is concerned. It is questionable whether those who have a bent for research, particularly along industrial lines in which wide opportunities are offered in electrical engineering, would not be better advised to complete the electrical engineering course, and proceed subsequently to a higher degree in pure science. They would obtain the engineering background, which is otherwise lacking by reason of the partial fulfillment only of one of the main ideas underlying the course. The increased facilities for study of communication engineering in the Department of Electrical Engineering are attracting the attention of students keenly interested in mathematics and physics, and some adjustment of ideas may take place naturally, whereby there will be less tendency for students to turn to Engineering Physics after two years of study in engineering. As the scheme works at present there is relatively little to justify the term "Engineering", unless students complete the course by taking the fifth year in Electrical Engineering. Without that fifth year, the course is practically an honours course in mathematics and physics in the Faculty of Arts and Science, and it is questionable whether there is any real justification for the specialized description now attached to it. This question will naturally engage the attention of the Faculty in considering the relation of our courses to contemporary needs.

TEACHING PERSONNEL.

Reference is made in departmental reports to the teaching personnel, and in some cases specific requests are made for additional instructors. Such requests involving appropriations in the budgets for next session, are not referred to here, as they are covered in the regular way by requests to the Finance Committee. Attention is, however, drawn to the lack of Fellowships and Scholarships sufficiently substantial in amount to attract students from elsewhere, or to encourage our best students to remain for at least a year after graduation, and engage in a combined course of teaching and research.

The much larger and more vital problem of attracting and retaining as teachers, men whose abilities would bring greater reward in engineering practice, is also emphasised. Our summer vacation brings to staff and students alike the opportunity of engaging in engineering work, with some attendant financial reward. The problem of filling vacancies in the senior staff when they arise either from death or resignation, is however a serious one, and the assured income from teaching appointments is not as a rule sufficient to attract men who can command much higher salaries in professional work. Great gains in teaching value result from the contacts which our instructors make in engineering work, because of the confidence born of the experience gained. Such benefits represent direct returns to the University as the result of members of our staff engaging in outside work, but salaries should not be so low as to make it difficult for them to ensure a total income commensurate with that which their abilities would command in other fields of engineering work.

In particular, the conditions outlined above become more serious when considering research professorships. Reference is made to this question in the reports to the Faculty of Graduate Studies and Research. Research work must be limited in amount, so long as it has to be directed by those carrying a heavy burden of undergraduate teaching. Professors are needed to devote their time mainly to research, and adequate salaries must be provided to attract and retain men of proper calibre for such work, so that they may not be forced to turn aside from their investigations to engage in outside work, but may pursue their researches throughout the year.

The difficulties due to insufficiency of salaries offered are always emphasised when senior appointments have to be made from outside the existing departmental staffs, and have a far-reaching influence on teaching personnel in the long run. The policy of promotion within the departments wherever possible, is on the whole a good one, but the importance of recruiting a reasonable proportion of our junior staff from the graduates of other universities should not be lost sight of. We should guard against the risk of becoming ingrown, and should introduce new blood as opportunity offers. The fact that we know our own men should not be allowed to weigh too heavily, for in it there lurk certain dangers. It may also be noted that our graduates have been chosen for engineering professorships in most of the leading universities and colleges in this country. This is a compliment to our training, but at the same time, it may tend towards creating a similarity of ideas and methods which would not ultimately be in the best interests of engineering education.

The institution of open Fellowships of substantial amount in the Graduate School would attract an increasing number of men from other universities, and aid us in making junior appointments.

The establishment of the principle of the Sabbatical year would likewise afford for members of our staff an opportunity to travel and study the problems of engineering education and practice at first hand, in other colleges and in other countries. Such a plan would re-act most favourably on our entire organization. It is true that something can be gained by conferences of teachers of engineering, and members of our staff take a share in such activities. But the broadened outlook which would result from visits to other institutions, and a more intimate study of many problems than is possible by conferences, are advantages that can only be gained if, and when, relief from teaching duties can be granted for a prolonged period.

NUMBERS OF STUDENTS IN COURSES.

The attached chart, Fig.1., shows the total number of students registered each session since 1919-20, in the third and fourth year courses in the various branches of engineering. It does not measure the relative amounts of teaching work in different departments, because students registered in any one department, attend classes in other departments. Furthermore, some departments give a large amount of instruction to students in the first and second year courses, and classification into various branches of engineering is not made until the third year. The figures do, however, indicate the total numbers of students proceeding to degrees in the various branches of engineering.

Many factors combine to influence such figures, and it is unwise to draw hasty conclusions from them. In all cases, there were definite decreases following the peaks reached about 1920 to 1922, and generally-speaking the lowest figures were reached about 1927. The number of engineers seeking employment in the early part of the post-war period was greater than was required to meet the needs of the country, and the numbers entering engineering colleges were reduced, these decreases being reflected

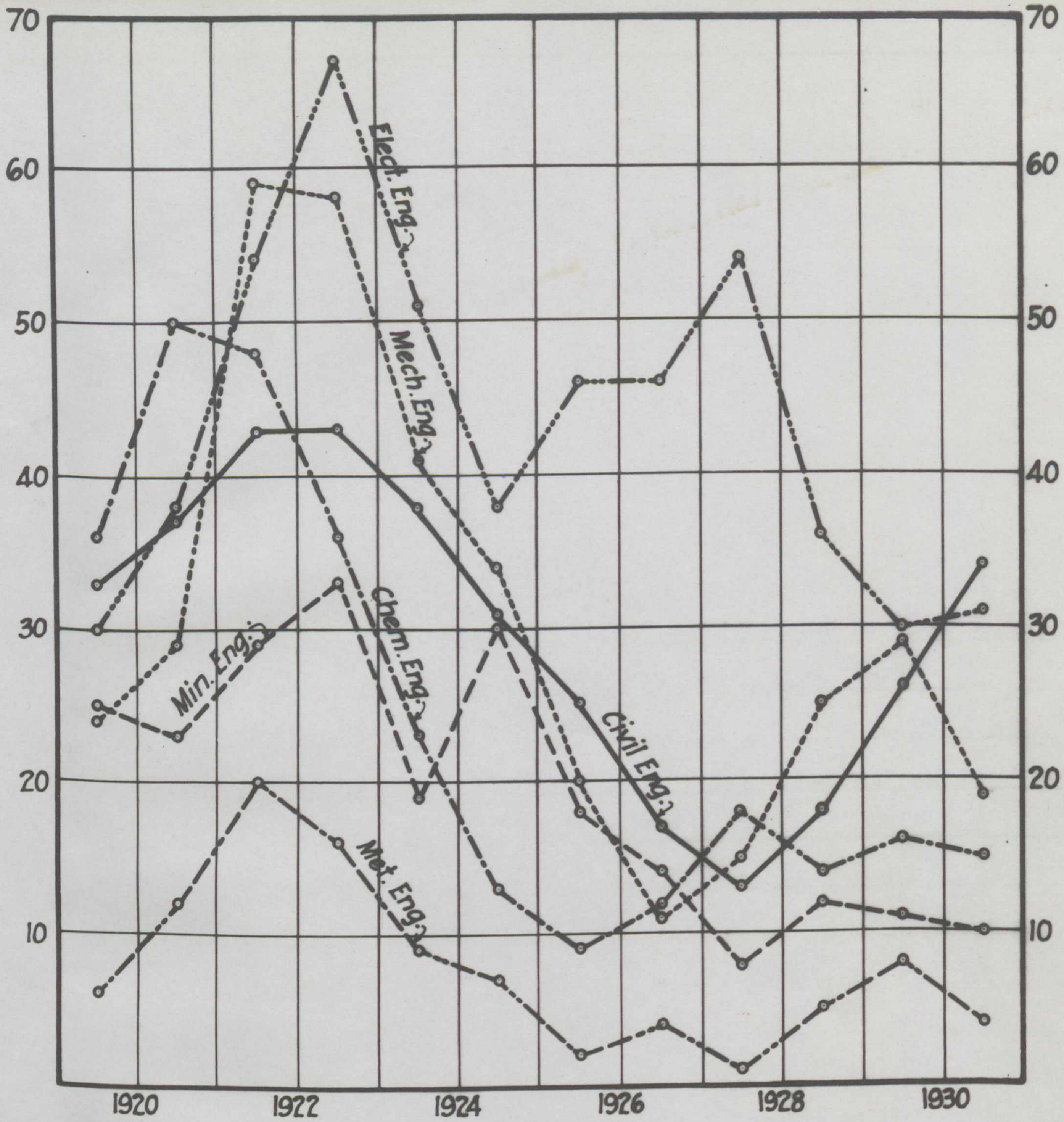


FIGURE 1.
Chart Showing Number of Students Registered
in Third and Fourth Years
of Engineering Courses, 1919-1931,
Faculty of Applied Science, McGill University.
To Accompany Report to Sir A.W.Currie, Principal.
April, 1931.

in the returns covering a period of years. The numbers in electrical engineering were affected to a lesser degree. The rise in numbers from 1924 to 1927 in this department contrasts strongly with the decreases in other departments, and is probably attributable to increased interest in communication engineering and the marked development in the uses of electrical power. Since 1927 the entry in electrical engineering has decreased considerably while that in other departments has become stabilized or has shown a distinct rising tendency. This rising tendency is particularly shown in civil engineering. The freshman class of 1927 was unusually small, as it was the first to enter under the new matriculation requirements. The smallness of their numbers is reflected in the numbers of third and fourth year students in the session 1929-30. Our freshman entry is now more normal, and the total numbers in the third and fourth year courses should tend to increase for the next two or three years. The business situation is, however, a disturbing factor, the influence of which it is difficult to judge. Some students may drop from our courses, probably only temporarily, on account of financial restrictions resulting from their inability to secure sufficiently lucrative employment during the summer months. Others may commence a college course on account of the lack of openings in business. It would be unwise to attempt to forecast figures for the near future in view of the many uncertain factors involved.

A second chart, Fig.2., shows the total numbers registered in the Faculty in all courses, including Architecture, for the period from the session of 1900-01 to the present session. For comparison the corresponding figures for the University of Toronto are also plotted. They show many striking resemblances. Starting at 1900, the numbers increased steadily in both universities, but rather more rapidly at Toronto. Their pre-war peak was reached in 1911, and ours in 1913. The curves for the war period and for the post-war period to 1925 are very similar. Since that date the figures for Toronto have shown a rapid rise and have reached a peak of 849 for the present session - an entry which is causing some anxiety in regard to the adequacy of existing accommodation. The decrease in registration which followed the post-war peaks continued with us to 1927, since when, in spite of the raising of entrance standards, the total registration has increased. Facilities in the Departments of Civil, Electrical and Mechanical Engineering provided in the Macdonald Engineering Building, have been improved greatly since the period of excessive congestion which followed the war, and when accommodation for Mining, Metallurgy and Geology is provided in a new building, thus making possible a substantial expansion in Chemistry, all departments of Engineering will be in a much stronger position than heretofore. Existing accommodation will provide for the probable needs of undergraduate work in the immediate future, assuming that the students are divided into courses in accordance with the normal expectancy. The provision of a new building for Geology, Mining and Metallurgy remains our most pressing major need.

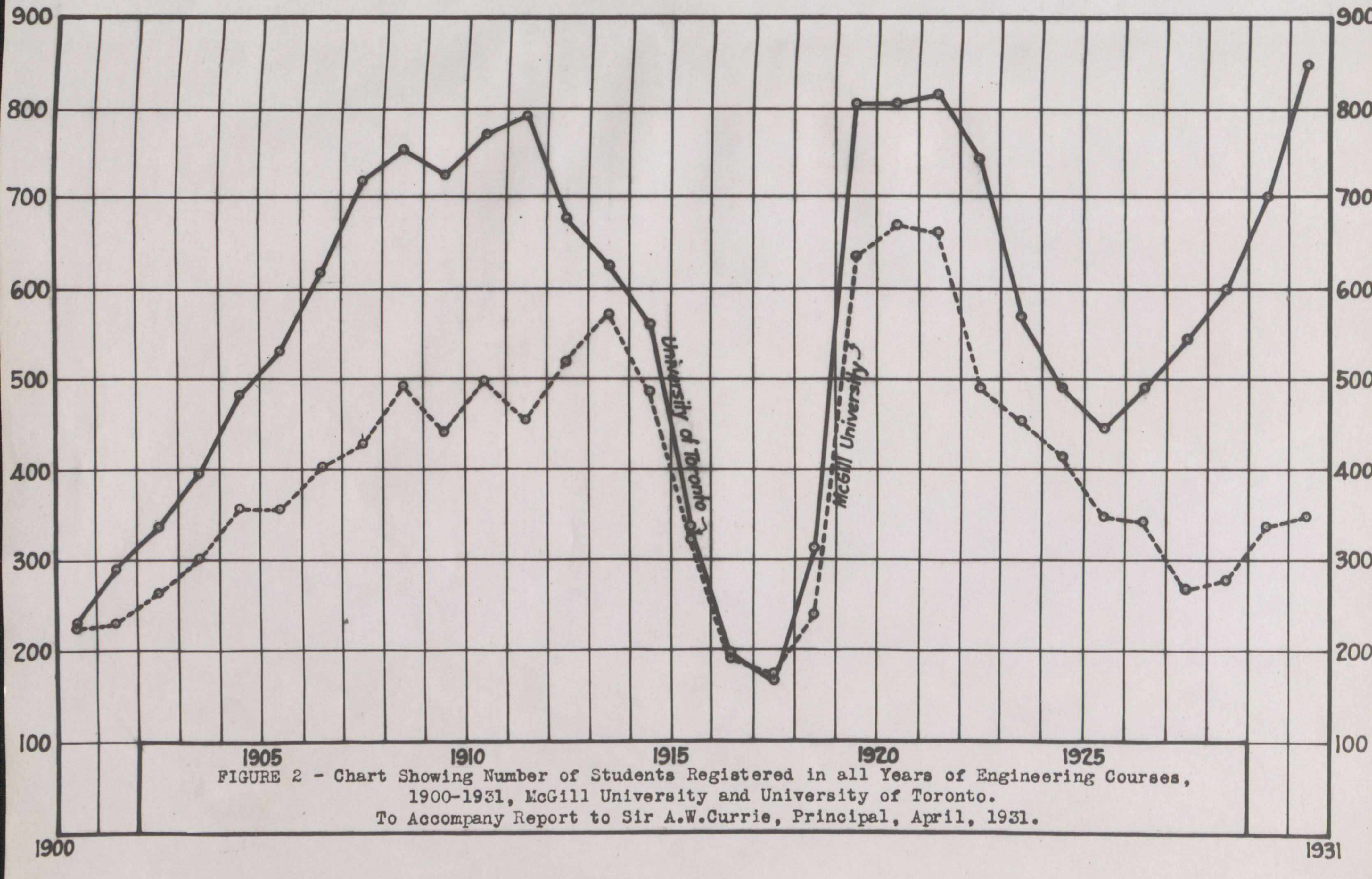


FIGURE 2 - Chart Showing Number of Students Registered in all Years of Engineering Courses, 1900-1931, McGill University and University of Toronto.
To Accompany Report to Sir A.W.Currie, Principal, April, 1931.

POSITIONS OCCUPIED BY OUR GRADUATES, AND GEOGRAPHICAL DISTRIBUTION.

The report on the development of the Faculty presented in the "McGill News" and the article on Professional Training in Applied Science prepared by the late Dean MacKay, and referred to at the beginning of this report, throw much light on the progress of our graduates. The impression that large numbers of our graduates were lost to this country because of better opportunities elsewhere was not supported by the facts, and the figures on incomes of graduates of five, ten, fifteen and twenty years' standing were almost the same in Canada and the United States.

A recent examination of the lists of over two thousand graduates whose addresses are known, shows that about 10.7 per cent reside in the United States. By far the largest proportion, almost 40 per cent, are in Montreal and district. Next in order, and classified by districts under the name of the principal city of each district, are the following:- Ottawa 8.7 per cent; Toronto 5.6 per cent; Sherbrooke 2.1 per cent; Halifax and Prince Edward Island, 2.1 per cent; Winnipeg 1.8 per cent, with smaller percentages scattered over a dozen other districts. Our graduates are also listed in Great Britain, European countries, Africa, Mexico, Panama, South America, China and Australia, representing in some cases those who have returned home after studying here, and in other cases those whose professional work has taken them abroad.

It would be invidious to single out the names of individual graduates to indicate the high positions which they occupy and the wide field of activity in which they are engaged. Throughout the Dominion, in Government service, in the executive and operating departments of our largest public utilities and of our manufacturing and construction industries, in mining and smelting, on the research staffs of the National Research Council and of industrial concerns, and on the teaching staffs of the universities, our graduates occupy leading positions, and touch our national life at many points. The Faculty of Applied Sciencecan justly claim that its graduates are playing an important part in the development of the resources of the Dominion.

RELATIONS WITH INDUSTRY, PROFESSIONAL TECHNICAL BODIES, RESEARCH COMMITTEES.

It is impossible to do more than summarize some of the activities of the staff of our departments outside of their teaching duties. The departmental reports indicate clearly that they are giving freely and generously of their time to the affairs of various national professional bodies, such as the Canadian Institute of Mining and Metallurgy, The Engineering Institute of Canada, Canadian Electrical Association, National Electric Light Association, Canadian Engineering Standards Association, etc. As members of various councils, as chairmen of local divisions of national organizations, or of sub-committees charged with the preparation of standard specifications or reports on contemporary engineering problems, our staff serve many organizations, to great mutual advantage. Contacts are established through such activities with engineers engaged in teaching and/in industry, which afford an opportunity for exchange of views on many matters of great interest to the profession. In the more definitely scientific field, service is rendered to the National Research Council of Ottawa through membership on committees dealing with the varied activities of that body. Representatives of our Faculty usually attend the conventions of the American National Engineering Societies, the American Mathematical Society, the American Association for the Advancement of Science, the Society for the Promotion of Engineering Education, the Canadian Universities Conference and similar bodies, so that close contact is maintained with modern developments and ideas.

Our laboratories serve the needs of industry in many ways, such as the following:-

(a) by carrying out standard tests of materials.

(b) by standardization of instruments of various kinds.

(c) by placing our testing facilities at the disposal of organizations or individuals seeking the solution of special problems, supervision of the use of equipment being maintained by our own laboratory staff.

(d) by the making of special investigations of a research nature, such work being directed by a member of our teaching staff.

Examples of investigations of a research character are given in the departmental reports such as:- study of ore-dressing problems; heat losses in paper mills; power developed by tug-boats of various designs as used in the pulp and paper industry; strength of steel beams haunched in concrete; the behaviour of ice under pressure; and many other problems of similar character in all branches of engineering.

In another field, our late Dean MacKay was honoured by being appointed a member of the Advisory Board for the Montreal Harbour Bridge. Other members of our staff have been called to serve on important technical commissions, and as consultants in many engineering projects of considerable magnitude. Such recognition adds to the prestige of the Faculty and of the University, and affords strong evidence of the high regard in which members of our Faculty are held.

The list of various activities outlined above shows clearly that we are maintaining close touch with contemporary engineering practice, and utilizing our facilities to good effect. It is our firm belief that by such co-operation we can best serve the wider interests of the profession, and the particular needs of individual organizations.

FUTURE POLICY AND NEEDS.

The Committee is satisfied that broadly speaking the policy heretofore pursued both in regard to teaching and to public relations is a sound one.

A process of gradual evolution of teaching courses to meet contemporary needs, is better than one of drastic changes put into effect at long intervals in an effort to sweep away the obsolete. We believe that the solution of the difficult problems of teaching, in such subjects as English, accountancy, law, economics, as well as technical subjects, lies in the application of such ideas. Similarly, some needful adjustments in the nature of the services rendered to industry, to professional bodies, and research organizations of various kinds can be made if a proper degree of watchfulness and a desire to serve are maintained. There are, however, definite limitations in this case which do not apply, or apply only in a lesser degree, to all phases of teaching. The question of physical equipment is involved, and while some subjects can be taught effectively if lectures are supplemented by the provision of books only, adequately equipped laboratories are also needed.in other subjects. It is evident that graduate work is governed by similar considerations. The necessity for providing a staff adequate to cope with all the problems outlined, is obvious.

The needs of the Faculty may, therefore, be classified broadly as follows:-

(a) The provision of new buildings to meet the requirements of departments in which laboratory space and equipment are now inadequate or obsolete.

(b) The provision of funds for the proper maintenance of existing equipment and for the purchase of new equipment as required in departments now reasonably well provided for as regards laboratory space.

(c) The provision of a staff to carry on undergraduate and graduate teaching, along the broad general lines outlined.

(d) The provision of a system of open Fellowships and Scholarships of adequate amount so that it may be possible for the ablest students in the Dominion to take advantage of our resources, both in graduate and undergraduate work.

The terms equipment and space used in thus defining our needs must be understood to include books and library facilities.

First among these physical needs is that of providing a new building to house the Departments of Mining and Metallurgical Engineering and Geology. The space which would thus be rendered vacant in the Chemistry Building would be well suited to developments in Chemical Engineering, in which department there is hope of re-organization in the near future. The promise of the early appointment of Dr. J. B. Phillips to devote his time to improving this course is most opportune. The provision of a new building would give a great impetus to the work of all the closely allied departments of chemistry, mining, metallurgy and geology, and this is beyond question our outstanding major physical need.

The provision of a new building would also help in solving the problem of lecture-room accommodation. The number of courses offered has increased steadily in recent years while the number of lecture rooms has remained fixed. As a result, undesirable time-table arrangements have to be made, and the opportunity of using lecture rooms in a building adjacent to the Engineering Building would be welcome.

It must not be thought, however, that the recent improvements in laboratory accommodation and equipment in the departments of civil, mechanical and electrical engineering meet all requirements, and that nothing more will be needed for several years. The chief gains in these departments are in added space, and in additions and improvements to equipment. Greater efficiency in the handling of undergraduate work and provision for reasonable increase in numbers are thereby assured. The accommodation has also increased the facilities for graduate work along certain lines such as hydraulics and communication engineering. There are, however, some notable deficiencies as for example in the lack of satisfactory high voltage equipment for work in electrical engineering. The present transformers are thirty years old, and while the voltage provided is sufficient for certain work, such as the testing of some types of insulators, it is wholly inadequate for the study of some of the problems of modern transmission systems. New transformers providing 500,000 volts are needed, and could be installed in the existing space if funds were available. Maintenance, in the case of engineering laboratories must be understood to mean not merely the proper upkeep of installed equipment, but something broader, including provision for the addition of the new equipment needed to keep abreast of the times.

The question of the teaching staff has been referred to above. Some of the difficulties met and factors to be considered in making appointments were stated. The teaching staff must always be the heart of our organization, and no effort must be spared in seeking to secure and retain men of proper calibre, who possess also the necessary teaching ability. Our general policy is to limit the undergraduate courses offered to the main branches of engineering science, while keeping in mind the necessity of providing for new developments of major importance, as for example in aeronautics, or for research work made necessary by the changing conditions in engineering practice. To meet these needs adequately will require a teaching staff which may be classified as follows:-

(a) Professors who would devote their time mainly to research.

(b) Professors who would deal with new and important phases of engineering work, involving either new appointments or the extension of duties of existing staffs.

(c) Junior staffs of such calibre that they may be worthy of advancement either here or elsewhere. The recruiting of such staffs from the best available sources is essential, and as already noted, would be aided by the provision of open Fellowships or Scholarships of substantial amount. A body of younger men not overloaded with undergraduate teaching, and capable of taking up the study of new problems, would be a most valuable asset.

CONCLUSION.

The attempt has been made to state the nature of the problem confronting the Faculty in the training of engineers, and to outline our efforts to meet it. Of necessity, many points have not been referred to, and future policy and needs have been defined only in the broadest way. It is possible that the committee as a whole, or in the first instance a smaller group, might consider in more detail some of the general questions raised when funds are available, or might formulate the most desirable schemes on which appeals for funds might be based. It appears to us best, at the moment, to give a picture of our organization and ideals, rather than to catalogue a number of specific needs as listed independently in the reports of the various departments. We are prepared to amplify any special points discussed in this report, and to assist in bringing to a working basis the specific suggestions of the departments having in mind the broad general principles laid down.

The reports of the following departments are appended in the order named:-

Department of Chemistry (including Chemical Engineering)

Department of Civil Engineering and Applied Mechanics.

Department of Electrical Engineering.

Department of Mechanical Engineering.

Department of Metallurgical Engineering.

Department of Mining Engineering.

The reports of the Departments of Physics, Mathematics and Geology were submitted to the Committee, but are not included here. They deal with general conditions in the University rather than with the specific relations of the departments to the Faculty of Applied Science.

The report on the School of Architecture is also appended. No comment has been made on this, as it deals with the organization of a self-contained unit within the Faculty.

E. Brown.

April 15,1931.

Chairman of the Faculty of Applied Science.

Associated Screen News Photo.

THE MONTREAL HARBOUR BRIDGE
In the construction of this bridge, spanning the St. Lawrence River and formally opened on May 24th, many McGill men were associated, the number including Dean H. M. MacKay, of the Faculty of Applied Science, who served on the Advisory Board of Engineers. The main span of the bridge is 1,937 feet long, and the total length of steel construction is 8,817 feet. The bridge clears the Ship Channel below by 163 feet and includes in its entirety 33,285 tons of steel.

Development of the Faculty of Applied Science

By H. M. MacKay

A DEEPLY charred piece of apple wood lying on my desk recalls some significant days in the history of the Faculty of Applied Science. It was one of the first products of the Thomas Workman shops and originally formed part of the ceremonial mallet used by Lord Stanley of Preston, the Governor-General of the the time, in laying the corner-stone of the first Macdonald Engineering Building, on October 30th, 1890. So far as is now known, its career for many years was uneventful; but in the great fire of 1907 it was a casualty and, indeed, almost a total loss.

The little procession which marched over the rain-soaked ground from the Redpath Museum on that gloomy autumn day forty years ago marked the beginning of the modern history of engineering training at McGill. True, "there were brave kings before Agamemnon". The Hamiltons, Carlyle and Mathewson had already begun their careers as miners and metallurgists. Several others whose professional distinction has not been surpassed by their successors were making their way in other branches. But the success of these men was due more to their native energy and ability, and to the personality of such pioneers as Bovey, Chandler, Harrington and McLeod, than to any curriculum or equipment which would be considered tolerable in a modern engineering school.

The building was ready to receive students in the autumn of 1891. A year later the equipment, on an extraordinarily liberal scale for the time, was practically completed. Early in 1893 the formal opening of the Macdonald Engineering and Physics Buildings took place with functions which lasted nearly all day and far into the night. No honorary degrees were granted, although some of the most distinguished engineers in America were present.

At one stride, thanks to the generosity of Sir William Macdonald and the vision of Dean Bovey, McGill had stepped into the first rank as an engineering school. The Department of Architecture was established in 1896, and the Chemistry and Mining Building with its facilities for mining and metallurgical work, became available in 1898; thus rounding out the organization in the general form in which we know it now.

The next twenty-five years was largely a period of natural evolution and growth. The Faculty of Applied Science was away to a good start. Other departments of the University required special attention. To some extent the influence of Balliol was felt over the whole institution. The Faculty of Arts was strengthened by a group of brilliant men who came (and in part went) from time to time. Pure science came into its own, culminating for the time in the golden era of Rutherford. The degree of B.Sc. in Arts was instituted, and the B.A.Sc. formerly awarded in Applied Science was abolished. And, of special importance, the foundations of the Graduate School were laid.

The work of the engineers, although, one trusts, respected, was not always understood in those days by our humanitarian colleagues. The writer, then a very junior member of the staff, was once arguing for the inclusion of economics, or history, or some such study in the engineering curriculum, when the entirely charming dean of another faculty expressed surprise that engineers should be interested in anything but "belts and screws." Perhaps this attitude was partly our own fault, for in the early days our new toys, machines and shops with their very practical appearance, received vastly more publicity than the solid scientific work which could not usually be explained to visitors.

In 1907 the fine old engineering building was burnt. Fortunately most of the more costly equipment remained intact. In the new structure which speedily arose on the same foundations, considerably increased accommodation was provided, more especially for drafting rooms. Laboratories were unfortunately but little enlarged, and for many years the cramped quarters were a source of considerable, and sometimes serious, embarrassment. Just as the new building was being completed, Dean Bovey was called to London to be the first Rector of the Imperial College of Science and Technology. He was succeeded as Dean by Dr. F. D. Adams, whose first great step was a thorough remoulding of the curriculum, so as to bring it into harmony with the broader ideas of engineering training which changing conditions suggested.

Canada was then in the midst of the era of railway building, and the number of students, particularly in civil engineering, rose rapidly. The newer universities of the western provinces, which have since grown to such imposing proportions, existed for the most part only on paper. Thus McGill received the cream of Canadian students, enriched by the influx of a very considerable number from Britain and other parts of the Empire. The staff was enlarged, additional equipment was crowded into laboratories and workshops, and neighbouring buildings were invaded in the search for classrooms.

Then came the war. Class-rooms and laboratories were depleted to an even greater extent than in other faculties. In the number of men enlisted, in casualties, and in the absolute and relative number of honours awarded, Applied Science led all other departments. It is a proud if sad record, in which graduates, undergraduates and past students share alike.

In the two or three years beginning with 1919, McGill, in common with all Canadian engineering schools, was thronged with those who had returned from overseas, as well as with an almost equally large number of students whose entry had been delayed. Unfortunately, just at the time when all the universities were pouring forth graduates in unprecedented numbers, a severe industrial depression occurred, with the result that there were many disappointed hopes and many difficult readjustments. Engineering societies were alarmed by the number seeking to enter the profession for whom there was no employment, and a note of warning was sounded which no doubt had considerable effect in turning the minds of many young men to other fields.

Although a somewhat discouraging period, it was not a bad time for taking stock of our methods and objectives. Probably no body of University teachers is so self-critical as engineering instructors. At this time, under the auspices of the Carnegie Foundation and the Society for the Promotion of Engineering Education, an international survey of the training of engineers was undertaken. In this survey McGill gladly took part. Amongst other means of obtaining information a very full questionnaire was sent to all our graduates. Many hundreds of replies were received, all of which were carefully noted and analysed, and it was very interesting to note the close correspondence of the information we secured as regards both opinions and facts, with the results of the inquiries of other leading engineering schools. The survey placed at our disposal not only the opinions of our own graduates, but the experience and consensus of opinion of all the leading institutions on the continent.

One point upon which the survey threw considerable light was the relative financial success of McGill and American graduates. The impression, which had gained wide currency, that Canadian graduates in general, and those of McGill in particular, were being lost to this country in large numbers, because of better opportunities elsewhere, received very little support from the facts presented. The median reported incomes of our men upon graduation were almost exactly the same as those reported by the American engineering schools taken as a whole. Nor was the comparison less favourable to our men in the case of graduates of five or ten or fifteen or twenty years' standing. In fact the trends and the actual figures as regards earnings were surprisingly alike in the two countries.

The exodus bogey too, when viewed closely, was not so alarming. A subsequent investigation showed that of our Science graduates whose addresses were known, about 11.7 per cent were in the United States. The tendency to emigrate is, however, diminishing, since the percentage of those graduating before 1905 who live across the line is nearly double that of the graduates in the last twenty years. Altogether about 15 per cent of the members of the classes since 1905 are living abroad, a perceptible proportion engaged in graduate work or apprenticeship courses, while about 10 per cent of the whole number of graduates in that period came from countries other than Canada. The net loss of our Applied Science graduates is therefore only about five per cent. It is probable that the distribution as to residence is nearly proportional among the six or seven per cent whose addresses are unknown. Quite possibly universities situated in less active industrial centres may have a larger loss to report.

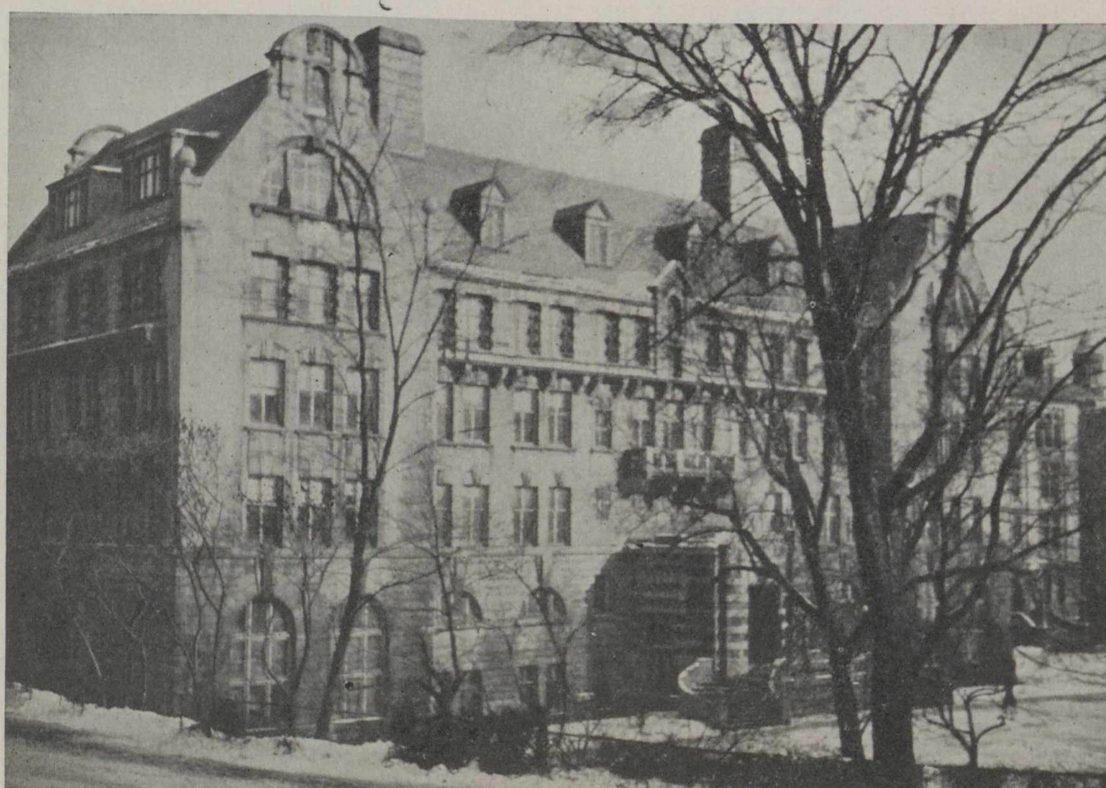
As regards policy and objectives, it was found that the principles by which we had been guided were in close harmony with the recommendations resulting from the international survey. The following extracts from a report drafted by the writer and approved by the Committee on Engineering Education of the National Conference of Canadian Universities indicate in part certain recommendations of the investigating board of the survey, and in part our own trend of opinion.

General Objective. "The curriculum should not be narrowly technical. As regards both content and methods of instruction it should aim at clear and accurate expression as well as clear and accurate thinking on the part of the student. The interest of the student should be stimulated and the engineering point of view developed in his mind by using every suitable opportunity of applying the principles taught, whatever the subject matter may be, to the problems of the engineer, of the community, and of life. . . . "

Curriculum. "The normal length of the undergraduate curriculum should remain four years. This proposal assumes that no attempt will be made to train men to be either specialists or all-round engineers in that period, and that further training is required to fit them to engage in the more advanced engineering specialties."

"As a general practice undergraduate curricula should be differentiated from each other to a moderate degree only. . . . The primary basis of the differentiation . . . should be restricted to the historic major divisions of the engineering profession, namely: Civil, Mining and Metallurgical, Mechanical, Electrical and Chemical Engineering. . . . "

"There should be a broad band of humanistic subjects extending through the curriculum. . . . It would be desirable to carry formal instruction in English



THE ENGINEERING BUILDING.

through more than one year, but it is deemed even more important to emphasize the necessity for clear and accurate expression in all subjects of the curriculum, and thus to create an atmosphere favourable to the correct use of the language. . . . "

"General economics should be included in all engineering curricula. . . . " "The criteria and technique of engineering economy, as related to costs, economy of design and economy of selection and application should be taught by engineers in connection with engineering subjects."

"It is recommended that elimination of unsuitable students be made as early as possible . . . and that the abler students especially, should be taught to depend upon their own resources to as great an extent as circumstances justify, and increasingly in the senior years."

Space does not permit reference to the recommendation regarding specific studies. One's excuse for dealing at such length with aims and curricula is the keen interest which so many graduates have shown in these matters.

Since the general lines on which we were proceeding seemed to be in accord with the best opinion, important changes in the curriculum have not been numerous. At least as much attention has been given to improved methods of instruction. The post-war generation of students has been much discussed. Perhaps for a time they were not quite so keen as their predecessors. Perhaps, on the other hand, more was demanded of them. At all events a more thorough preparation before entry was deemed indispensable, and accordingly the matriculation standard was raised by about one year. For most of the entrants from the province of Quebec this means one year in the Faculty of Arts; but the best secondary schools in some of the other provinces can meet the requirements quite satisfactorily. Naturally the number of students entering was reduced for the time being, and the effect of this will be felt in the upper classes for two or three years yet. The freshman class this year is about the same in number as before the change in the matriculation standard. In raising the entrance standard there was no thought of increasing the total content of the undergraduate course. It was hoped that the average student would be enabled to do more thorough work, and that the proportion of eliminations for academic reasons would be reduced. Both these hopes are being fairly realized.

Shopwork, at one time considered a very important feature, has been abolished except in a specialized form for mechanical engineering students. It was increasingly realized that student practice in the shops was far inferior to experience under commercial conditions, and that the time and effort required could be used to better advantage in other ways. As a substitute, all students, before proceeding to a degree, are now required to have at least six months experience in engineering or industrial work. Under present conditions students have little difficulty in fulfilling this requirement. A faculty committee gives its aid in making suitable connections. The industries are every year showing greater interest in making contacts with undergraduates, which in about fifty per cent of the cases lead to permanent connections. This vacation work is in part a period of individual adjustment and experiment for both industry and student, while the advantage to the latter of experience in the realities of engineering and industrial life, particularly on the personal and human side, is obvious.

In mining, the former "trip" or school of inspection has been replaced by a season's work in mining or metallurgical plants, under the supervision as occasion requires of a member of the staff.

In electrical engineering the growing importance of electrical communications has led to the organization of a senior option maintained at first with the valued co-operation of the Department of National Defence, but now taken over by the departmental staff.

The Department of Mechanical Engineering has arranged a senior option leading to work in aeronautical engineering. Full training in this branch is so specialized that it must be left to the graduate school.

Beginning next session, it is intended greatly to improve the course in chemical engineering. A new professor will, it is expected, be appointed whose duty it will be to bridge the gap between the engineering and chemical sides. He will doubtless deal with the problems of design and operation relating to the principal unit processes connected with the chemical industry.

A course in the preparation of reports and in public speaking has been established under the supervision of Professors French and Wood. Instruction is largely carried on by means of practice and criticism rather than by formal precept. The appeal of this course has been such that the sophomores to whom it is given have requested a double ration; and upon the request of a large number of the senior class a course in public speaking has been organized for them.

With the co-operation of the St. John Ambulance Association, a course in First Aid has been organized by Professor McBride, who has had much experience in that line of work. Students of the second, third and fourth years are availing themselves in large numbers of the opportunity.

In general, there has been an effort to reduce the number of lectures wherever possible; several descriptive courses have been abolished, the student being encouraged to obtain readily accessible information for himself. There has also been an extension of supervised problem work, with or without explanatory lectures. All this is in reality an effort to replace lectures so far as practicable by tutorial instruction. The engineering library has been greatly augmented and placed in charge of a trained assistant. Rigid attendance rules have been abolished for upper classes, except where irregularity would lead to disorganization, as in laboratory courses. Interest in work does not seem to have suffered from this step.

If we except the reconstruction of the Engineering Building following the fire of 1907, there had been no notable building additions in the quarter of a century following 1898. And this was hardly an exception, since although drafting room accommodation was greatly increased, other important facilities were but slightly improved and in some cases curtailed. For example, the hydraulics laboratory was virtually squeezed out of existence, although hydro-electric development is by no means an exotic growth in Canada. The splendid Reuleaux collection of mechanical models was not replaced and, an omission which is now keenly felt, no room was provided for the exhibition of engineering models. The inadequacy of office room may be illustrated by the fact that the writer, then about to assume the direction of the Civil Engineering Department, was assigned by the committee in charge to a small attic room without natural light. An unqualified refusal to accept the assignment secured him a room with a window, or to be exact, since his language was devoid of the circumlocution which it now displays, two windows.

Although the successful financial campaign of 1921 placed from five to six million dollars in the hands of the Governors in the next few years, little money was available for the needs of this Faculty. Nearly all was pre-empted to meet obligations of a more general nature, or else ear-marked for specific purposes in other faculties, by the terms on which a large contribution was made. A few crumbs, however, fell to Applied Science.

With the assistance of the Montreal Light, Heat and Power Consolidated, the Shawinigan Water and Power Company, the Bell Telephone Company of Canada, and the Northern Electric Company, a new wing on the site of the old smithy and foundry provided some 60,000 square feet of space on four floors. The ground floor contains an enlarged high voltage laboratory, and a commodious laboratory for internal combustion engines. This latter has been well equipped with units of moderate size, excellently adapted to their purpose. The first and second floors accommodate the heavier equipment of the Electrical Engineering department with room for expansion. The upper floor contains large laboratories for electrical measurements and electrical communications, as well as the departmental offices and library. The whole wing, while economical in construction, is splendidly lighted and well suited to its purpose. A large amount of new equipment has been installed, some by gift, some by purchase and some by indefinite loan.

For eighteen years the hydraulic equipment had been represented by little more than a few tanks and pipes fitted up "temporarily" in a corner of the testing laboratory. Space made available by the erection of the new wing, mentioned above, was utilized to fit up an excellent modern hydraulics laboratory spendidly adapted to instruction purposes and, within limits, to research. Apart from space, the principal limiting condition is that the city water supply only is available. The most is made of this supply through re-circulation by means of a powerful pump. Acting upon the suggestions of the professors of hydraulics, the engineers of the Montreal Island Power Co. incorporated features in their plant at the Back River which will greatly facilitate the installation there of a supplementary laboratory with an ample water supply, when opportunity offers. The hydraulics laboratory was designed by members of the staff and constructed under their personal supervision. The fact that although nearly all the work and equipment was of a very special kind it was completed nicely within their estimates, is a tribute to their engineering skill.

The greatly increased importance of Highway Engineering necessitated the construction of a laboratory equipped with all the apparatus required for making the standard chemical and physical tests of road building materials, bituminous and otherwise. Some of the operations being noisy and dusty, the laboratory is appropriately placed in an out of the way basement where it is seldom seen by visitors. This laboratory, too, was completed within the estimates of the professor in charge.

A new high pressure boiler has been installed to supply the steam laboratory which greatly extends the scope of the work which can be carried out.

Space will not permit of dealing with all the reconditioning and improvement carried out. But while much remains to be done, it is within the mark to say that the recent improvements while involving a comparatively small expenditure, have resulted in a marked strengthening of the teaching work, and constitute by far the most important advance in the material resources of the Faculty in the last thirty years.

At the present time there is every reason to hope that before the year is out work may be started on a new building to house the departments of Mining, Metallurgy and Geology, all of which, and particularly the last named, have been heavily handicapped by insufficient room.

A notable development of the last few years is the rapidly widening field of opportunity for engineering graduates. Probably a minority of those now graduating will follow what used to be understood as professional engineering. On the other hand, most of the leading industries are now seeking to build up their organizations with young men who have had an engineering training. Probably many of the richest prizes as regards both reward and opportunity for service, lie in the industrial field, in which the demand is far greater than the supply. Character, personality and at least reasonable ability, developed by a sound and sensible scientific training, rather than special knowledge, are the qualifications sought after as regards the rank and file. On the other hand, the rapid development of science and its application to engineering practice requires a number of men of exceptional ability and more highly specialized training. To meet this demand satisfactorily, it is necessary to strengthen our graduate work.

In graduate work considerable progress has been made. Every year new courses are being added or old ones strengthened. There are, however, two serious obstacles in the way of development—limitations of staff and lack of scholarships. All graduate instruction is carried on voluntarily by men already heavily loaded with other duties. The leading American engineering schools have numerous scholarships for which Canadian graduates are welcome applicants. We have but one—founded a year ago by a well known graduate, Dr. Walter Colpitts, Sc. '99,—which is open to graduates of other universities.

The future prestige of the Faculty of Applied Science is, in the writer's opinion, bound up with the development of graduate work. In order that this development may proceed at a reasonable rate we urgently need, not one or two, but several professors who can devote the whole, or the greater part of their time to advanced work and to research; and a system of scholarships which will make it possible for the ablest young men in Canada to take advantage of our resources.

The Library Department of the Modern Hospital

A Study of Voluntary Administration

By Inez M. Baylis

To the ill-informed a hospital was, and is, a place in which to die; to the better educated it is a place where the body can be mended, for which purpose all kinds of wonderful instruments have been provided. A great amount of money is always spent in hospitals on magnificent kitchens for feeding the body; and in a modern, up-to-date hospital a central, well-kept room supplies food for the mind—this is the library.

Books in a hospital library must be considered from two points of view—their literary, and their therapeutic, value. Many persons who have never before had time to read are given this opportunity in hospital. As one old man said, it had been the dream of his life to read 'David Copperfield', and this dream came true in the hospital. "From now I shall always think of a hospital as a place of joy."

Similarly, a public patient, meeting one of the volunteer librarians, said: "I want to tell you how much this library and your visits have done for me. I had never read much, or cared for books, and I cannot thank you enough for bringing this pleasure into my life. I find books a necessity now, and I am glad to tell you what the hospital library has done for me."

Doctors say that psychology is used more than medicine in the curing of patients. If a sick person's mind is taken away from himself and made happy, his recovery must certainly be faster. Books have this therapeutic value. Books, however, are medicine and must not be given in a careless way to patients. The librarian must not only know the books, but must also have details of the patient's condition. This applies to all patients, but particularly to the neurological. A harmless book given to the wrong person may cause a crisis. A young woman, a mental patient, for example, was given L. M. Montgomery's "Blue Castle", and within five minutes was suffering with hysteria. After hearing details of the patient's condition from both nurse and doctor, I spent over an hour exchanging that book for "Ivanhoe." Love was the cause of the trouble with the first book; and the other was accepted as the patient was Scotch. Another day, "Eliza for Common" was returned by a mental case with every page torn. She said she had enjoyed the book, but her guardian angel had told her to destroy it.

These incidents explain why co-operation between doctors, nurses, and hospital librarians is necessary. Details of these special cases must be given by nurses to librarians; and doctors often prescribe books for the patients—or perhaps it is more accurate to say, prohibit certain types of books for special cases.

In a hospital of any size there are patients of all nationalities and to these the librarian must be able to give books. I shall never forget the expression on the face of a Greek—for he could not express his thanks in English—when a book in his own language was loaned to him. A few days later, Polish books brought great

PROFESSIONAL TRAINING IN APPLIED SCIENCE

BEING A SUMMARY OF REPLIES TO QUESTIONNAIRE SENT TO GRADUATES IN APPLIED SCIENCE

By PROFESSOR H. M. MACKAY

Dean of the Faculty of Applied Science, McGill University

SOME two years ago questionnaires were sent to all the graduates in the Faculty of Applied Science of McGill University whose addresses were known, partly with the purpose of securing information as to their activities and partly to obtain their views on questions of educational policy which the Faculty was considering. One form was sent to the graduates in classes 1922-24 inclusive. Replies were received from nearly forty-five per cent. of the members of these classes, and a summary of the results was published in a previous issue of the *McGill News*. A second form was sent to the graduates in all previous classes. Some twenty-five per cent. of the recipients replied, and the present article is intended to summarize the more important features of these replies.

It is, of course, difficult to estimate the extent to which the limited number of replies received represents the status and experience of the whole body of

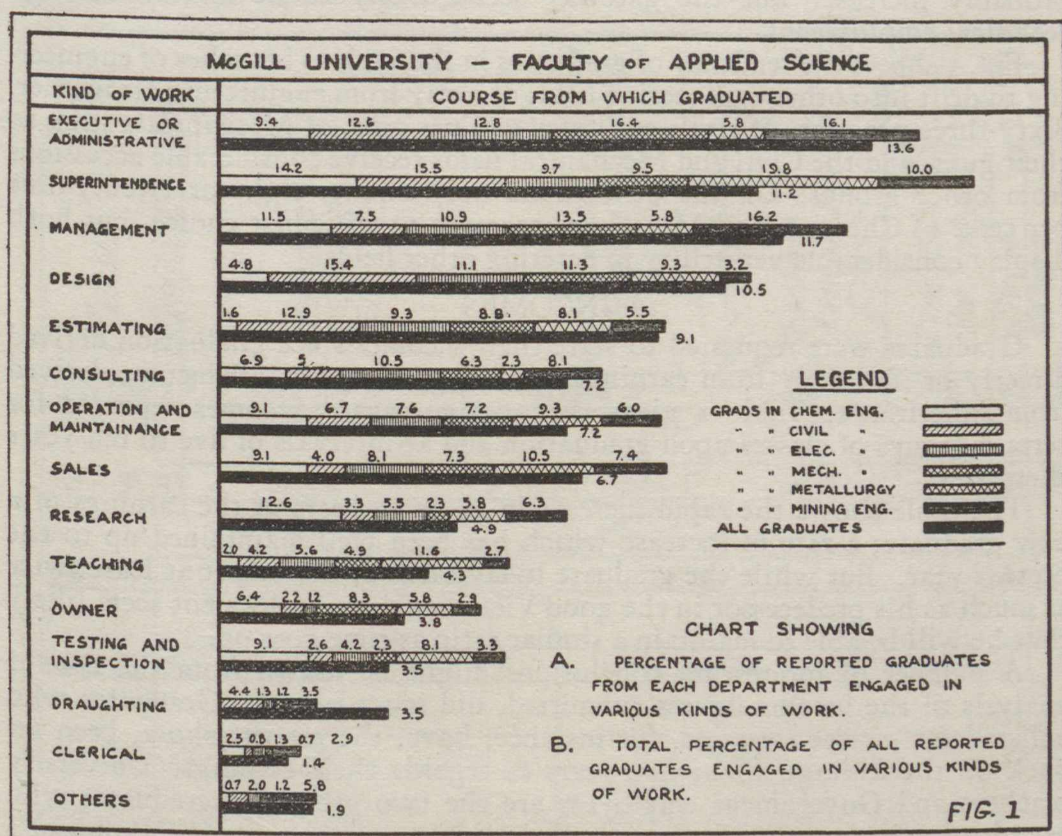


FIG. 1

graduates. However, careful consideration of the replies as a whole, together with comparison of the figures with those obtained by other leading engineering schools convinces the writer that this summary gives, in most respects, a fairly accurate cross section of graduate experience and opinion.

OCCUPATION

Fig. 1 shows graphically the percentage of the activity of the graduates in each of the major branches of engineering devoted to different kinds of work on a functional basis. Thus the first line in the diagram indicates that 9.4 per cent. of the activity of graduates in Chemical Engineering and 16.1 per cent. of the activity of those in Mining is devoted to executive or administrative work, while 13.6 per cent. of the activity of all the graduates reporting is so engaged. Mechanicals lead by a small margin in executive work; Metallurgists in superintendence and Miners in management. Civils do more than their share of designing and estimating, while Chemicals lead in research. Electricals are to the fore in consulting work and Mechanicals reach the happy stage of ownership to a greater extent than their fellows.

Tendencies in occupations are better shown, however, by Fig. 2, which indicates the gradual shifting of the centre of gravity as the years elapse after graduating, from activities which are mainly technical to those which are mainly executive or administrative. More than eighty per cent. of the graduates in the classes 1920-24 were engaged in work mainly technical, while forty-five per cent. only of the graduates previous to 1900 were so engaged. This drift from technical to executive work is entirely satisfactory and will probably increase. But the gateway seems likely to be mainly through technical employment.

Fig. 3 shows the tendency of graduates in the various branches of engineering to drift into other engineering fields or away from engineering altogether. Sixty-three per cent. of civils and forty-five per cent. of Mechanicals stick to their guns, and the Civil and Mechanical fields receive considerable accessions from other groups. On the other hand only twenty-eight or twenty-nine per cent. of Chemists and Miners are constant to their first choice, but both display considerable versatility in entering other fields.

INCOMES

Graduates were requested to state their incomes since graduation derived directly or indirectly from earnings, omitting, however, all income derived from inheritance. Table 1 gives the average earned incomes reported for certain groups of classes upon graduation and at intervals of five to ten years thereafter.

The table shows the rapid increase in 25 or 30 years of the earnings of a new graduate; a rate of increase which has been well maintained up to the present year. But while the graduate today earns at the outset at least twice as much as his predecessor in the good Victorian days, it does not seem likely that he will be able to maintain a similar ratio as time goes on.

A number of interesting conclusions might be drawn from the careful analysis of the income figures submitted, did space permit. Graduates who enlisted for service overseas, for instance, have, the reports show, been set back on the average about five years as regards their earnings. University teachers and Government employees are the two groups of graduates who earn least. Both start off pretty well, but after twenty years the Professor's

Table 1
Average Earned Incomes

Classes	Years after Graduation					
	0	5	10	15	20	30
1870-95.............	620	2,000	3,860	7,640	12,000	16,600
1896-00.............	720	1,820	3,360	5,640	9,600	
1901-1905...........	775	2,100	3,700	5,440	7,350	
1906-10.............	905	2,060	4,500	6,210		
1911-15.............	995	2,480	4,850			
1916-20.............	1,340	2,960				
1921................	1,440					
All Classes..........	995	2,380	4,300	6,100	9,300	16,600

income (unless he has private means) is less than half, and the Civil Servant's less than two-fifths that of the average man.

The average man is, of course, an abstraction whom we meet as seldom as we enjoy an average spring. On the other hand, the "Median" man, or the one who has as many below as above him, is a real personality. His income, therefore, probably gives a truer idea of the economic position of the graduates. The median earnings are shown in Table 2. These figures are much lower than the averages since the latter are unduly raised by a limited number of exceptionally high reported incomes.

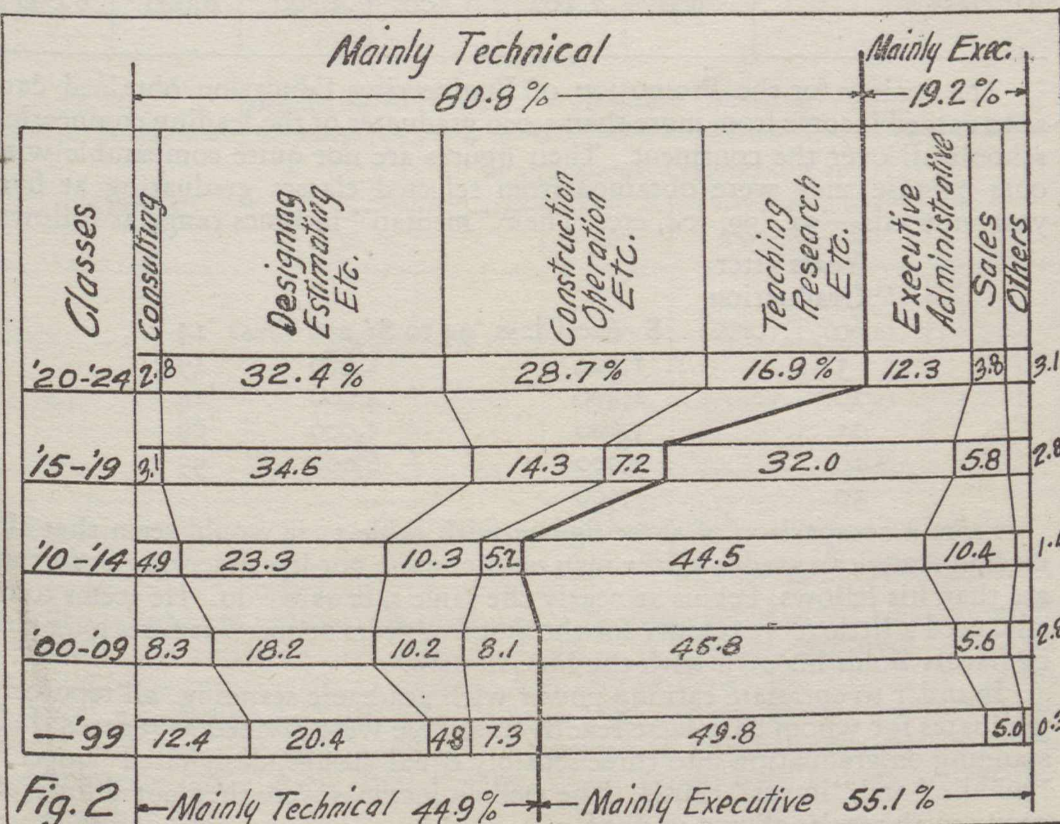


Fig. 2

Table 2
Median Earned Incomes

Classes	Years after Graduation					
	0	5	10	15	20	30
1870-95	600	1,200	2,400	6,000	7,000	8,000
1896-00	600	1,800	2,800	4,800	6,500	
1901-05	720	1,800	3,000	5,000	5,500	
1906-10	900	1,950	3,500	4,500		
1911-15	900	2,100	3,750			
1916-20	1,200	2,700				
1921	1,410					
1924	1,470					
All classes	900	2,100	3,500	4,800	6,000	8,000

The Society for the Promotion of Engineering Education obtained data as to earned income from more than 5,000 graduates of the leading engineering schools all over the continent. Their figures are not quite comparable with ours because they were obtained from selected classes graduating at five-year intervals—'94, '99, '04, etc. Their "median" incomes range as follows:

Years after Graduation					
0	$ 600	Class '94	to	$1,476	Class '24
5	1,500	" "	"	2,860	" '19
10	2,400	" "	"	4,000	" '14
15	3,600	" "	"	5,000	" '09
20	5,000	" "	"	6,000	" '99
30	7,500	" "			

From a comparison of these figures with table 2, it would seem that the median American graduate, the man neither more nor less deserving or fortunate than his fellows, begins at nearly the same rate as we do. He seems to be advanced a little more rapidly for the first five years or so. But for a long pull he hardly holds his own with the McGill man.

In order to correlate earning power with academic standing, all reporting graduates for whom data were readily available were divided as regards their standing on graduation into three sensibly equal groups, designated "upper," "middle" and "lower" thirds. The median incomes were then noted for each group with results shown in Table 3.

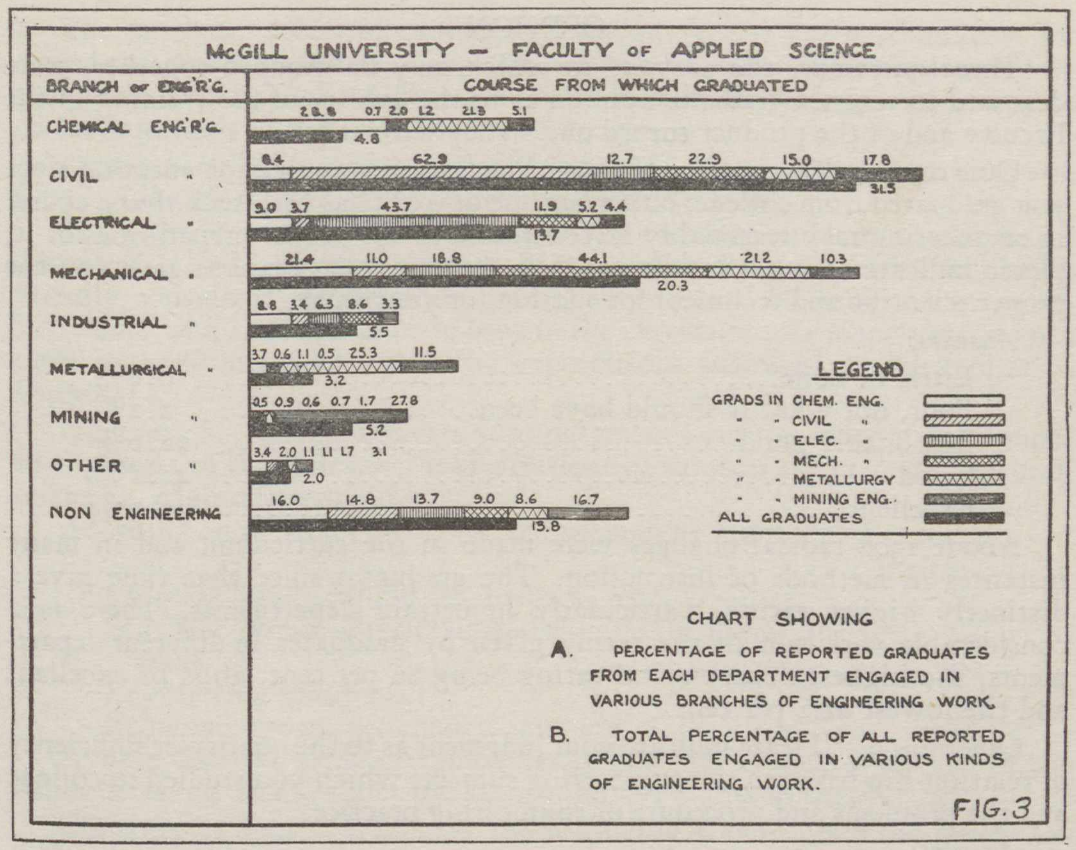


Table 3

Median Incomes related to Academic Standing

Group	Years after Graduation					
	0	5	10	15	20	30
Upper	900	2,250	3,600	5,200	6,000	11,500
Middle	900	2,100	3,250	4,500	6,250	12,000
Lower	780	2,000	3,200	4,200	4,800	4,000
All groups	900	2,100	3,500	4,800	6,000	8,000

The number of individuals represented by the figures in the last column is probably too small to give reliable results. It appears, however, that the man who graduates with an average standing or better has a decided and increasing advantage over the "low" man. Putting the matter another way, in the two upper groups one man in 2.9 enjoys an income of $10,000 or more, twenty years after graduation. In the lower group only one in 5.6 accomplishes that feat.

OPINION

Three questions, the answers to which may be grouped together, were designed to register graduate opinion as to the quality of the training in the Faculty and of the product turned out. They were as follows:

QUESTION 5. "If you have followed engineering as a major vocation since you graduated from college, or if your line of work has been such that a course in engineering may reasonably be considered as the proper preparation for it, please indicate to what extent you believe your college course gave you the proper scientific and technical foundation for your work."

Answers:

Little or none	0.8%
Poor, not what it should have been	2.2%
Reasonably good	22.6%
Good	42.1%
Excellent	32.3%

About 1908 radical changes were made in the curriculum and in many instances in methods of instruction. The graduates since that time give a distinctly higher rating, particularly in certain departments. There is a considerable variation in the rating given by graduates in different departments, the highest departmental rating being 86 per cent. good or excellent and the lowest 62.2 per cent.

QUESTION 9. "Please indicate your judgment as to the quality or sufficiency of relationship between the engineering subjects which you studied in college and the problems and procedure of engineering practice."

Answers:

Conspicuously poor	0.0%
Poor, not what should have been	8.0%
Passable	24.0%
Good	55.6%
Excellent	12.4%

Here again the rating of the more recent graduates is materially higher. The highest departmental rating is 80.5 per cent. and the lowest 52.4 per cent. good or excellent.

QUESTION 10. "Please indicate your judgment on the standard of work done and of graduates produced by the engineering colleges as fixed by the requirements of the field of engineering practice."

Answers:

Conspicuously poor	0.5%
Poor, not what they should be	4.9%
Passable	24.7%
Good	58.7%
Excellent	11.4%

This question refers to graduates of all colleges in so far as our graduates come in contact with them. Departmental ratings, therefore, lose their significance, in part at least. The highest and lowest departmental ratings are respectively 79 per cent. and 59.3 per cent good or excellent.

QUESTION 6. "What elements which you consider might properly have been included in your college course were omitted?"

The business aspects of engineering, including law and accountancy, received the greatest amount of support, followed at a considerable distance by economics and English. Languages, cultural subjects and greater insistence on fundamentals also received some emphasis.

QUESTION 7. "What courses or lines of study you took in college have you found of the most practical or professional value to you?"

The palm is in this case awarded to the technical subjects of the major divisions (Civil, Electrical, etc.). Mathematics and Applied Mechanics, broadly considered, in the order given. Physics and Chemistry come next. Economics and Law which have been in the curriculum for many years do not seem to have measured up to the expectations indicated in the replies to Question 6.

QUESTION 8. "Please indicate your judgment as to the order of importance to engineers of the following four divisions of subjects of curricula, cultural, scientific, engineering, economic."

Adopting an arbitrary scale, the replies may be summarized as follows:

	Weight
Cultural group, languages, history, etc.	45
Scientific group, physics, chemistry, mathematics, mechanics, etc.	100
Engineering group	92
Economic group, economics, law, etc.	66

A more detailed study of the replies shows that graduates in each of the major divisions attach about the same relative weights to these groups.

QUESTION 11 asks, "Which of the following statements most nearly expresses your views as to the objectives of engineering courses?" The vote is as indicated.

(*a*)	To train broadly for the general needs of industry (the word "industry" being used in the broad sense)	18%
(*b*)	To train for the specific needs of specialized divisions of engineering practice—to give a professional type of training of the same general character as law and mechanics	9%
(*c*)	To provide the former type of training for the majority, but provide the latter type for those who desire to spend the additional time needed to acquire it	73%

QUESTION 12. "If you employ, or have to do with the employment of engineers, please state the relative weight which you give to the following qualifications . . . "

The table gives the percentage of replies under each head.

QUALIFICATION	RELATIVE WEIGHT		
	Little	*Moderate*	*Great*
Evidences or estimates of good character	1	24	75
Physical qualities, including appearance and neatness	11	72	17
Scholastic record	34	58	8
Evidences of initiative and qualities of leadership	4	21	75
Training in a particular course or specialty	23	52	25

Many replies to this question are very properly qualified. The weight to be attached to special training, for example, depends greatly upon the duties for which a man is required. It will be observed that the only qualifications to which the majority attach great weight are character and initiative. Scholastic record fares badly; the vast majority considering it of little or moderate importance. While much may be said for this point of view were high scholastic record considered an end in itself, the writer's experience in placing graduates and following up their careers leads him to think that it is a valuable "indicator" of other desirable qualities. The imposing list which could be drawn up of graduates with high scholastic rank who have been exceptionally successful, a list which certainly could not be duplicated from any other group of equal number, seems to point in the same direction. However, the subject is too controversial to deal with here.

Question 13. "Please indicate . . . the manner and extent to which you believe your college experiences have been valuable to you."

The percentage of replies under each head is indicated below.

	Little or none.	*Moderate.*	*Great or very great.*
Discipline in methods of thinking or habits of work	11	25	64
Knowledge of the fundamental principles of science	1	22	77
Training in engineering courses and direct preparation for engineering work	17	41	42
Training in shops, laboratories, etc. (acquisition of craftmanship)	33	41	26
Acquisition of the basis of a liberal education	27	38	35
Inspiration and guidance from members of Faculty	35	30	35
Associations and friendships with fellow students	27	30	42
Development derived in a not easily definable way from the college life and atmosphere	12	31	57

A more detailed study shows curious fluctuations in opinion from one period to another. During the war years, for instance, both faculty influence and that of fellow students were sharply reduced. Both, however, more than recovered their ground when the storm passed away.

The replies to question 14 indicate the percentage of graduates reporting who have continued their technical education since graduation by each of the methods stated.

Graduate work in college or university	15.5
Extension, correspondence or similar course	14.5
Systematic self planned and self-regulated study	25.2
Systematic study or courses given, supervised or required by employer	47.5
Such unsystematic study as requirements of work have demanded	71.3
Other methods	16.7
None worth mentioning	12.0

QUESTION 15. The summary given below shows the extent to which an engineering course is deemed likely to promote or develop in the students the qualities indicated.

	Little %	*Moderate* %	*Great* %
Integrity and dependability	25	40	35
Habits of accuracy and thoroughness	3	21	76
Diligence	21	47	32
Powers or initiative and originality	25	48	27
Qualities of leadership	46	33	21

More interesting than the necessarily dry summary of formal replies are the individual comments frequently accompanying them, and which space limitations make it impossible to publish. On some points indeed diametrically opposite opinions fairly balance one another, but in many instances weak points are unerringly bared and ideas capable of development suggested. Both the general trend of opinion indicated and the individual suggestions and criticisms have been and will continue to be most useful to the Faculty in the process of readjustment which is now going on.

REPORT OF DEPARTMENT OF CHEMISTRY.

This department is responsible for the instruction of students registered in three faculties; Engineering (formerly Applied Science), Arts and Science (formerly Arts) and that of Graduate Studies and Research. A small amount of teaching is also done for students of the Department of Pharmacy, the School for Graduate Nurses and the School for Physical Education.

FACULTY OF ENGINEERING

The numbers of students taking Chemical Engineering in each year for the past ten years is shown in Table I. The greatest number (73) attended during the session 1920-21. This large number was a consequence of the war. After 1923-24 the numbers have been fairly uniform, average 19.

It has been felt for some time that the curriculum for students in Chemical Engineering should be revised. To that end a small committee of the department has given careful consideration to this question and its recommendations are to be made shortly. Last spring the Principal agreed, with certain reservations, to add to the staff Dr. J.B. Phillips, a graduate in Chemical Engineering and a Ph.D. in Chemistry, now at the Massachusetts Institute of Technology. His appointment will it is hoped take place in the fall.

The applications of engineering to chemical problems have, we believe, not been adequately taught in the department in the past. With the help of Dr. Phillips we thus hope to remedy a serious defect in the present teaching of Chemical Engineering.

In the year 1932 and after Chemistry will be compulsory for entrance to the Faculty of Engineering. This change will greatly help in improving the curriculum, not only for students in the faculty generally, but particularly for those intending to take up Chemical Engineering as a profession.

FACULTY OF ARTS AND SCIENCE

In many universities the number of students taking elementary chemistry is large. This is also the case at McGill. Since 1920-21 the number of such students has only twice been less than 300. This session it is 436.

The number of students reading for an Honours Degree in Chemistry has never been large. Since 1920-21 the minimum has been 8 (1923-24) and the maximum 17 (this session). The training offered by the curriculum for the Honours Degree is probably the best preparation for students intending to pursue post-graduate work in pure chemistry, or for those intending to follow chemistry as a profession. Students begin the required courses in the second year. Since a high standing in the first year examinations is required for entrance, only those well trained before entering McGill, or possessed of ability above the average, are qualified to undertake the required work. The number of such students is therefore small.

FACULTY OF GRADUATE STUDIES AND RESEARCH

Dr. Maass has prepared the following report covering the years 1920 - 1930.

REPORT ON THE GRADUATE SCHOOL IN CHEMISTRY AT McGILL COVERING THE YEARS 1920 to 1930.

This report is of a statistical nature and is designed to give an idea of the number of students in the Graduate School in Chemistry, the number receiving degrees, the positions held after the receipt of degrees, and certain details such as the number with Ph. D. degrees who remain in Canada. Besides this the question of National Research Council Scholarships is discussed as showing the place McGill University occupies as a Graduate School in Chemistry when compared with other Canadian Universities. Table II shows that the number of students in the Graduate School has increased in a more or less continuous manner reaching the maximum number in the present session. The term maximum is used advisedly since it is probable that with the present facilities a much larger number cannot be accommodated advantageously.

Before 1919 only four candidates had received the Ph. D. degree during all preceding years, so that this year may be taken in a sense as being the starting one as far as the Graduate School in Chemistry is concerned. It was about that time that it became recognised that four years of undergraduate work was inadequate to equip a student for the chemical profession, either in University work or in an industrial position involving research. Since 1919 sixty-four candidates have received the Ph. D. degree in Chemistry at McGill. The number per year is indicated in Table II, and a large part of the remainder of this report is concerned with the subsequent careers of these men.

Table III indicates the nature of the positions held at present by these men. It is a matter of some pride that fifteen of them are now permanent members of the staffs of Canadian Universities, and six of American Universities, so that a third of the Ph. D. graduates hold University positions. Previous to 1919 the Chemistry Departments of the Canadian Universities had no McGill Ph. D. graduate on their staff. The Canadian Universities who now have one or more McGill Ph. D. on their staffs are the University of British Columbia, University of Alberta, University of Manitoba, Western University, Queens University, McGill University, Mount Allison, University of New Brunswick and Dalhousie University.

Another fourteen of the students under consideration are employed in laboratories of the Canadian Government, and most of the others are distributed in research positions in Canadian and American industrial corporations. In this connection, the fact that twelve are in the United States, and thirteen in Canada is due to the larger number of industrial research organizations in the United States. Added to this is the fact that only recently, that is within the last few years, have Canadian industries realised the necessity of engaging experts on their research staff. Several American corporations have signified their willingness to take McGill Ph. Ds. on their permanent staff at any time, provided they have the proper recommendations, a compliment to the McGill Graduate School, but one which, if followed, would mean the loss of specially trained men to the country. Of the twelve men now in industrial work in the United States most have been engaged before 1927.

Of the fifty students in the Graduate School at present only ten percent are McGill graduates, the rest having obtained their undergraduate training elsewhere. The popularity of the Graduate School at McGill among students in Chemistry is indicated by the fact that in all branches of Chemistry over fifty percent of the National Research Council Student Scholarships (awarded since 1916) have been awarded to students who elected to hold these at McGill. The growth of the popularity is indicated by the fact that of twenty-four scholarships awarded in 1930 to students in Chemistry throughout Canada, twenty-two were granted to students of other Universities who elected to come to McGill.

Table IV shows the positions held at present by those of the sixty-four Ph. Ds. under consideration who held National Research Council Scholarships. This table indicates the positions held at present by these men.

It has been erroneously stated that these highly trained men find their way to the United States resulting in a loss on account of the money spent by the University in their training, and a loss to the Government in the case of students holding scholarships. Table V shows that relatively few, in fact only about twenty percent, have found their way to the United States, and as has been indicated before the majority of these obtained their Ph. D. degree before 1927. Five students were Americans who naturally would return to the United States. With regard to post-graduate scholarships the 1851 Exhibition has not been popular among the students in the Graduate School in Chemistry. Having once started on their course towards the Ph. D. degree they showed a preference to continue here till the end rather than elsewhere. Since the large majority of those in the Graduate School come from other Universities this attitude has not been criticised by the staff of the Department. On the other hand scholarships available subsequent to the Ph. D. degree have been in great demand. In this connection the Ramsay Memorial Scholarship, open to applicants from any part of the Dominion, has only been held by members of the Graduate School at McGill since the foundation of that Scholarship in 1919.

Higher degrees have not yet been given in Chemical Engineering. With the addition to the staff of a qualified Chemical Engineer it should be possible to offer courses and research leading to such a degree. Certain facilities may have to be provided, but these are of such a nature that we can see no serious obstacle in attaining our objective in this direction.

As indicated by Dr. Maass in his report the recognition of the value of research in industry is fairly recent, that is by the industries themselves, although its value has always been recognised by those with scientific training. The growth of the graduate work in chemistry at McGill is similar to that in many of the better American Universities, but quite exceptional in Canada. The extent to which expansion may be looked for or provided for requires consideration.

A development which we believe would aid the chemical industries of Canada is one which has already been successful at certain American Institutions, e.g. The Massachusetts Institute of Technology.

Students who have obtained a higher degree, preferably the Ph.D., can in many cases spend another one or two years in research on fundamental problems of value to particular industries. Such students should be supported by the industries interested, and their work carried out under the direction of a member or members of the staff. The value of such work lies, not so much in the research accomplished as in the increased value of the research worker to the industry directly concerned.

Attention is drawn to the fact that during the last ten years one hundred and forty-nine papers have been published by the staff and students in the Graduate School in Chemistry.

In connection with the development of graduate work in this department mention should be made of the Pulp and Paper Research Institute.

The first practical step towards the creation of the Institute was taken in 1920. The Institute was finally com- no pleted and formally opened in the fall of 1928. The Pulp and Paper Research Institute represents a cooperative effort of the Pulp and Paper Division of the Forest Products Laboratories of the Dominion Government, the Pulp and Paper Association, and McGill University.

The fundamental research carried out in the Institute forms an integral part of the post-graduate work in chemistry. Since the session 1926-27, nine to fifteen students have been engaged in researches in the organic chemistry related to cellulose, and in the present session an additional number of ten students are engaged in problems related to the physical chemistry of cellulose.

In view of the great importance of the pulp and paper industry in Canada, the value of post-graduate training along these lines cannot be over-estimated.

STAFF

TABLE

Session	1920 -21	1921 -22	1922 -23	1923 -24	1924 -25	1925 -26	1926 -27	1927 -28	1928 -29	1929 -30	1930 -31
Professors	1	2	2	2	4	4	5	5	4	5	4
Assoc. "	3	3	3	3	1	1	1	1	1	-	1
Ass't "	2	2	2	2	2	2	2	2	2	1	3
Lecturers	1	-	-	-	-	-	-	-	-	1	1
Total Senior Staff	7	7	7	7	7	7	8	8	7	7	9
Demonstrators	8	9	10	9	9	9	10	10	10	11	13
Total	15	16	17	16	16	16	18	18	17	18	22

The figures in the above table are of interest when taken with the figures in tables I and II showing the numbers of undergraduates and graduate students.

In ten years the senior staff has increased from 7 to 9, i.e. less than 30%. In the same period the increase in number of undergraduates has been from 499 to 626, i.e. about 26%.

The increase in senior staff has therefore been approximately in proportion to the increase in undergraduate numbers. When the number of graduate students is considered it is seen that the relation is quite different, since such students have increased 500% in number. To meet this situation more undergraduate lectures are now given by the younger men, thus allowing those chiefly interested in research to devote themselves more particularly to such work.

It should be understood that the researches on which our graduate students are engaged are of a type considered suitable for the training of such men. The work though of scientific value is thus limited in scope.

Another type of research, more uncertain in its results but of greater scientific interest and possibilities, is thus excluded. Such work is however most desirable from many points of view, and could be made available by the appointment of one or more paid assistants or technicians of the type met in European Universities.

ACCOMMODATION, EQUIPMENT, ETC..

A considerable portion of the elementary teaching in chemistry is carried on in the older part of the Biological Building. This work could be done more effectively if space were available in the Chemistry Building to provide an elementary laboratory for 250 students. Several research students also carry on their work in the Biological Building. This work could be done to better advantage in the Chemistry Building.

Space is desirable for small experimental units for the teaching of Industrial Chemistry and Chemical Engineering.

Special rooms should be available for gas analysis, water analysis and micro-analysis. An optical room is also desirable. Office room for even the present senior staff is quite inadequate.

The shelf room of the Baillie Library has been increased recently. It is suggested that a library, common to both the departments of Physics and Chemistry, would have definite advantages. This could be accomplished by the construction of a suitable annex common to both buildings. In order to develop the teaching of the history of Chemistry a library to that end should be developed.

The Chemistry and Mining Building is now over thirty years old and cannot be expected in its present condition to satisfy modern requirements. Much of the electric wiring is of the old type and a source of fire hazard; the water pressure is insufficient on the upper floors; drainage, in some places, is inadequate; wooden lockers in the basement present a fire hazard; ventilation from hoods and elsewhere is quite insufficient. A building devoted largely to chemistry can hardly be too well ventilated and the Chemistry Building probably is one of the worst equipped in this respect in the University. A common room suitably furnished would have great advantages particularly for our graduate students. Such a room where students could meet and discuss their work with each other, and possibly with members of the Staff would be of great value to our Graduate Faculty work.

It is therefore recommended that:-

(a) The present Chemistry and Mining Building be devoted to chemistry only.

(b) Alterations to be made in the building to provide:-

1. A large elementary laboratory.
2. More research space.
3. Space for small experimental plant.
4. Improved library facilities.
5. Rooms for special analytical work.
6. Rooms for members of the staff.
7. Proper ventilation.
8. A common room.

(c) The Building be rewired where necessary.

(d) Water pressure and drainage be increased.

(e) Wooden lockers be replaced by metal lockers.

(f) Certain laboratories be remodelled.

(g) A small refrigeration plant be installed.

GENERAL.

There are many obvious developments which would be welcomed by this department when funds are available.

Chemistry is becoming more specialised daily, and while this department largely confines its work to what are generally considered to be the fundamental branches of chemistry, certain other branches such as electrochemistry, photochemistry, etc. might with advantage be considered in the future.

This department would like to make it clear that its suggestions involving financial expenditure are made with a keen realisation that many other departments have similar needs. For this reason such suggestions have been purposely limited. It must be a matter of extreme difficulty to decide whether this department or that has the greater need.

It is respectfully suggested therefore that the appointment of a permanent small University Committee be made. The duties of such a committee would include the formulation of policies concerning the aims of McGill and the making of decisions consistent with such aims.

It is believed that a university with a definite objective has a greater chance for success than one in which Faculties and Departments each strive for their own welfare, more or less regardless of that of others.

Only those matters largely peculiar to this department are considered in this report. Subjects of broader interest such as: school training; scholarships; Sabbatical year; honours degrees; etc., are, it is believed, better considered in reports from Faculties.

F. McG. Johnson

TABLE I.

U N D E R G R A D U A T E S

TAKING COURSES IN CHEMISTRY

COURSE	SESSION 1920 1921	1921 1922	1922 1923	1923 1924	1924 1925	1925 1926	1926 1927	1927 1928	1928 1929	1929 1930	1930 1931
CHEMICAL ENGINEERS III YR	39	28	18	8	9	11	14	7	8	9	8
IV YR	34	33	31	16	9	7	8	10	9	9	7
TOTAL	73	61	49	24	18	18	22	17	17	18	15
ELEMENTARY CHEMISTRY (all faculties)	362	360	345	345	332	348	262	330	262	384	436
HONOUR STUDENTS IN ARTS	12	11	14	8	11	13	13	12	12	11	17
CHEMISTRY II;III;IV, (other than engineers and honour students)	37	32	41	44	57	135	121	133	147	160	140
ADVANCED COURSES (other than engineers and honour students)	15	11	22	15	12	16	16	27	20	17	18
TOTAL	499	475	471	436	430	530	434	519	458	590	626

T A B L E   II.

YEAR	1919 1920	1920 1921	1921 1922	1922 1923	1923 1924	1924 1925	1925 1926	1926 1927	1927 1928	1928 1929	1929 1930	1930 1931
Total number of Students in the Graduate School	8	8	10	15	18	24	26	31	32	35	38	50
Number obtaining M. Sc. degree	2	3	2	5	7	4	6	5	3	6	5	
Number obtaining Ph. D. degree	3	2	0	7	3	5	6	6	8	15	9	

TABLE III.

Positions held at present.	Specializing in Physical Chemistry	Specializing in Organic Chemistry	Total
Permanent member of staff in a Canadian University	12	3	15
On staff of Government Laboratory in Canada			
(a) Forest Products	3	1	4
(b) Research Council	2	6	8
(c) Biological Station	1	1	2
On Research Staff of a Canadian Industry	4	9	13
Further study at foreign University holding scholarship with intention to return to Canada	1	3	4
Permanent member of staff in an American University	4	2	6
On the Research staff of an American Industry	5	7	12
	32	32	64

TABLE IV.

Ph. D.'s who held National Research Council Scholarships.

Positions held at present.	Specializing in Physical Chemistry	Specializing in Organic Chemistry	Total
Permanent member of staff in a Canadian University	12	2	14
On staff of Government Laboratory in Canada			
(a) Forest Products	2	1	3
(b) Research Council	2	6	8
(c) Biological Station	1	1	2
On Research Staff of a Canadian Industry	4	7	11
Further study at foreign University holding scholarship with intention to return to Canada	1	3	4
Permanent member of staff in an American University	1	1	2
On the Research staff of an American Industry	5	5	10
	28	26	54

- 7 -

TABLE V.

TABLE SHOWING DISTRIBUTION OF PH. D.'S BETWEEN CANADA AND THE UNITED STATES.

	Specializing in Physical Chemistry		Specializing in Organic Chemistry	
	Permanent position in Canada	Permanent Position in U. S. A.	Permanent Position in Canada	Permanent Position in U. S. A.
Ph. D.'s	23	9	23	9
Ph. D.'s who held National Research Council of Canada Scholar- ships.	22	6	20	6

TABLE VI.

Positions held at present.	Maass	Johnson	Ruttan	Whitby	Hatcher	Hibbert	Total
Permanent member of staff in a Canadian University	9	3	2	1			15
On staff of Government Labobatory in Canada							
(a) Forest Products	2	1		1			4
(b) Research Council	1	1	2	3		1	8
(c) Biological Station	1					1	2
On Research Staff of a Canadian Industry	4			3	4	2	13
Further study at foreign University holding scholarship with intention to return to Canada	1			2		1	4
Permanent member of staff in an American University	4			1		1	6
On the Research staff of an American Industry	5		1	4		2	12
	27	5	5	15	4	8	64

REPORT OF THE DEPARTMENT OF CIVIL ENGINEERING AND APPLIED MECHANICS.

This report deals mainly with the affairs of the Department during the past ten years. The many changes which have occurred in this period in regard to personnel, laboratory facilities, courses, numbers of students, etc. are recorded. The organization and general policy of the Department are described, so as to give a picture of its functions in regard to undergraduate teaching, to the services rendered to engineering industry by special investigations and routine laboratory tests, and to professional and scientific bodies through the participation of the staff in the work of various committees of such organizations.

A statement on graduate work is made in a separate report to the Faculty of Graduate Studies and Research.

Laboratories.

The Department administers the following laboratories:

Hydraulic Laboratory.

Highways Laboratory.

Strength of Materials Laboratory.

The construction of the new Electrical Building and the consequent release of space in the Engineering Building, made possible an extensive rearrangement of our laboratories. The Hydraulic laboratory was expended to occupy some five times as much floor space as hitherto, and a considerable amount of new equipment was added. This included an experimental turbine with interchangeable runners of the latest types, centrifugal pumps, experimental pipe line, and many improvements to existing apparatus. The original laboratory had been entirely inadequate, even for undergraduate work, and considering the growing importance of this subject in Canada, especially in recent years, the necessity for strengthening our facilities had become pressing. We are now equipped to cover undergraduate work satisfactorily, and can also provide for graduate research investigations where flows of water not greater than 10 c.f.s. are required. This flow is obtained by recirculating the water through our own pumps, as our connections with the city mains will not provide this amount. The space allotted to hydraulic work is fully utilized, but the piping was laid out so that connections for temporary work can be made at many points. The cost of new equipment, structural and installation charges, was within the estimates and a small balance remained by which additional equipment has been purchased from time to time as the needs became apparent in operating the laboratory. All engineering services in connection with the remodelling of the building involving extensive changes, and with the design and installation of the equipment, were furnished by the staff of the Department. The only expenditure for such services was the salary of a draughtsman for a few weeks. Apart from the reinforced concrete construction involved, all the work was carried out by the staff of the Supervising Engineer of the University.

It may be mentioned that through the courteous cooperation of the owners of the Back River Power development, recently completed, and at no cost to the University, a small section of the dam was so constructed as to provide for hydraulic experiments involving the use of much larger quantities of water than are available in the laboratory. This provision makes possible the carrying out of certain kinds of tests either by the Montreal Island Power Company or by this Department, whenever desired.

The Highways laboratory occupies a room in the basement of the Engineering Building, in close proximity to the Strength of Materials laboratory. It contains the necessary equipment for conducting standard tests of highway materials as well as some apparatus which was built for use in special investigations. The laboratory courses are designed to familiarize students with the peculiarities of the materials with which they will have to deal.

This laboratory has been freely used by municipalities and railways. Thus, for example, over one hundred samples of filter sands were investigated during the construction of the latest extension of the filtration plant of the City of Montreal, and many samples of rock ballast have been tested for the Canadian Pacific Railway Company.

Numerous research projects of practical value could be carried out if someone, such as a graduate student, were available to devote the necessary time to them. Up to the present, however, no graduate students have specialized in such work.

Some additional space was made available in the Strength of Materials laboratory by the re-arrangement of the Hydraulics laboratory, mentioned above, and this has eliminated unsatisfactory congestion. New equipment acquired includes a set of Johanssen standard dimension blocks, and an Amsler box for the calibration of testing machines up to 100,000 lbs. capacity, both in tension and compression. This standard calibrating device has been most useful not only in our own laboratory, but in the calibration of testing machines in industrial plants in Montreal, this service being rendered at a reasonable charge as a part of the commercial work done in our Testing laboratory. A set of Hugenberger extensometers, and a complete equipment for photo-elastic measurements of stress, have been donated recently by Mr. C. M. Morssen, Honorary Research Fellow in the Department. No new major equipment has been added with the exception of that donated by the Imperial Munitions Board at the end of the war, but existing testing machines have been maintained in a proper state of efficiency by repair and renewal of parts.

In general, the laboratories serve adequately the needs of our undergraduate courses, and we are well equipped for certain kinds of work in the Graduate School. In research work, it has been our general policy to investigate problems closely allied to contemporary engineering practice, and our limited resources have been used to build up a thoroughly good equipment for certain classes of work, particularly in structural engineering, rather than to provide inadequately in a larger field.

Our equipment is also available for commercial testing work, a considerable amount of which passes through our laboratories. Broadly speaking, we undertake work of a special character, which, for one reason or another, cannot be performed satisfactorily by commercial laboratories. Our commercial testing varies from simple routine investigations, such as tensile tests of specimens of wire rope, to most elaborate investigations, such as those on pin friction and the strength of eyebars in connection with the design of the Quebec Bridge. The procedure followed depends on the nature of the investigation. Routine work is performed by our permanent laboratory staff under the supervision of a member of the staff of the Department, who takes the responsibility for and signs the reports of tests. Until his death last October, the late Dean MacKay looked after this work. Investigations involving original research are usually under the direction of a member of the staff of the Department. Occasionally our facilities are placed directly at the disposal of the representatives of the organization making the test, the equipment being operated under our supervision. In this way we render very useful service to the profession, in solving special problems which arise and in aiding new development. Reasonable charges are made through the Testing Fund for such work.

Among recent investigations supervised by members of the staff, the following may be mentioned:-

Tests on Pin Friction.	Quebec Bridge.	Dean MacKay and Professor Brown.
Steel Beams Haunched with Concrete.	Dominion Bridge Company.	Dean MacKay.
Behavior of Ice under Pressure.	St. Lawrence Waterways.	Professor Brown.
Tension Splices for Timber.	Highway Bridge Construction.	Professor Jamieson.

The designers of the Back River Power development made use of the facilities of our Hydraulic laboratory in making an elaborate series of tests on models in connection with the design of the hydraulic features of the power-house, where unusual problems arose owing to the seasonal fluctuation of river levels. A small experimental model of the hydraulic turbines used in this development was built specially for these tests, and was donated to the laboratory by the Montreal Island Power Co. on completion of their work.

Number of Students.

Undergraduates become students in this Department proper, only in their third and fourth years. Their numbers have varied considerably during the period under review. The congestion of the immediate post-war years gave place to much smaller numbers as in other departments. Similar reductions occurred in engineering schools generally as the profession was overcrowded and industrial conditions unfavourable. More recently the numbers were influenced by the change made in entrance requirements in 1927. The numbers are again on the increase, as will be seen in the following table:-

Session	Total undergraduates in third and fourth years.	Number of graduates
1919-20	33	19
1920-21	37	17
1921-22	43	20
1922-23	43	21
1923-24	38	23
1924-25	31	13
1925-26	25	18
1926-27	17	13
1927-28	13	6
1928-29	18	8
1929-30	26	16
1930-31	34	-

During the current session there are 16 fourth year students and 18 third year students in the Department.

Graduate students have averaged one each session, some of these have come from other universities. Occasionally there have been two graduate students in a single year, doing structural work. It would be difficult to provide for a much greater number per year in this branch (assuming that a thesis based on experiment is to be submitted) owing to the necessity of setting aside a testing machine for the experimental work. Since the completion of the hydraulic laboratory previously mentioned, facilities are available for graduate work in hydraulics and two graduate students are doing hydraulic work this session.

Staff.

Numerous changes have taken place in recent years in the staff of the Department. Those involving members of professorial rank only are noted. Dr. Batho resigned in 1923,after many years of service, to accept the Chair of Civil Engineering at the University of Birmingham. The death of Professor H. M. Lamb in 1924 and of Dean MacKay in 1930, were severe blows to the Department. Professor F.M. Wood joined the staff after the death of Professor Lamb and took over the work in Railway Engineering, giving also some lectures in Mathematics and assisting generally in the laboratory and draughting-room work of the Department. Professors Jamieson and Dodd shared to an increasing extent in the work in Strength of Materials and Structures previously undertaken by Prof. Lamb. They also assisted Professor MacKay in the draughting-room work of fourth year students in Bridge Design and Theory of Structures. Their responsibilities were increased after Professor MacKay became Dean, and at the time of his death they were very largely responsible for this work under his general direction.

At the beginning of the period under review, the teaching staff of the Department consisted of three professors, two associate professors, and three lecturers. At present the staff consists of two professors, one associate professor, and two assistant professors. A considerable portion of the teaching work of the Department is in courses which are common to a large proportion of the students. Thus, in the second year, Engineering Reports and Mechanics are obligatory for all students except those in Architecture; in the third year, Strength of Materials and Strength of Materials Laboratory are in the same category, while Structural Engineering is required of all except students in Electrical Engineering; and in the fourth year, Hydraulics and Hydraulic Laboratory are general courses for all students. It is apparent therefore, that the number of students in the Department is not a measure of the teaching work required of the staff. Moreover, it has been a long-established practice for this Department to cooperate with the Department of Mathematics, in that certain members of our staff have also done considerable teaching work in Mathematics. This policy has worked to the mutual advantage of the Departments, both from the viewpoint of economy and teaching efficiency, and has produced very satisfactory results.

On the death of Dean MacKay last October arrangements were made for carrying on his teaching work during the present session. Professors Jamieson and Dodd took over his lectures to third and fourth year students, and were relieved of some teaching in Mathematics, which was undertaken by Prof. Wood. The duties of the Dean's office were assumed by Professor Brown who, in consequence, was unable to share as actively as heretofore in some parts of the laboratory and draughting-room work. Our staff is now at a dangerous minimum and there is practically no leeway, should any member of it become incapacitated through accident or illness. Re-organization and strengthening are urgently needed.

Changes in Courses.

In 1921, following the abolition of shopwork a re-arrangement was effected in the course in Mechanics given by this Department to second year students. A lecture course in Mechanics had been given previously in the first term only, and was followed by a course in Graphic Statics in the second term. This resulted in a serious interruption in study for those who were required to take Mechanics in the third year. The courses in Mechanics and Graphic Statics were combined, and provision made for two lectures per week together with a two-hour problem period per week throughout the year. This arrangement has proved satisfactory on the whole, and the introduction later on of a course in Engineering Problems in the First Year has helped to co-ordinate the study of Mechanics.

The course in Engineering Problems referred to, consisting of problem practice for three hours per week throughout the session, was organized by this Department. The work is carried on by our staff with the assistance of Professor Weir of the Department of Surveying and Geodesy.

After experiencing difficulty for many years, in developing a reasonable proficiency in the students of the Faculty in the writing of English and the preparation of reports, it was decided to establish a course in Engineering Reports in the Second Year. The course has been organized and directed by Professor French, assisted by Professors Wood and Weir. One lecture per week is given throughout the session, and a two-hour period per week is allotted for practise in writing engineering specifications, business letters, etc., and in public speaking. This course has now been in operation for three years, and it is believed that definite progress has been made. As outlined in the general report of the Faculty, we believe that the value of such a course can be greatly increased by extending it to other years.

There have been no fundamental changes in third or fourth year courses during the period. Changes in subject matter and details are made from time to time in conformity with contemporary engineering practice, without changing the broad general policy of the Department. It is felt that, at any rate for undergraduate courses, the fundamentals do not change materially, and that it is the grounding in these fundamentals which is essential.

Staff Contacts.

It has been the considered policy of the Department to encourage its members to make commercial and technical contacts by engaging in engineering work as opportunity offers, and by serving as members of various technical committees associated with professional work. This develops in the younger members of the staff, a self-confidence which is a valuable asset, and enhances the effectiveness of their teaching. Students quickly appreciate a man who not only teaches, but practices what he teaches, and there is a distinct gain in prestige in the eyes of the student and of those who employ our students when an instructor is known to display a knowledge of his subject which practical application only can give. In addition to engaging in engineering practice our staff have given generously of their time to the work of numerous professional engineering societies, and of national engineering and research organizations. They have been honoured by appointment as members of advisory boards in connection with important engineering projects, and in many ways have added to the prestige of the University and of the Department. The following bodies may be named as typical of those on which different members of our staff have served, or are serving, or for which they have carried out important investigations:-

Committees of the National Research Council.

Committees of the Canadian Engineering Standards Association.
(Main committee and committees on preparation of standard specifications for concrete, reinforced concrete, and various types of bridges.)

Canadian Electrical Association - Hydraulic Power Committee.

National Electric Light Association - " " "

Advisory Board - Montreal Harbour Bridge.

St. Lawrence Bridge Company - Erection of Quebec Bridge.

Council and Education Committee of the Engineering Institute of Canada.

City of Montreal Technical Commission.

Board of Engineers of St. Lawrence Waterways.

Department of Bridges - Government of New Brunswick.

Dominion Fire Prevention Association.

Positions held by graduates.

Graduates of the Department are to be found occupying positions of the highest responsibility in all parts of Canada, and in many other countries. In the engineering departments of the Government service, and of our railroads; in the construction of our great canals, harbours, and hydro-electric plants; in all kinds of structural work, whether in steel or reinforced concrete, and in many other fields of engineering work, distinguished service has been and is being rendered by men who have passed through our course. Positions requiring the exercise of great executive ability combined with technical knowledge are held in all branches of engineering activity. In university work, high distinction has been gained, as the chairs of civil engineering at Dalhousie, Winnipeg, Edmonton and Vancouver have all been occupied by our graduates. No attempt will be made to list the names of graduates in high positions, but personal knowledge of a large number of individual careers enables us to claim for the Department a large share of credit in the development of the Dominion, through the creation of its vast transportation systems, and the utilization of its natural resources.

Future policy and needs.

The notable additions to laboratory space made during recent years will enable us to meet adequately the requirements of undergraduate courses, and of some special branches of graduate study, provided reasonable appropriations are available for upkeep and new equipment. The extensive character of the service rendered to industry through our laboratories has been emphasised, and it is important both from the view point of teaching efficiency and of our ability to continue to serve the reasonable demands of industry, that our equipment be kept up-to-date. Such equipment may at times be relatively costly and involve special appropriations, but in laboratories in which the depreciation by wear and tear is small, as is the case with testing machines and a large part of our hydraulic equipment, provision should be made for meeting proportionately large expenditures for new apparatus at irregular intervals. Appeals for such appropriations must inevitably arise, and while the existing laboratory situation is on the whole satisfactory, the necessity for larger appropriations for new equipment must be faced. At present, certain unexpended balances from the capital sums allotted for providing the new Hydraulic and Highways laboratories are available, as the work was carried out within the estimates. When these funds are exhausted, a sum of at least $500.00 per year should be allotted for new equipment instead of $200.00 as at present. It would probably be of some advantage to be able to carry over unexpended balances as is now being done from capital account, because from time to time apparatus costing more than say $500.00 would be needed in one year. The necessity for appeals for special amounts could never be eliminated, but some freedom of expenditure over two or three years within the limits of total amounts corresponding to an accepted annual allowance would be of assistance in planning for the purchase of new equipment.

Changes made recently in our courses are working out satisfactorily and no radical revisions are contemplated. Gradual change and re-adjustment are more commendable. We are satisfied that our general policy of working in co-operation with the Department of Mathematics is a good one from every stand-point, and should be continued.

The question of staff is our most serious problem at the moment, and steps should be taken to build up a junior group capable of carrying on the traditional policy of the Department. Sound knowledge of engineering principles and of fundamental mathematics, combined with distinct teaching ability, are the qualifications necessary to enable an instructor to bear a proper share of responsibility in the Department, and to assist in the teaching of mathematics. The teaching duties of the late Dean MacKay, both in graduate and undergraduate work, as well as his administrative duties, have all been carried during the session now closing by various members of the Department, and serious difficulties would have arisen had any one of them been incapacitated.

The demands on our staff are determined largely by the total number of students in the Faculty, as a great amount of instruction of a fundamental character, required of all students, is given by the Department. We have at present no leeway in the personnel of the Department and additional junior members of high calibre are needed to fill the breach in case of emergency. The burden of a large amount of undergraduate teaching of fundamental subjects in first, second and third years is a heavy one, and the staff must be strengthened to cope with it adequately.

The question of establishing a research professorship should also be considered as a part of the general problem. Such a professor, while devoting his time mainly to research, would take some share of undergraduate work, and would be available as a substitute.

The satisfactory settlement of the staff problem is our most pressing need, and everything possible should be done to place our organization on a sound and stable basis, having in mind all the conditions created by the death of Dean MacKay, and the recognition due to those who assisted him in his teaching work during recent years and who have carried the teaching burden since his death.

E. Brown.

April 15,1931.

R.DL. French

REPORT ON THE DEPARTMENT OF ELECTRICAL ENGINEERING.

During the period from 1920 to 1925, the Department of Electrical Engineering had very little opportunity for expansion. Undergraduate instruction was carried on in a satisfactory manner, and minor changes in the curriculum were made to meet the changing conditions in the electrical industry, but little new apparatus was added to the equipment of the laboratories, and a comparatively small amount of research work and post-graduate work was done. Dr. Herdt took an active part in solving the electrical problems confronting the city of Montreal more especially in the work of the Tramways Commission and as Chairman of the Electrical Commission, which designed the underground conduit system for the city.

In 1925, the Electrical wing was built, providing new and large quarters for the department. A grant of $5000.00 was made to provide for the establishment of a Communication Engineering laboratory and an Electrical Measurements laboratory. A course of two lectures per week was offered in Communication Engineering, in which the department had the valuable and active assistance of the Department of National Defence at Ottawa, who very kindly made available the services of Colonel W. A. Steel, who lectured for two years in Radio Communication, and assisted in the procuring and construction of laboratory apparatus. These lectures have now been taken over by F. S. Howes, Ph.D., a regular member of the staff, but the valuable contact with the Department of National Defence is still maintained.

At the same time (1925) the course in Electrical Measurements which had been given by the Department of Physics, was transferred to the Electrical Department, and both the lectures and laboratory work were taken over by Professor G. A. Wallace. The equipment of the Electrical Standardizing Laboratory was expanded and made available for the students in this course. This equipment had been very largely purchased from funds received for commercial standardizing work carried on by members of the staff.

The grant of $5000.00 was not sufficient for the equipment of these two laboratories, but by very careful buying, and by construction of some necessary apparatus, and through gifts from various electrical companies, reasonably adequate equipment was eventually secured.

The content of the course in Electrical Engineering has been modified from time to time by replacing courses of lesser general utility, by courses designed to fit graduates for their positions in industry, but the greatest care has been exercised to maintain the fundamental character of the instruction. Great stress has been laid on the solution of engineering problems and an increasing amount of time has been devoted to this type of work to the great benefit of the students. A short course in modern physics was added in the third year, so that the students would maintain their contact with the department of physics. When the course in Communication Engineering was first organized it was offered as an alternative to some of the other more specialized subjects in the curriculum of the fourth year, but it has now been incorporated in the in the regular work taken by all graduates in electrical engineering.

Changes in the courses have been discussed with engineers and others in the larger corporations employing our graduates, and it is a great satisfaction to be able to report that in every case our decision to teach only fundamental subjects and to refrain so far as possible from specialization was heartily approved by them.

It must be recognized that the field of electrical engineering has broadened very materially during the last ten years due largely to the developments in radio communication, and it is becoming more and more difficult to present a balanced course of only four years which will prepare our graduates to follow any one of the roads open to them.

Power Engineering Laboratories.

The equipment of the third and fourth year power engineering laboratories has been improved by the addition of three motor generator sets, and by the construction of four transformers. The metering equipment has been increased, and last year a modern oscillograph was purchased.

The requirements of undergraduate instruction in the laboratories are reasonably well met, but much of the apparatus is so old that heavy expenditures are required for its upkeep, and a great deal of it must be replaced in a short time.

Graduate Studies and Research.

The department offers instruction in a number of graduate courses for men wishing to proceed to the degree

M.Sc.or M.Eng., but in many branches the laboratory equipment for graduate work is inadequate.

The following courses are offered:-

(a) Design of Electrical Machinery, Special problems of design.
Professor Christie.

(b) The protection of Electrical Power Systems. Professor Burr.

(c) Stability of Electrical Systems under normal and transient conditions; determination of short-circuit currents; design of generators and excitation systems for maximum stability.
Professors Christie & Burr.

(d) Inductive coordination of Power and Signal Systems.
Professor Wallace.

(e) Electric Circuit Analysis, The general theory of electrical networks composed of constant circuit elements. Dr.Howes.

(f) Advanced Wire Transmission Theory. Professor Wallace.

The Thesis may be in one of the following fields of investigations:-

Design of Electrical Machinery, Properties of Dielectrics and Electric Insulators, Electric Measurements, Protective Devices, Power System Stability under Normal and Transient Conditions, Inductive Coordination of Power and Signal Systems, Telephone Transmission Circuits, Radio-frequency Measurements, Acoustical Measurements.

Research Problems:-<u>Professor Wallace</u>.

(a) Research in connection with transmission networks, filters, attenuation equalizers, phase distortion equalizers,

(b) Investigation of influence of power circuits voltage waveform on interference induced in Communication circuits.

Dr. Howes.

(a) Investigations in connection with radio-frequency circuits, rectification of high-frequency, generation and detection of ultra-short waves. Signal strength investigations.

(b) Development of means of measuring directly velocity, pressure and energy in audible frequency sound waves.

High Voltage Laboratory.

The high voltage laboratory when it was originally installed in 1900, gave McGill a commanding place in the field of high voltage measurements, and testing. Some additions to the equipment were made in the intervening years but today, thirty years after the establishment of this laboratory, the equipment remains practically as it was at the beginning of this century, when the electrical industry was in its infancy. This equipment is very useful for commercial testing up to 200,000 volts, but is showing signs of its age and requires heavy expenditure for its upkeep.

This laboratory is large enough to house a 500,000 volt transformer, and such equipment should be provided as soon as possible.

For research work in the important field of dielectric materials, cables, etc. no equipment is available.

Standardizing Laboratory.

The Electrical Standardizing Laboratory at McGill occupies a very important place among the standardizing laboratories in this country, and its certificates are accepted without question, but the equipment of this laboratory is rapidly becoming obsolete, and the present standing of the laboratory cannot be maintained unless modern apparatus is provided.

During the last year, two power contracts were made representing an annual payment of over four million dollars in both of which it was stipulated that the measuring instruments were to be calibrated at the Standardizing Laboratory, McGill University.

Cooperation with Industry.

That the members of the staff are alive to their broader responsibilities in the field of industry and in the various scientific activities of government bodies, is evidenced by the list of committee affiliations listed below.

C. V. Christie.-Macdonald Professor of Electrical Engineering.
Head of the Department of Electrical Engineering.
Member of Corporation, McGill University.
Member of the Associate Committee on Physics & Engineering Physics of the National Research Council
Member of the Main Committee, Canadian Engineering Standards Association.
Chairman Electrical Section Committee, C.E.S.A.
Member Subcommittee on Inductive Coordination, CESA.
Member Committee on Electrical Measuring Instruments, C.E.S.A.
Member of Council, Engineering Institute of Canada.
Chairman Engineering Section, Canadian Electrical Assoc.
Member Inductive Coordination Committee, C.E.A.

Member Executive Committee, Engineering Nation Section.

National Electric Light Assoc.

Member Inductive Coordination Committee, N.E.L.A.

Member Transmission & Distribution Committee, A.I.E.E.

Member Sectional Committee on Electrical Definitions of the American Standards Association.

Chairman Subcommittee, Rotating Machinery, A.S.A.

Professor G. A. Wallace.- Associate Professor of Electrical Engineering.

Member Subcommittee on Electrical Measuring Instruments, C.E.S.A.

Member of Subcommittee on Inductive Coordination, C.E.S.A.

Chairman Subcommittee on Conductive Coordination, C.E.S.A.

Member Inductive Coordination Committee, C.E.A.

Member Inductive Coordination Committee, N.E.L.A.

Professor E. G. Burr.-Member of Main Committee, C.E.S.A.

Vice Chairman, Sectional Committee on Electrical Work, C.E.S.A.

Member Subcommittee on Conductive Coordination, C.E.S.A.

ADDITIONS REQUIRED IN THE DEPARTMENT.

For undergraduate instruction and for the maintenance and upkeep of the main laboratories, the present appropriations are adequate. This does not refer to the salaries of the members of the staff.

For the development of suitable laboratory equipment for research the following sums are required:-

For electrical measurements and communication --- $5000.00

For dielectric measurements and investigation of dielectrics ---------------------------------- 2000.00

For proper equipment of the high voltage laboratory -------------------- $12,000.00 to $15,000.00

Appropriations should be provided for two junior demonstratorships tenable for two years, giving the holder the opportunity of obtaining the degree of M.Sc. or M.Eng. in two years, while serving as a part time demonstrator in the department.

2 x $750 = $1500.00 per year.

With the above equipment, valuable engineering research can be carried on, which will grow in importance from year to year.

<u>Salaries of the Teaching Staff.</u>

The salaries paid to members of the regular teaching staff are not sufficient to enable the men to live comfortably, and they must be supplemented from sources outside the University.

While consulting work and the carrying out of special investigations are advantageous, in that they keep the members of the staff in close contact with those industries for which they are training men, they take up the time which might otherwise be employed in scientific research.

C V Christie

Head of the Department.

REVIEW OF MECHANICAL DEPARTMENT.

1920-1930.

During the war the attendance fell off to practically a minimum. It was as though a dam had been placed in the flow, so that after the war was over we were swamped with students. In the figures given below the "total students attending" in the third year refer only to those taking engineering and do not include architectural students.

Year.	Total Students attending 3rd. Year.	Mechanical 3rd. Yr.	Percentage.	Mechanical in 4th. Year.
1919-20	107	14	13	14
1920-21	143	26	18.2	15
1921-22	190	46	24.2	33
1922-23	164	29	17.5	47
1923-24	93	30	32.6	27
1924-25	71	12	16.9	28
1925-26	57	7	12.2	13
1926-27	52	6	11.5	6
1927-28	57	10	17.5	7
1928-29	74	17	23	11
1929-30	55	13	24.5	17

These figures show the effect of the slump in business conditions in 1920 and the years immediately following and also the effect of increasing the entrance requirements in 1927-28.

Equipment.

The equipment in our department was allowed to run down during the war as we were unable to get competent help. Much of the equipment was over twenty years old and was none too good in 1914. Our instruction suffered also due to the fact that we had no room for new apparatus. All the apparatus used for internal combustion work was housed in a lean-to against the Mining Building. This was difficult of access and a most unattractive place in which to work. The pressure on the boilers had been reduced by the boiler inspector to seventy pounds per square inch where originally it had been one hundred and twenty-five pounds per sq.in.

We were fortunate, after the war, to get a very efficient man as laboratory engineer. We repaired, properly, such of the apparatus that was worth saving and scrapped the rest. We endeavored to carry-on with what we had, augmented by some new machinery that we simply had to have until it was decided to do away with the pattern-shop, foundry and smith shops.

The Mechanical Engineering Department was given a portion of the space vacated by these and an up-to-date well equipped internal combustion laboratory was installed. This marked the great advance made in the material equipment of the Department during the period of years covered. Later, all the antiquated apparatus in our boiler-room was removed and a new 385 pound B. & W. boiler was installed, complete, with pumps and accessories. At the present time therefore, we have examples, in good running order, of most of the apparatus used in the production of steam, oil and gas power.

We have also most of the up-to-date small apparatus for testing fuels, high speed engines and high pressure machines.

When the shops were eliminated, one was kept. This was the machine-shop. This is used as a laboratory for the mechanical engineering students taking the industrial engineering option and as a repair shop for the other departments. We do not use this shop as a place where the students get training as artisans, primarily, but as a laboratory where time studies are carried out. So we are provided in part with a laboratory where industrial engineering, so-called, may be studied.

Background.

Before going into the subject matter taught it might be well to consider the background of our course as evidenced by the demands made by employers for our students.

Among the reasons why many of our students choose one course in preference to another is their chance of getting a position when they graduate. So that if the graduating class in any one department has difficulty in finding positions, I find that two years afterwards the number taking the course has decreased.

What kind of work do our mechanical men usually get when they graduate? The question is hard to answer for they go into such a variety of work, governed by the variety offered. Ten years ago employers were not as anxious to get technical men as they are to-day and so to-day the opportunities are far broader than ten years ago. It so happened that the Pulp and Paper industry was having a great boom about 1920 and many of the graduates of the years just preceeding and following that date went into the industry. I think I can safely say that there is not a mill from Vancouver to Newfoundland that has not a graduate of McGill in the mechanical engineering in its employ either in an engineering or executive capacity.

At present there is a big demand for sales engineers. The demands are from such diverse industries as "Life Insurance" to"Furnace" builders. The request comes to us to give the men a thorough training in engineering and the employer finishes the education of the student in his own specialty.

It would seem therefore that our ideal, in as far as the employer is concerned, should be " a broad general foundation in mechanical engineering". Practice in specialized subjects coming after graduation.

Teaching in general.

What should be our ideal and how shall we measure our attainment.

Our ideal should embrace the following:-

1. An endeavor to make the course sufficiently broad and comprehensive so that our students are sure of what they know and not so broad that the treatment of the subjects is

superficial.

2. The subject matter should be of such a nature that its applications are general in theory and illustrated by specific problems. In other words given a problem, the student may attack it with honesty and some hope of success.

3. The method of presentation should at all times be such that the objective of the lectures is clear and emphasis placed on the necessity of clear reasoning and honest interpretation of results.

What measure of success the teachers in the Department have obtained is difficult to measure for the standard to be used is not known.

Is the Undergraduate reaction a good standard? Oftimes no, because their opinion is likely to be biased by their personal feeling for the teacher. An unpopular lecturer may give an excellent course while the reverse may be true. Still as the courses are given to the Undergraduate if they are not apprehended or for any reason the course is not found interesting, in fact is found to be boring, then the course is not a successful course in the broad meaning of the term. Unfortunately it is only from the Undergraduates themselves that his information can be obtained, though most teachers know whether they are getting any positive reaction. As Head of the Department I hesitate to question any student on the work of my colleagues. However when I have heard from any source, an expression of dissatisfaction I have always endeavored to aid the situationwith advice and sympathy.

Shall the success of our graduates be the criterion? As we prepare our men for a more or less definite objective this would seem to a fair standard for measurement. However it often happen that the successful student after graduation is not one whom we thought would have done well. Those men who are fortunate enough to find, early in their career, a place where their talents are used and appreciated are the ones who succeed. Others equally well equipped sometimes, alas, do not get properly placed and are ranked as failures.

Should we measure our success by the opinion that the Employers have of our graduates?
As they use the finished product it would seem that in the final estimate of success or failure their opinion should carry weight. Here however we are met with difficulty.
We may recommend a man to them whom we think will be suitable but after he starts working the Employer finds him too slow, careful, unaggressive or lacking in initiative and because of this damns the University. On the other hand the Employer may get a man, who in temperament social standing and training just suits his needs and the the University is wonderful.

To sum up briefly I can honestly say that during the past ten years I know of but few criticisms levelled at the subject matter given by the teachers in the Mechanical Engineering Department and so assume that most of the material in the lectures has been within the limits set by our ideal and has been presented in a reasonably interesting way. I would be the last to say or think that either the teachers or material have been ideal nor that they could not be improved, but I will say that every member of the Staff has been conscientious, loyal and honest to the best of his ability, in the presentation and preparation of his work. We may lack in ability but not in desire to do our work well.

The Graduates of the Mechanical Engineering Department have been as a rule fairly successful. Some have risen to positions of responsibility in both the executive and engineering departments of the firms employing them. The majority have had no difficulty in obtaining positions and keeping them. I should say in all honesty that the business conditions have affected the mechanical engineering branch of industry probably least of all branches, so that this factor has in part helped in this condition. Those of our graduates who return to Montreal and have taken time to drop in to see the various members of our staff, and they are many, have offered suggestions and appreciation of the work attempted. The spirit in which the majority of the suggestions have been offered has seemed to me to have been friendly, though some have been biased by personal opinions of the Lecturer. The graduates, on the whole, in my opinion, based on many conversations, appreciate our efforts and have received valuable help in their profession.

Subject matter of the courses.

Without going into too much detail it is enough to say that the main courses in the Department have not been greatly changed in their fundamentals during the past ten years. The subject matter has been kept up-to-date in so far as methods of attack and new theories have been developed to explain or improve methods of solving vexing problems. In the main courses there is so much that is fundamental that it is difficult to change the subject matter of the courses very materially. The laws of nature do not change- only our understanding of them. So it is in the field of understanding and application that the change has taken place.

I may say that when the shops were eliminated some drastic changes took place in the courses in the first and second years. A course in Shop-Methods given to the first and second years was dropped. The courses given in Mechanical Drawing which were given in the Mechanical Engineering Dept- were placed under the direction of the Department of Descriptive Geometry and Drawing for administration. The Mechanical Engineering Department still retaining a supervision of the course itself.

There has been one great change in industry which has taken place during the last ten years and that is in the study of the method of organization and managing the business itself. This is called by the broad term Industrial Engineering.

Such problems as how to organize, manage and operate a business efficiently, come under this general heading. In 1923 an attempt was made to meet this need by the introduction of an option in the third year. Our idea was not to change greatly the general fundamental course in Mechanical Engineering but to graft onto that an option which would enable a student to get more of management and less of the advanced work in Engineering subjects. This course has been broadened and enlarged since those early days and is now a real grind for those taking it.

With the great attention given to Aviation at the present time it was but natural that we should consider this subject. After due consideration it was felt that it would be wiser to leave this out of the course as a major option and give only those courses which would prepare a man to take a post-graduate course at some other University. Correspondence was taken up with the Mass. Institute of Technology, and they agreed to take our men upon graduation if we change our course slightly giving the students more mathematics and Theory of Structures. This we have done. So that a man electing this option takes Calculus for one term in the third Year as an extra and also one term of advanced Theory of Structures in the fourth. These in addition to a course given on aerodynamics in the Department satisfies the Mass. Institute of Technology entrance requirements. I understand that this is a very unusual concession.

Teaching Staff.

The Staff consisted in 1919-20, of one Professor, one Associate Professor, three lecturers, six Demonstrators and instructors. To-day the staff consists of two full-time Professors, one part time Professor, two Assistant-Professors, one lecturer, one part time Demonstrator and one Instructor. The decrease in demonstrators and instructors being caused in part by the decrease in students and the elimination of the shops.

There is in all our minds the desire to get the very best of instructors in our Department, but this is not always possible.

I suppose that there are a thousand schools offering instruction in some phase of Mechanical Engineering, all looking for the best man at the minimum price. When we think that for each Head in the Department of Mechanical Engineering, there are from three to ten assistants, we get some idea of the number employed in this branch. On the other hand the opportunities offered to Graduates of Mechanical Engineeiring in industry are so much more alluring than offered in teaching, that it is not surprising that it is difficult to get the most promising Graduates in Mechanical Engineering to go into the teaching of Engineering. I imagine that his holds true in all Departments though not to quite the same extent as in Mechanical Engineering.

Relations with the Public.

The Department has at all times endeavored to meet representatives of Industry with sympathetic consideration. There are many problems coming the general headings of Power development, steam boiler economy, heat transfer and new inventions upon which an independent unbiased opinion is wanted and it is in this field that we have been of most assistance. Many inventions which cover such diverse fields as perpetual motion and furnace design have been submitted for opinion or test, and opinion and test.

Several important investigations have been carried on.

i.e.:-

By Professor McKergow - On the design of extended surfaces for steam and water radiation.

By Professor Roberts. - Heat Losses in Paper Mills.

By Professor Coote - Automobile costs for the Tariff Board.

By Professor Patten - The insulation value of certain building materials.

By Mr. McCurdy - On the power developed by tug-boats of varying design as used in the Pulp and Paper industry.

These were all financed by different firms and the results were therefore given to and used by the firms paying for the work.

A number of researches have been carried out under the direction of Professor Roberts on the Lubrication of Surfaces by Oil. He is at present engaged in working up his results and it is hoped that a report on his work may be made public.

The Future.

What of the future? Has dry rot settled in our Department and are we satisfied to continue as we have been doing?

In this department all the teachers are graduates of McGill University. Professors McKergow, Roberts and Coote have all had some outside experience in industry in addition to their teaching work. Professor R. H. Patten has had little continuous experience in industry, but his work in our laboratories does not suffer on this account. Mc. McCurdy has had some considerable experience in drafting and design and this is a great help to him.

In future should an opening arise on the teaching staff of the department, I would recommend that some outside new blood be brought in.

Professor McKergow has had many outside contacts with Professors of Mechanical Engineering through the Society for the Promotion of Engineering Education and has kept in touch with them and their work. He finds that Mechanical Engineering has become highly specialized, though each specialty is based on a broad knowledge of Engineering as taught in McGill. The methods adopted at McGill fit our traditions, though out-of-line with the methods used in many of the Universities of the United States.

Here we are more or less bound by the lecture system while in the States the recitation system is largely used. By this system a lecture or portion of the text-book is given to the class. The class is then divided into small groups under an instructor who goes into details or gives the group a "Quiz".

It is hard to compare these two systems. Both have failed in part and both have in part succeeded. In either case it is the teacher that counts. If he is stimulating, interested and clear, he will succeed in either method. If the teacher is not what he should be, his success or failure is measured by his personal qualities and knowledge of his class as well as his knowledge of his subject.

If satisfaction with things as they are is a measure of dry-rot then it has not set in, in our Department. We are not satisfied that we are perfect but unless there is some radical change in the whole system of teaching and administration, we cannot see how we can improve very materially.

The methods used at McGill by its teachers have been moderately successful. I have been asked many many times to supply men to the Universities in the United States as well as for industry. I doubt whether the introduction of new methods of teaching avail much unless the teachers are above ordinary, then, as I have said, it won't make any difference.

Research.

In research there is an ever increasing trend to centralise this work, either in a Research Department of the University or in Buildings and equipment furnished by industry and placed under the direction of the Head of the Department. The Department is therefore free to do undergraduate work and its equipment and men not called upon to serve in a dual capacity.

It seems to me that our Research work must be carried out in the Graduate School where men are prepared for carrying out research work by means of more or less simple investigations which will show their fitness for this highly specialised branch of engineering.

General Remarks.

The criticism which I am now offering is made not of any special department, any more than my own.

I ask the question, "What do you think are the chief faults of your students?"

I find that the vast majority of the students coming under my observation are lacking in the faculty of analysis. They find it difficult to study efficiently. Groping and feeling for a reasonable answer but not sure that they are right when they get it. This is evidenced not only in the examination papers but in the class-room work as well. When they are given a problem, the vast majority wait for some one else to give them a hint on the solution or they grope and fiddle around with some formula which they hope may prove right. Such sloppy mental habits are reflected in lack of initiative and positiveness which is so essential for even reasonable success.

I feel that method of thought and attack in our work is of vital importance and without it the student will fail until he attains this priceless attribute.

That this symptom is not confined to our University, I know, for in my many conversations with other teachers, they all lament this lack in their own students.

What is to be done about it? I think that if nothing else comes out of all our work in making a survey, then that, something must be done about this one thing, and something is done, then our work will not have been in vain.

A suggestion is offered which might be valuable. In medicine, the students have their theoretical work at the University and then have Clinics at the Hospital, where these theories are seen in operation, how they are modified in practice and application. These two might be called the Science and Art of Medicine. Would it be possible to have talks to our students by experts on the application of the Theory they have learned in the class-room. It would be simple in some cases and very difficult in others. Some such scheme might serve to stimulate the analytical and deductive faculties of the students and give them more self-reliance and appreciation of what we are trying to do.

Alas. M. McGregor

Head of the Department.

COMMITTEE ON AFFAIRS OF THE ENGINEERING FACULTY

Report from the Department of

Metallurgical Engineering

Introduction. At the meeting of the Committee on December 18th, 1930, each department was asked to prepare a report showing how closely the instruction it gave had kept pace with the advances of science and industry during the past ten years. As the housing of the Metallurgical Department and its main teaching equipment was arranged more than thirty years ago and as it has not been found possible to bring about any fundamental change in accommodation since that time, it will be appropriate in the first place to survey the changes that have taken place during this interval.

Accommodation and Equipment.

When the Mining and Metallurgical laboratories were built and equipped, about the year 1898, the metallurgical laboratories were provided with large roasting and smelting furnaces which at that time were considered suitable teaching equipment for a metallurgical school. The laboratories themselves were not suited to such appliances, and, among other difficulties, there was a serious danger of fire in the fire-assaying laboratory which has a very low wooden ceiling.

Before coming to McGill in 1901 I had carried on metallurgical research for several years in London, developing the methods of "thermal analysis" and using microscopical and other methods of investigation which were new at that time. At McGill there was no equipment for such work and no laboratory in which such apparatus could be placed; there was no metallurgical class-room, no accommodation for a teaching collection of models, specimens and diagrams; there was no adequate chemical laboratory and there was not even suitable storage for the supplies needed for the large scale furnaces and for appliances that were not actually in use.

Repeated attempts have been made to obtain new quarters that would be better suited to our requirements, but on each occasion the plans failed to materialize, the last of these being in 1930. In view of these failures we have made a number of changes in order to make our laboratories and offices more useful and more in accord with modern requirements, but these changes can only be makeshifts and we need entirely new accommodation.

Recent Changes in Metallurgy.

These include changes in metallurgical practice and changes in metallurgical teaching and methods of research. Changes in practice cannot be enumerated here in detail and it will be sufficient to say that there has been a great advance in the branches of electro-metallurgy and hydro-metallurgy and that scientific methods and control of processes have increased enormously, so that while twenty or thirty years ago chemical analysis was only used to a limited extent, today chemical analysis, thermal analysis, microscopic and even x-ray examination of metals are all in regular use.

When I came to McGill the term "metallurgy", in Canada, was limited very largely to the recovery of metals from their ores by smelting and other methods. At the present time the scope of metallurgy has been greatly widened: a new branch of the subject - "Physical Metallurgy" - has grown up and is becoming increasingly important, particularly in large industrial cities like Montreal, and a large number of metallurgists have no direct interest in the smelting of ores. Thus the American Society for Steel Treating, only twelve years old, has already a membership of six thousand, and the Montreal Chapter of this Society has one hundred and twenty members.

Changes have also been made in metallurgical teaching. Twenty or thirty years ago the emphasis was on practical smelting methods, as was shown by our laboratory equipment at that time. It is now realised that such instruction is of limited value in view of the rapid changes in practice, that practical operation can be learnt very much more easily and more correctly in the smelter or the "works" than in the laboratory, and that there are many fundamental studies of a scientific character that should occupy the student's time while in the University.

Changes in the Metallurgical Department
as regards teaching and equipment.

To what extent has the teaching and equipment of the

Department kept pace with the advances of industrial and theoretical metallurgy during the past ten or twenty years? Having in view the cramped accommodation, the limited finances and the small personnel of the department, I believe that we have made satisfactory progress and kept pace reasonably well with outside advances.

Mr. Sproule and I keep informed of changes of metallurgical practice by means of the technical press, by our connection with technical and scientific societies (I belong to twelve of these) and by periodical visits to smelters and other metallurgical works. We also have a very close contact with practical metallurgy through problems that are referred to us from time to time. It follows from this that we can keep our lectures and other instruction reasonably up to date. Although it is essential that a student should have some knowledge of metallurgical practice, it is even more important that he should be well grounded in the theoretical studies that enable him to understand the principles on which practice is based, to ascertain the degree of efficiency of any operation and to judge correctly in what way the present practice can be improved. I have therefore endeavoured to advance the teaching of fundamental studies such as thermo-chemistry, physical chemistry and electro-chemistry and their application to the problems of metallurgy.

In my report to the Faculty of Graduate Studies and Research I point out the importance of metallurgical research and its suitability as a subject for graduate study. In the

Department of Metallurgy researches are continually in progress by the fourth-year students, graduate students and the staff. Publications are made frequently by members of the staff and some of the senior students.

As regards the teaching equipment, we have during the past twenty years thrown out much of the large smelting equipment and replaced it by the scientific apparatus and testing appliances that are needed for metallurgical instruction and research. We have placed the assaying furnaces in the large furnace room, thus removing the danger of fire, and we have converted part of the assaying laboratory into a chemical laboratory for class instruction. We have no separate room for a metallurgical library and reading room but in my own office I keep a working library of metallurgical books and periodicals and a classified file of pamphlets and cuttings from technical journals. These are all available for the students and the staff and greatly facilitate the collection of data on any problem that may come up for consideration.

Students receiving
<u>Metallurgical Instruction.</u>

We are only prepared to receive a moderate number, perhaps six a year, of undergraduate students taking the course leading to the degree of B. Eng. in Metallurgical Engineering and this is as many as would be likely to obtain suitable positions on graduation. Metallurgical instruction is also given by us to Mining and Chemistry students in the 3rd and 4th years, to Dental students in the 1st year and to all

Engineering students in the 2nd year. We can take about two students for a post-graduate course leading to the degree of M. Eng. in Metallurgy, and we are arranging a special short course of post-graduate instruction for officers of the Royal Air Force. In addition to full-time students we give instruction in the evening to men who are engaged in metallurgical occupations in the City. Mr. Roast has at present a class of twenty receiving practical instruction in Metallography and we also give instruction through the medium of the Montreal Chapter of the American Society for Steel Treating which has a membership of one hundred and twenty.

In view of the rapid advances that are being made in the science and art of metallurgy and of its great and growing importance in Canadian industry, it appears strange that a larger proportion of undergraduate students do not enter this course either at McGill or in other universities. I have given a good deal of attention to this question but it is too complicated a subject to be treated satisfactorily in this report and must be left for the present.

Desirable Changes in
<u>Equipment and Staff.</u>

It is very desirable that new quarters should be found for this Department so that satisfactory provision can be made for the various branches of instructioh and research. Our views of these requirements are bound to change from time to time, but the following should probably be included in any scheme for a new building:

A lecture room devoted to metallurgical instruction in which it would be possible to have models, specimens and diagrams in addition to the usual equipment.

A room with books, papers, blue-prints etc. in which the students can read, write, calculate and make drawings.

Separate laboratories for analytical chemistry, metallography, hydro-metallurgy and furnace metallurgy.

Small laboratories equipped with scientific apparatus for metallurgical research.

One important item of equipment which should be provided is a high-frequency electrical equipment for the electrical melting of metals. This is a recent development of electro-metallurgy which is being adopted in commercial metallurgy and is particularly valuable for metallurgical research. It is included in all modern research institutes and we should obtain one in the near future.

As regards the teaching staff, it is not possible for one or two instructors to cover the whole field of so wide a subject as metallurgy; neither is it possible to have a separate instructor for each branch, and a reasonable compromise must be arrived at. Mr. Sproule gives instruction in the second year in materials of construction and in the third year in elementary metallurgy and in fire-assaying. He also gives special attention to physical metallurgy, including the microscopic and physical testing of metals and pyrometry. I give more advanced descriptive lectures on metallurgical practice, both ferrous and non-ferrous, and teach theoretical metallurgy and metallurgical calculations as applied to furnace charges, metallurgical design, and the applications of thermo-chemistry, physical chemistry and electro-chemistry to metallurgical processes. Mr. Roast is in metallurgical practice in the City and gives a part of his time to instruction in metallography and metallurgical analysis.

In addition to the present personnel it is desirable to have on the staff an instructor with a good chemical training and some experience in a smelter who would be able to give instruction in hydro-metallurgy and metallurgical analysis, would have charge of these laboratories and would be able to make the chemical analyses that are continually needed in metallurgical research.

It is also desirable to have on the staff a professor who has had a considerable experience in smelter practice and would be familiar with works management and the mechanical, human and financial aspects of metallurgical practice.

In this connection it must be remembered that the students have already more work than is desirable in their third and fourth years and it is not possible to add any more courses of study. When visiting English universities a few years ago I was impressed by the large amount of time that was available for metallurgical studies, and it seems reasonable to suppose that the introduction of the year in Arts before the first year in Engineering should make it possible for Metallurgical and Mining students to have more time for the professional studies in their third and fourth years. The only alternative is to leave some of these studies to a post-graduate course.

Alfred Stansfield

Department of Metallurgical Engineering,
McGill University,
March, 1931.

A REVIEW OF CONDITIONS IN THE DEPARTMENT OF MINING ENGINEERING

Made for Principal's Committee

The trend of mining operations, including ore dressing and the smelting of non-ferrous minerals, shows the following influences which bear directly upon the education of the mining engineer:-

1. Operations are conducted on a much larger scale than formerly. The Utah Copper Company at its Bingham Canyon Mines in Utah has mined up to 70,000 tons per diem of metal-bearing, and an equivalent amount of barren, material. This is a steam-shovel mine, but breaking, shovelling and transporting 140,000 tons of material in 24 hours is decidedly impressive. Miami Copper Company hoists through one shaft 18,000 tons of ore per diem.

2. This large-scale mining has necessitated the use of larger-scale equipment. Power shovels are now being used in mines with a dipper capacity of 20 cubic yards.

3. Technical control of the operations is becoming more thorough and more exacting. This applies to all the stages of prospecting, mining, ore dressing and metallurgy.

4. Electrification is going on at a rapid rate. Even large power shovels, churn drills and other machines, which were formerly operated by steam, are now electrically driven.

5. Manual labour is being replaced by machines to a very great extent.

6. Mines are going to great depths: the Village Deep on the Rand has now reached a depth of 7,600 feet below the surface, or about 2,000 feet below sea level. This introduces new problems in rock support, hoisting and ventilation.

7. Methods of mining, ore dressing and metallurgical treatment are becoming more complex and scientific.

8. Lower-grade material is being mined, which requires greater economy and closer attention to details of operation.

9. Increasing technical demands make specialization almost essential, but the graduate has little opportunity to choose his specialty and must have a sufficiently broad training to enter any field. This he can do if he is well grounded in the fundamentals.

10. Mining engineers are more and more being called upon to assume the general management of mining enterprises.

These tendencies in mining make a greater demand upon the mining engineer and necessitate his having a broad scientific training. At present it is desirable for a mining engineer to have, in addition to the fundamental knowledge necessary in all branches of engineering, a working knowledge of electrical engineering, inorganic chemistry, the geological sciences, surveying, ore dressing and non-ferrous metallurgy. In addition to this he needs at least elementary knowledge of mechanical engineering, hydraulics, structural engineering, the strength of materials, and methods of mining. An elementary knowledge of organic, physical and colloid chemistry is desirable for those engineers who intend to follow milling but cannot be given except in post graduate years or as optional subjects. The introduction of options into the undergraduate course seems undesirable and the few who definitely plan to take up flotation work after graduation should take at least one year of post graduate study.

In the past four years the time devoted to electrical engineering by our students has been doubled, and the time allowed for fundamental metallurgical calculations increased one hour throughout the fourth year. An attempt has been made to secure more time for geological work, but this has not been successful. We have, however, been able to make changes in the time table to enable the Geological Department to give our students more practical work in geological mapping and map interpretation. The additional time allotted to Electrical Engineering and Metallurgy has been taken from Ore Dressing Laboratory, Mining lectures and the students' free time. In addition to these changes we have put Electrical Engineering into the third year in order to have the students better prepared for their Ore Dressing and Mining work in fourth year, and have rearranged the Mining work to give more time to Mine Design or the working out of engineering problems that arise in mining.

We would like to secure more time for geological work, but our calendar is already too heavy in the third and fourth years. In the third year the students have one free hour in the first term, and two in the second; in the fourth year they have two free hours in the first term and three in the second. This does not give sufficient time for library and other independent work, and I feel that some of our third year subjects should be moved back into the second year. This, I understand, is impossible at the present time; but I believe that, if the pre-Science year could be taken in the Engineering Faculty, a rearrangement of the curriculum to give our students a better-balanced calendar throughout the five years would be quite feasible, and I would recommend that this change be given serious consideration. As a temporary alternative I would suggest that an attempt be made to rearrange the pre-Science year for engineering students to secure a course which would be more suitable to their needs. It is particularly desirable to have a change made in the English reading course.

Geology is extremely important to the mining engineer. The Geological Department is making an earnest effort to give our students adequate training, but they are handicapped by insufficient staff and antiquated charts and other accessories. I feel that our Geological Department can be greatly strengthened and our Mining students materially helped by the addition of at least one man to the staff of that department.

We need a rearrangement of the equipment in our laboratory and new apparatus to bring the laboratory up-to-date. We are also badly handicapped by the lack of library and reading room space, but these conditions cannot be remedied until a new building is secured.

We attempt to serve the community in any way possible but pay particular attention to the following:-

1. Investigation of ore dressing problems in our laboratory.
2. Giving advice to prospectors and others who are interested in the development of mineral deposits.
3. Assisting in the work of the Canadian Institute of Mining and Metallurgy and other associations of mining and metallurgical engineers.

Most mining problems have to be investigated on such a large scale that work in a college laboratory is useless. During the past four years we have confined our efforts largely to a study of the flotation process. Our first work was on the separation of a complex copper-zinc ore from the Rouyn district. The second problem investigated was the possibility of applying flotation to the recovery of gold. In both cases the results obtained were encouraging and were given to the mining companies interested and to the Department of Mines in Ottawa. Graduate students were assigned certain problems in these investigations and the work was supervised and coördinated by Professor Bell. We are at present carrying out an important investigation on the settling of finely divided matter in the Dorr thickener. This gives promise of very important results. We plan, if we can secure the equipment, to investigate, in the near future, certain phases of fine grinding in ball and rod mills. This work should have great practical value and lies in a somewhat neglected field.

W G McBride

THE SCHOOL OF ARCHITECTURE.

Report on the work of the School during the last ten years and on its immediate prospects.

To the Principal,
McGill University.

Sir:

The School of Architecture is at present conducted as a department of the Faculty of Engineering and provides a course of five years leading to the degree of Bachelor of Architecture (B.Arch.)

Graduates who desire to practice architecture in the Province of Quebec are exempted from the ordinary examinations of the Province of Quebec Association of Architects. They are required to spend twelve months in the office of a member of the Association and to pass the examination in Professional Practice of that body. Upon fulfilling these conditions they are eligible for election to the Association and are thereby entitled to practice in the Province.

The School is "recognised" by the Royal Institute of British Architects and its courses meet the requirements of the Board of Architectural Education of that body. The Royal Institute annually appoints two examiners who report upon the work of the School and supervise the School examinations in Professional Practice. Graduates are in this manner exempted from the ordinary examinations of the Institute and may present themselves as candidates for the associateship (A.R.I.B.A.) This privilege is highly valued by the graduates, many of whom have thus joined the Royal Institute.

The School also gives instruction to students and draughtsmen who may not be able, or may not wish, to take the full course. These facilities are found useful by students preparing for the P.Q.A.A. or R.I.B.A. examinations and are open only to men studying architecture with a professional aim.

It is not possible, nor is it attempted in the University course, to supersede that training in the practice of architecture which can only be gained by direct contact with building works and by experience in an architect's office. In order that students may obtain some knowledge of the practical conduct of an architect's business and in order that their academic training may not lose touch with reality, all undergraduates are required to obtain employment during the summer months under an architect or builder, or to do equivalent practical work.

The University course is designed to train students in the principles which underlie the design of buildings, to give them practice in the solution of architectural problems, a knowledge of the history and traditions of architecture and of the methods of construction at present in use.

Buildings of special interest, and buildings under construction are visited from time to time on which the students are required to write reports.

A "School" is held every year in September for the study of the old architecture of the Province. The drawings made by the students are of permanent value as historic records and the study of these buildings helps them to realise the value in architecture of local and traditional methods.

Foreign travel is very desirable to the completion of an architect's education. A scholarship for this purpose, of the value of $1000, has been founded by the generosity of members of the McLennan family in memory of the late Hugh McLennan, who was killed in action at Ypres in 1915. It is awarded annually to that student of the graduating class who is considered most deserving, and was awarded for the first time in 1930.

The late Professor S. H. Capper, on his death in 1927, left a sum of money to found a travelling scholarship in the School of Architecture, subject to certain life interests. On the expiry of these, the scholarship will be founded and the needs for foreign travel are therefore amply provided for.

The architectural library as originally founded by Sir.Wm.Macdonald possesses a large and valuable collection of books; to this has been added the Gordon Home Blackader Memorial library, endowed by Dr. and Mrs. Blackader and Mr. Gordon Blackader in memory of Captain Gordon Blackader who died on active service. This latter is primarily a reference library for the use of advanced students. The combined libraries form a valuable reference and working library.

The Architectural Society is the undergraduate body of the School; graduates and member of the staff are honorary members. Its objects are to bring the students into touch with the graduates and the profession and for this purpose addresses and demonstrations are given by architects, contractors and craftsmen upon subjects of professional interest. The meetings are held in the school and are in charge of the undergraduate officers of the Society.

Ten years ago the school was just recovering from the effects of the war. At that time it had twenty-two under-graduates, since then the number has increased steadily until last year there were thirty-eight and this year forty-three undergraduates, whilst some candidates, otherwise eligible, had to be declined owing to lack of room. It seems probable that this number, about forty, will continue for some time to come.

Without overcrowding the School has accommodation for thirty students; with the present number it is seriously over-crowded.

Some additional accommodation has been provided, but as a result, the rooms are scattered over four floors, to the great inconvenience of both students and staff.

But the present accommodation is insufficient for the number of students in attendance and reasonably to be expected. The accommodation required is as follows:-

(1) The draughting room should accommodate 45 tables comfortably instead of 30 as at present.

(2) A room or gallery for exhibiting students' work on walls or screens is urgently needed. Such exhibitions are for the purpose of criticism as well as for public exhibition and may be made into a valuable part of the educational course.

(3) Space is required for exhibiting buildings and engineering models. These are much used in the construction courses and there is at present nowhere where they can be placed for the use of the students.

(4) An additional lecture room is urgently needed. There is only one at present.

(5) The private room accommodation is very inadequate in view of the growth of the staff. One private room at least should be large enough to allow of taking a small tutorial class.

(6) The accommodation should be concentrated upon one, or at most two floors.

For teaching purposes a school of about 40 students is satisfactory. It allows of personal contact between teacher and student and yet each class is large enough to encourage competition amongst its members. It is therefore very desirable that the accommodation of the School should be increased to take this number with efficiency.

The distribution of duties of the staff is as follows:-

(a) History of Architecture, Ornament and Decoration.

Elementary subjects and general management.

A Professor ------------------------ full time.
An Assistant Professor ------------- full time.
A Demonstrator --------------------- full time.

(b) Design and Theory.

A Professor ------------------------ in practice.
A Demonstrator --------------------- in practice.

(c) Construction and Practice.----------

A Special lecturer ----------------- in practice.
A Special lecturer ----------------- in practice.

(d) Drawing and Modelling.

A Special instructor --------------- in practice.

A number of subjects, particularly in the first year, are taken with the students of the Faculty in general, or in the Faculty of Arts and Science.

Reference has already been made to the study of Canadian Architecture by the students. This is done as part of the survey of the old Architecture of Quebec which has been in progress since 1925. Since then a number of monographs of old and historical buildings in the province have been published by the

University. The collection of photographs and measured drawings of old buildings is the largest in Canada, and this research is increasing in importance every year. It is hoped eventually to publish an authoritative work upon the subject.

A list of University Publications by members of the staff is appended:-

1. Traquair, Ramsay. The old architecture of the Province of Quebec. Reprinted from The Journal, Royal Architectural Institute of Canada, January-February, 1925.

2. Traquair, Ramsay. The buildings of McGill University. Reprinted from The Journal, Royal Architectural Institute of Canada, March, 1925.

3. Carless, William. The architecture of French Canada. Reprinted from The Journal, Royal Architectural Institute of Canada, July-August, 1925.

4. Carless, William. The arts and crafts of Canada. Reprinted, with additions, from The Family Herald and Weekly Star, April 1 and 8, 1925.

5. Traquair, Ramsay. The cottages of Quebec. Reprinted, with additions, from Canadian Homes and Gardens, January, 1926.

6. Traquair, Ramsay. Art and life: the influence of the classics. Reprinted from The Teachers' Magazine, Montreal, February, 1926.

7. Nobbs, P.E. Suburban Community planning. Reprinted from Town Planning, April, 1926.

9. Traquair, Ramsay. The planning of three European cities. Reprinted from Town Planning, Ottawa, August, 1926.

13. Traquair, Ramsay & Barbeau, C.M. The Church of Sainte-Famille, Island of Orleans, Que. Reprinted from The Journal, Architectural Institute, of Canada, May and June 1926.

14. Traquair, Ramsay & Barbeau, C.M. The Church of Saint-Francois de Sales, Island of Orleans, Que. Reprinted from The Journal, Architectural Institute of Canada, September-October, 1926.

15.	Turner, P.J.	Liverpool Cathedral. Reprinted from The Journal, Royal Architectural Institute of Canada, March 1927.
16.	Turner, P.J.	Development of architecture in the province of Quebec. Reprinted from Construction, June, 1927.
17.	Turner, P.J.	Christ Church Cathedral, Montreal, Reprinted from Construction, November, 1927.
18.	Traquair, Ramsay) & Adair, E.R.)	The Church of the Visitation, Sault-au-Recollet, Quebec. Reprinted from The Journal, Royal Institute of Canada, December, 1927.
19.	Traquair, Ramsay.	Old churches and church carving in the Province of Quebec. Reprinted from the Journal of The Royal Institute of British Architects, February 25, 1928.
20.	Traquair, Ramsay.	The origin of the pendentive. Reprinted from the Journal of the Royal Institute of British Architects, January 28, 1928.
21.	Turner, P.J.	The old English Inn. Reprinted from the Journal, Royal Architectural Institute of Canada, August, 1928.
22.	Traquair, Ramsay) & Barbeau, C.M.)	The Church of St. Pierre, Island of Orleans, Quebec. Reprinted from The Journal, Royal Architectural Institute of Canada, February, 1929.
23.	Traquair, Ramsay) & Barbeau, C.M.)	The Church of Saint Jean, Island of Orleans, Quebec. Reprinted from The Journal, Royal Architectural Institute of Canada, June, 1929.
24.	Turner, P.J.	Library Buildings, their planning and equipment. Reprinted from The Journal, Royal Architectural Institute of Canada, May, 1929; July, 1929; September 1929.
25-26.	Traquair, Ramsay.	The Chapel of Mgr. Olivier Briand in the Seminary of Quebec (25) and The Presbytery of the Basilica at Quebec. (26) Reprinted from The Journal, Royal Architectural Institute of Canada, December, 1929, & February, 1930.
27.	Traquair, Ramsay.	No. 92 St. Peter Street, Quebec. A Quebec Merchant's House of the XVIII. century. Reprinted from The Journal, Royal Architectural Institute of Canada, May and July, 1930.

28. Traquair, Ramsay. The Huron Mission Church and Treasure of Notre Dame de la Jeune Lorette, Quebec. Reprinted from the Journal, Royal Architectural Institute of Canada, September and November, 1930.

29. Nobbs, Percy E. Present tendencies affecting architecture in Canada. An address delivered at Ottawa on December 9th, 1929. Reprinted from The Journal, Royal Architectural Institute of Canada, Vol. VII., July, September & November.

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respectfully submitted,

Ramsay Traquair

Ramsay Traquair.
Macdonald Professor of Architecture and
Head of the School of Architecture.

February 6th, 1931.