

# Part Two: Electrical Engineering and Technology Education

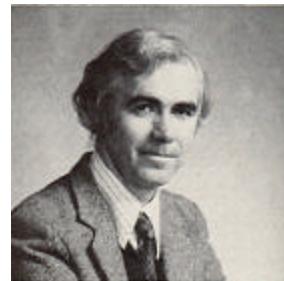
By Raymond D. Findlay

## 1854: The Teaching of Engineering in Canada Begins

In the days before Confederation, the universities in British North America were elitist institutions pandering to the whims of the upper classes, especially to adherents of the Church of England. However, the vast majority of people in what is now Canada were decidedly of the opinion that ancient Greek and Latin, together with a rigorous grounding in the precepts of the Church of England, did little towards preparing a young man to live in a pioneering community. Consequently they rose up in indignant wrath, first in an effort to suppress the institutions, then to open their own “people’s” universities, and finally to wrest control of the offending, state-supported schools from the clutches of the clergy. University College in Toronto, later to fall under the umbrella of the University of Toronto, came under early attack. Adherents of the Church of Scotland, unable to obtain satisfaction, finally subscribed their own university, Queen’s, in the City of Kingston. With the financial assistance of the city, Queen’s University was established in spite of the lack of support from the provincial government. The University of Toronto, as a state-supported school, enjoyed the largess of the provincial government.

Nowhere was the fight to free an institution from Anglican dogma more bitter than in New Brunswick, where repeated efforts were made in the legislature to close that province’s university, King’s College. Two decades of quarrel and acrimonious debate in the provincial legislature were not enough to convince the college governors that the church-oriented, Oxford style of education was inappropriate to the needs of the province. Finally, in exasperation, Sir Edmund Head, the Lieutenant-Governor, suggested that means be found to make the institution more practical. Accordingly, he convinced the College Council to appoint a lecturer in Civil Engineering. The University, later to become the University of New Brunswick, opened its doors to twenty-six students in the new course on the fifteenth of February, 1854. This was the first course of lectures in engineering to be offered in a university in British North America.

Head realized that the engineering course would be seen as a temporary solution only, and that a more structured approach to change was required. With the agreement of the government, he appointed a commission of inquiry into means to improve the college. Members of the commission included Egerton Ryerson, then Superintendent of Education in Upper Canada, and William Dawson, Superintendent of Education in Nova Scotia. The commission’s report, authored by Ryerson, and published in 1855, recommended the permanent establishment of courses in engineering.



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Before the New Brunswick report could be acted upon, Head was appointed to the post of Governor-General of Canada, which at that time encompassed what is now Ontario and Quebec. Among his first duties was to advise the college council at the ailing McGill University in Montreal on the appointment of a new principal. Head recommended William Dawson, then Superintendent of Education in Nova Scotia, and a noted naturalist and geologist. It should be remembered that in that era, most university appointments were chosen from Britain. It was almost unheard of to recommend a "colonial" for such a prominent position: it was equally unheard of for a university to accept such a recommendation. But accept it they did, and most providentially for the fortunes of McGill. As an applied scientist, Dawson was able to perceive the need to implement more practical subject material into the university curricula. In keeping with his expressed opinions before the New Brunswick Commission, Dawson's inaugural address (November, 1855) included provision for the establishment of an engineering program:

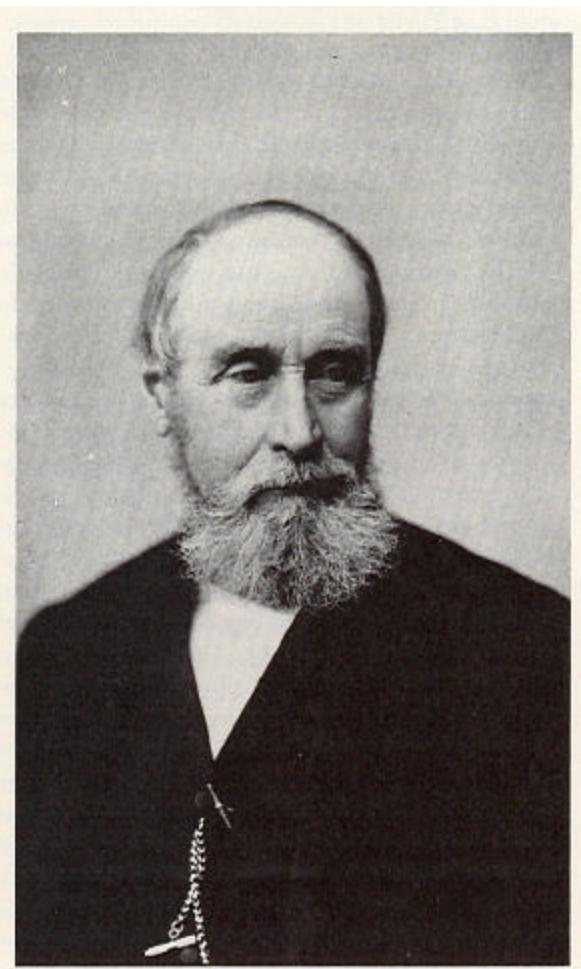
"A course of Civil Engineering. This will embrace English Literature, Mathematics, Natural Philosophy (physics), Chemistry, Geology and Mineralogy, Surveying and Civil Engineering, including construction of machinery."

In 1856 (the session following the address) Dawson appointed Thomas Keefer to give the first set of engineering lectures at McGill.

Up to this time engineering had not been taught at Toronto, although provision had been made for it as early as 1851. We may easily conjecture that Governor-General Head's involvement as Visitor to the University of Toronto provided the stimulus necessary to effect the establishment of the engineering course there also. By 1858 Toronto's program had begun. It is certain that Head was directly responsible for the program at New Brunswick, and indirectly responsible for that at McGill. Dawson was an outspoken proponent of engineering education within the university system. Even Ryerson, not generally noted for his favorable attitude to engineering, had strongly supported its implementation in his report on the situation at King's College, New Brunswick.

For their parts in the stories of these first programs in Canada, Head, Ryerson and Dawson, none of them engineers, but all of them profound thinkers of their time, may justly be called the fathers of engineering education in Canada.

Engineering education got off to a rather slow start. In spite of the early successes, the depression which preceded Confederation, slowing railway construction and industry in general, caused a decline in interest for practical courses of instruction at the university level. It was not until the late seventies that engineering again came to the fore, and not until the formation of the

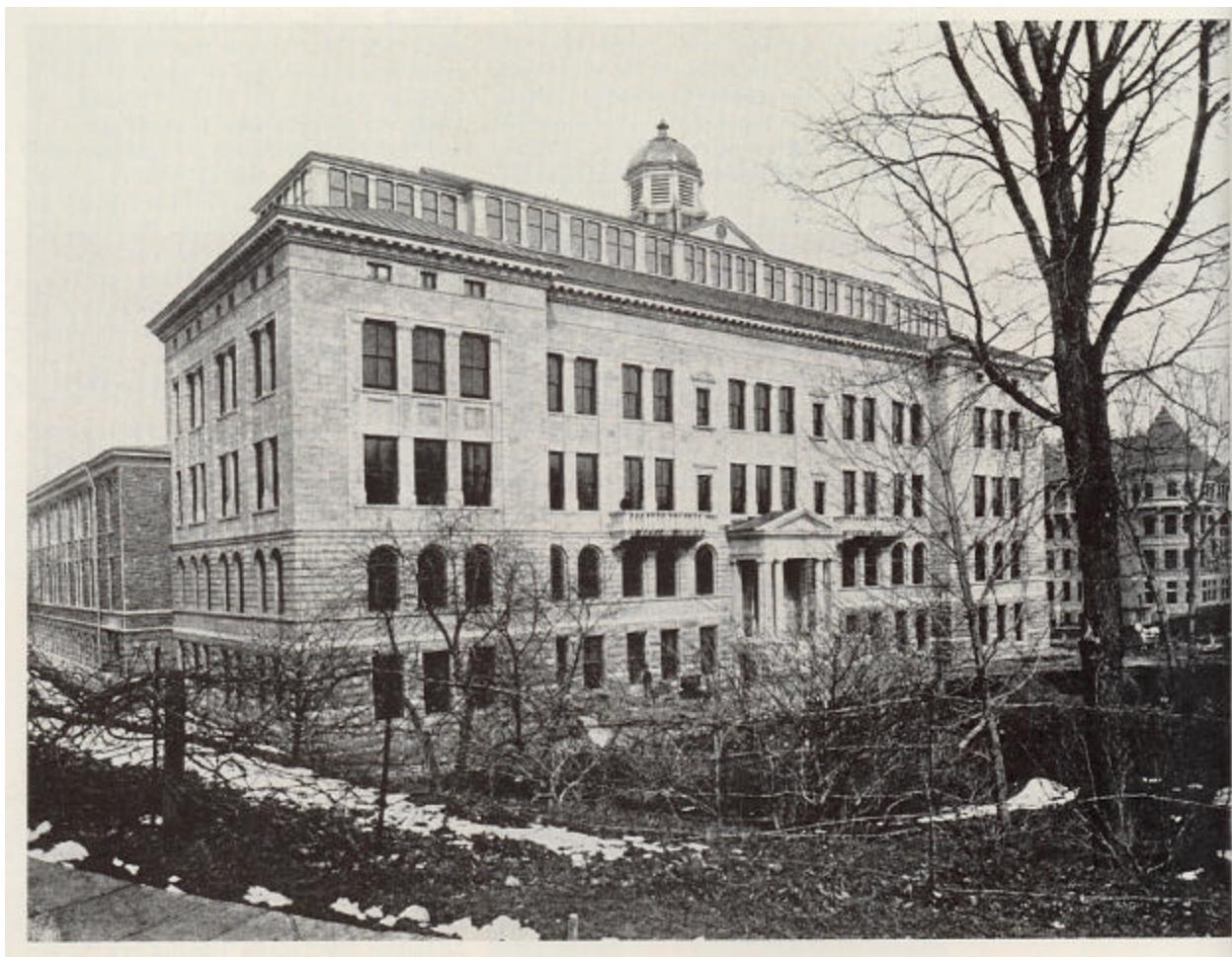


*William Dawson, Principal of McGill University in 1855, introduced an engineering education program. Photo courtesy of McGill University Archives.*

American Institute of Electrical Engineers in 1884, that the discipline of electrical engineering gained any great prominence. The first program in electrical engineering in North America had been started only two years before, at Massachusetts Institute of Technology. Electrical engineering programs were begun shortly thereafter in Canada. The first was at McGill in 1890, followed by Toronto and New Brunswick in 1891, then at Queen's about 1896.

## Ecole Polytechnique: The Rise of Engineering Education in Quebec

During the rather turbulent economic times immediately after Confederation engineering instruction suffered both from a want of students as well as from a want of trained faculty. When times began to improve the Province of Quebec was the first to take advantage. Not only did a very much rejuvenated program appear at McGill, but also the seeds were sown for the rise of one of Canada's foremost engineering institutions, Ecole Polytechnique. It had rather humble beginnings, starting in January, 1874, on the first floor of I'Ecole du Plateau in Montreal. The founders were M. Urgel Eugene Archambault, the first principal, the Honourable Gedeon



*Engineering Building, from pamphlet "Formal Opening of the Engineering and Physics Buildings, McGill University, 1893". Photo courtesy of McGill University Archives.*

Oulmet, on behalf of the Government of Quebec, and M. Charles Pfister. Perhaps the single individual most responsible for establishing the school. It was under M. Pfister's hand that the first program took shape. It was a very carefully conceived general program incorporating the principles of civil engineering, mining, metallurgy, metalworking and industrial production techniques. The first class of January 1874 included twelve students of whom only six remained

at the first examination in March. In September four entered the full program while another three students began a preparatory course to equip them for work in the full program. Altogether there were six faculty including M. Emile Balete, who played a very substantial role in establishing the fortunes of the school over the next twenty-four years. The first graduating class in 1877 numbered five students, a very respectable size for the times. Due to the reputation of the school, so quickly established, it was not long before the government and the school itself sought means to ensure its future. Consequently, in 1887 the school became affiliated with the Montreal campus of Laval University. When the Montreal campus of Laval was incorporated under its own right as the University of Montreal in 1920, Ecole Polytechnique transferred its affiliation to the new university, although retaining its financial independence.

#### **World Wide Web Resources as of March 2000:**

École Polytechnique de Montreal - [www.polymtl.ca](http://www.polymtl.ca)

### **Sir William Macdonald and His Legacy**

In 1891, William Macdonald, a prominent Montreal tobacco merchant, contributed \$40,000, to endow a Chair in Electrical Engineering at McGill. Macdonald preceded this endowment with a sizable donation to enable construction and equipping of a new engineering building. The original building fund had been started from a bequest of \$60,000 by Thomas Workman. However, this amount fell far short of that actually needed. The program was advertized in the McGill program for 1890; but it was not until the following year, with the establishment of the Chair, that the new electrical engineering program got underway, with both building and faculty.

### **University of New Brunswick and the Theory of Electricity**

In 1889 the University of New Brunswick established a Chair of Experimental Science (a position which included both electrical engineering and physics as subject material), appointing Alexander Wilmer Duff to the position in 1890. Duff left after two years. His replacement was George Miller Downing, who graduated from Penn State College in 1888, proceeding thence to MIT as an instructor in physics and electrical engineering, and from there to the Polytechnic Institute of Brooklyn, where he obtained the degree of Bachelor of Electrical Engineering. In deference to Downing's status the appointment was changed to the Chair of Physics and Electrical Engineering. Downing laid the foundations for a four-year diploma program in electrical engineering in 1892. The description of the program in the calendar for the following year read:

"The Theory of Electricity is thoroughly taught, and is supplemented by an extensive laboratory practice. The University has been granted the use of the dynamos, motors, lines, etc., of the Fredericton Electric Lighting Company, and each year a number of practical tests will be made, which will enable the student to become familiar with many of the appliances used in the generation and distribution of Electricity."

The third year of the program included calculus, applied mechanics, physics, theory of the steam engine, dynamo-electricity, electric transmission of energy and electrical measurements; while the fourth year included physics, statics, theory of electricity, alternating current theory and dynamo and transformer design. Only two students registered for the program in 1893. Lack of equipment, a blight as difficult to eradicate then as now, hindered the teaching of the program. When no University funds were made available to supplement the equipment budget for the laboratory, Downing took the matter into his own hands: "I made an appeal to Mr. Frederic Nicholls, General Manager of the Canadian General Electric Company. After some

correspondence, he responded by presenting to the university: one 3 kW compound dynamo with rheostat, one 3 kW shunt motor with starting box, two 25 ampere double-pole fused switches, one 0-150 volt voltmeter, and one 0-25 ampere ammeter. The aggregate listed price of these machines and associated instruments is over \$300.00. The Company rounded out this handsome donation by paying the freight charges to Fredericton." Which shows that even at that early date there was cooperation between industry and university.

#### **World Wide Web Resources as of March 2000:**

University of New Brunswick - [www.unb.ca](http://www.unb.ca)

### **The School of Practical Science in Toronto**

The School of Practical Science opened its doors for students under the cooperative endeavour of the University of Toronto and the Department of Education in 1878. However, it was not until a reorganization of the school in 1890 that any mention was made of electrical engineering, and then only as an adjunct to mechanical engineering. In 1891 Thomas Reeve Rosebrugh, a Demonstrator in the laboratory, and graduate in mathematics and physics, was elevated to the post of Lecturer in Electrical Engineering. Although the diploma course was nominally of three years duration, an extra year was encouraged to obtain a certificate based on laboratory work. This post-graduate year led to the establishment of the degree of Bachelor of Applied Science, of which the class members of 1893 were its first recipients. By 1896 the Department of Mechanical and Electrical Engineering had acquired a new switchboard, a "rotary transformer", built especially for the school to provide either three or four phase power, and a three-phase induction motor, in addition to measuring equipment including galvanometers and electrometers.

### **A Bench an Electric Motor and one or two Lathes**

Rev. George Grant, who accompanied Sir Sandford Fleming on his historic survey trip for the railway through the Rockies, was appointed principal of Queen's University in Kingston in 1877. His appointment was fortuitous for the cause of engineering education, not only due to his personal convictions, but also to his friendship with Fleming. It was Grant's drive and energy which placed Queen's among the early scientific educational institutions in Canada. The Faculty of Practical Science was established at Queen's in time for the session of 1894-5, using some of the facilities and lecturers of the fledgling School of Mining. N.R. Carmichael (M.A., Queen's) took on the post of instructor in electrical engineering, but with very little in the way of laboratory equipment. As one graduate noted, speaking of equipment for the whole engineering program: "We had a bench, an electric motor, one or two lathes and little else".



*Charles LeGyt Fortescue, born at York Factory, Manitoba, 18876, son of chief factor of Hudson Bay Company-was the first electrical engineering graduate of Queen's University. After graduation Fortescue joined Westinghouse Electric and Manufacturing Company at East Pittsburgh and attained universal fame for his contributions to the engineering principles and analysis of power transmission and distribution systems. He is especially noted for development of polyphase systems analysis by the symmetrical components method. Photo courtesy of IEEE Center For the History of Electrical Engineering.*

In spite of the want of facilities, equipment and space, the program survived to turn out very creditable graduates even in those early years. Charles Legeyt Fortescue was among the first, graduating in 1898 and going on to a very distinguished career in electric machine design with Westinghouse. He is remembered principally for his articulation of the theory of symmetrical components, although he obtained many patents and authored a profusion of papers as well. Also among the first graduates of Queen's was H.S. Baker who began his distinguished career at Westinghouse before moving on to Ontario Hydro, contributing his great management and invention skills to the founding of the electrical power industry of the province.

There was great rivalry between Toronto and Queen's for public support, and perhaps no small amount of animosity owing to sparsity of public funding for higher education. James Louden, the president of the University of Toronto, was incensed at Principal Grant's repeated efforts to obtain public funding for applied sciences at Queen's. Louden remarked in 1900 that: "a new feature (has) appeared in the demand of Queen's University for Provincial aid and should the Government choose to ignore the claims of its own child (Toronto), either the adoption must be complete and the child subject to full control, or else the money must be given to irresponsible hands (Grant's) to expend." The Government agreed in some measure with these sentiments, providing no funding for the faculty in the early years, although providing limited support to the School of Mining which was loosely affiliated with Queen's. However, to appease Toronto, the government also provided funding to Toronto to implement a competing department of mining. Fortunately, although lacking in government support, Queen's had the overwhelming support of the citizens of Kingston. They subscribed enough funds, principally through private donations, to enable the new faculty to begin operations. The degree program was to be of four years duration in one of the four regular disciplines of engineering. Supported both morally and financially by Sir Sandford Fleming as Chancellor, Grant managed to overcome the expressed disapproval of the Provincial Government and obtained tacit agreement to the engineering program by the turn of the century.



*University of New Brunswick—the oldest functioning university building in Canada, built in 1829. This view shows the building as it was prior to 1878. The first electrical engineering classes were held here.*

## **Students Give Their Own Cash for a New Building**

The want of space and facilities continued to hinder all of the programs, although Toronto managed to pump the public purse with some success, while McGill continued to enjoy the largess of its benefactors. In 1899 the University of New Brunswick was still entirely housed in a single seventy year old building. The situation there had become so acute that the students themselves petitioned for more adequate facilities and space. The University Senate accepted the argument when it became clear that the students were prepared not only to assist in obtaining subscriptions to a building fund, but also to subscribe substantial amounts towards it themselves. It was generally recognized that the whole university would benefit from the addition of a new building.

The building was completed in 1900 and opened with considerable pomp and ceremony by James Louden, president of the University of Toronto, to an audience which included representatives of academe from the entire western world. A similar building program was underway at Queen's with subscription towards Fleming Hall. Toronto was blessed with exceptional governmental support for its building program (although the faculty at Toronto did not agree with this sentiment in any measure!)



*The "Gymnasium", built in 1904, later became the Electrical Engineering Building at University of New Brunswick.*

## **Several Waveshapes and Frequencies-in 1899**

In contrast to other Canadian programs and many others elsewhere in the world, McGill's program was rich in both facilities and quality of faculty. The calendar for 1899 lists R.B. Owens, an electrical graduate of Columbia, as the Macdonald Professor of Electrical Engineering. Louis Herdt, a graduate of McGill who also had the degree of M.E. in E.E. from the Electrotechnical Institute of Belgium, was appointed as lecturer, while Ernest Rutherford was appointed as Macdonald Professor of Physics. Subject material included, in addition to the fundamental material in mathematics and physics, "direct current dynamo-electric machinery, alternating currents and alternating current machinery, electric lighting and systems of electric distribution, and electric railways." It was also noted that the Montreal Street Railway Company had made a special test car available for the students to use in their investigations. For the electrical laboratory it was noted that; "Alternating current of several wave shapes and of frequencies up to 150 periods per second, and of voltages up to 200,000 is available." In addition there was a dynamo laboratory with "twenty-five commutating machines, generators, motors, boosters, motor-generators, dynamotors, converters, closed and open coil arc machines, varying in capacity from a fraction of a kilowatt to 75 kilowatts-twelve alternating current machines, including generators, synchronous motors, compensators, and synchronous converters, together with a large amount of stationary and rotary induction apparatus".

## **The Baccalaureus In Arte Ingenaria**

The McGill degree program in electrical engineering met with both recognition and success. Four students graduated in the first class of 1894. By 1909, 214 students had graduated from this, the most successful of the early programs in Canada. In contrast there were two diplomates in 1894 from the University of New Brunswick, but by 1909 there had been only 11 degree recipients in electrical engineering. Others took somewhat longer to establish. Although there was provision for a professional degree at the School of Practical Science, those proceeding to a

degree usually took the B.A.Sc. through the University of Toronto, of which S.P.S. was an affiliate. In contrast to McGill, the electrical program at Toronto was much slower in formation. Until 1911, the three year diploma course was given in the joint Department of Electrical and Mechanical Engineering. Although provision was made for the award of the professional degree of E.E., it was not a popular option. Students could also take the degree of B.A.Sc. The fortunes of the Toronto program were very much intertwined with, and subject to the whims of, the Mechanical Department.

The program at UNB was not popular, even though the total engineering student population constituted about a third of the entire student body. The want of a degree program aroused some discontent among the students, leading them in 1899 to petition the senate to establish a degree in engineering. The petition was granted establishing the Baccalaureus in Arte Ingenaria. Unfortunately, the students were not altogether happy with this choice of name, petitioning again in 1907 for a more "modern" version. One could speculate that the modern student of engineering might appreciate the significance of the B.A.I. rather more than the students of yesteryear.

## **Programs East and West**

Electric street railways, telephone and communication systems, the invention of wireless telegraphy all contributed over the next decades towards an enthusiastic acceptance of things electrical. More and more electrical engineering graduates were needed to satisfy the needs of industry as electrification became a reality. By 1911 Toronto's graduating class of 24 rivalled McGill's in size. In 1909 two new schools were opened to help satisfy the demand. The first, Nova Scotia Technical College, was established to provide the last two years of a five year engineering program. Students took their first three years at one of the liberal arts and science colleges of Nova Scotia, Prince Edward Island or New Brunswick. The Electrical program was begun in the fall of 1909, coinciding with the opening of the college.

When the University of Manitoba requested a substantially increased grant from the province in 1907, the province responded with an increase but only on condition that the university implement programs in civil and electrical engineering. Edward Phillips Featherstonhaugh, an 1899 graduate in electrical engineering from McGill University, became the first Professor of Electrical Engineering at Manitoba with the establishment of the department in 1909. The department was temporarily housed in various makeshift facilities while the newly created Manitoba legislature attempted to come to grips with the problem of providing permanent accommodation to the university. In 1915 the engineering departments were established in "the old Deaf and Dumb Institute", an act which doubtless gave rise to many a ribald jest from the Arts faculties, which had been established in the old law courts building. There were two graduates with the degree of B.E.E. in 1911. Since then the department has grown in prominence and prestige commensurate with its early founding.

## **H.M. Tory and H.J. MacLeod and the Westward Movement**

McGill's great tradition of scientific and educational accomplishment was carried westward in 1906 by Dr. Henry Marshall Tory, who established McGill University College of British Columbia. In keeping with the McGill tradition the college appointed an instructor in engineering, opening its doors in that first session to 15 students in applied science. With the incorporation of the school as the University of British Columbia in 1908, and for some years thereafter, only the first two years of the engineering program were completed, students then proceeding to McGill University for the final years. Shortly after the founding of the school in

British Columbia, Dr. Tory was lured to Alberta to assume responsibility for a new university for that fledgling province. As President of the University of Alberta, Tory moved quickly to hire faculty to teach applied science and engineering. The Department of Electrical Engineering was established in 1913 under Dr. R.W. Boyle. Hector J. MacLeod, a 1914 graduate of McGill, was appointed as instructor in the department shortly thereafter, obtaining his M. Sc. from Alberta in 1916. The Western University Battalion (196th) was formed and went overseas in the fall of 1916 with Captain H.J. MacLeod commanding the Company. After obtaining his Ph.D. from Harvard in 1921 Dr. MacLeod returned to Alberta and was later appointed as Head of the Electrical Engineering Department. In 1936, some twenty-two years after his arrival on Alberta's campus, he transferred his service to the University of British Columbia, becoming head of the Department of Electrical Engineering there. World War II saw him actively engaged in research on behalf of his country with the National Research Council. For his service he was awarded the O.B.E. in 1943. In 1973 Dr. MacLeod, by this time, Dean Emeritus of Engineering at UBC, was awarded the MacNaughton Medal by the Canadian Region of IEEE.



*Dr. Hector J. MacLeod, 1914 graduate of McGill, and Mrs. MacLeod, receiving MacNaughton Medal in 1973.*

## **Marching Off to War**

As the "Great War" descended upon the world, the population of the universities took a turn for the worse. In some cases programs folded up completely. The pre-engineering program begun at Saskatchewan in 1916 closed its doors when its entire faculty marched off to war. Alberta's fledgling program came to a halt, not recovering again until 1920. Manitoba's program reached a hiatus in 1917, while enrollments in the larger schools were cut to a quarter. On the other hand, at war's end, the returning veterans brought with them a strength of purpose that served the universities well in the longer run. The veterans also helped to increase the popularity of the programs.

## **After World War I**

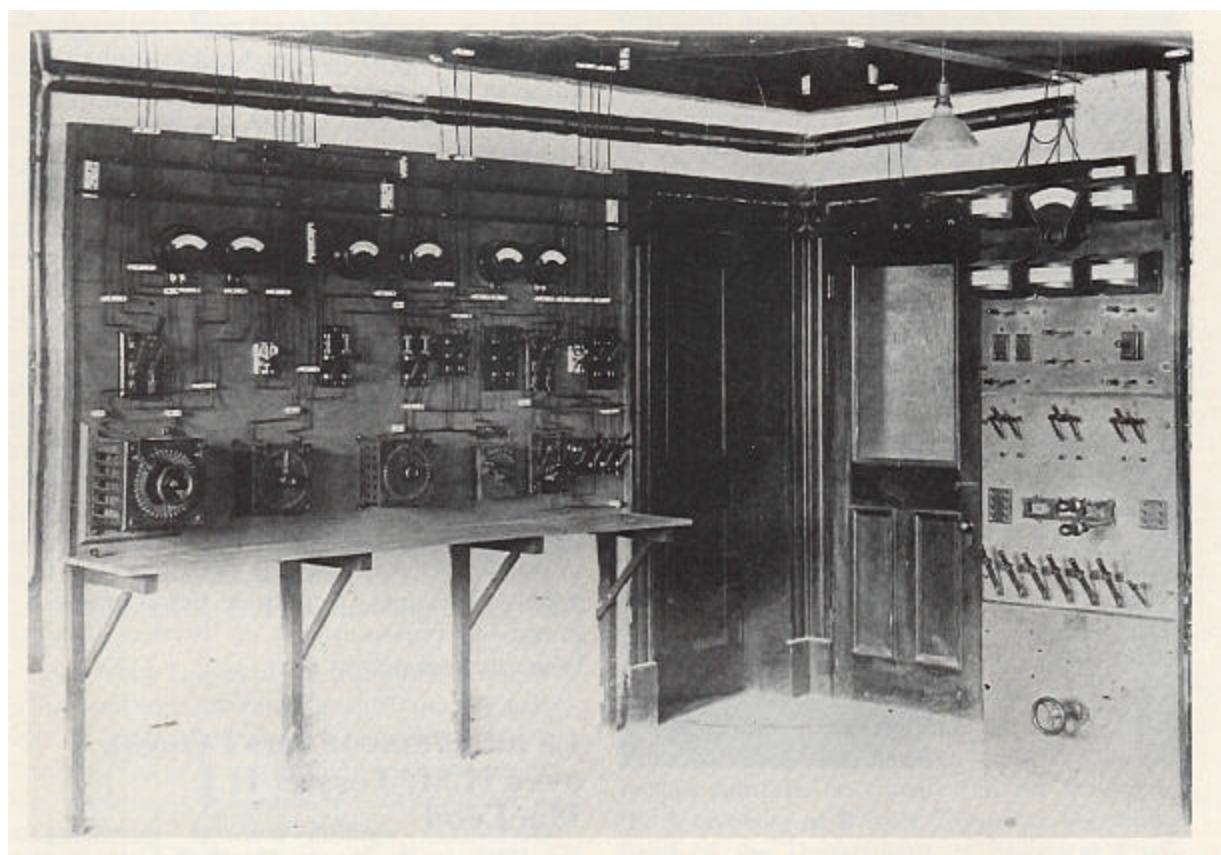
After the degree program in electrical engineering was begun at the University of British Columbia in 1922, no new programs were begun in Canada for more than two decades. The eight universities with the electrical programs continued to supply the needs of Canadian government and industry with electrical graduates. The principal needs during this time were in the burgeoning area of power development. Telephonic systems took a few graduates, while commercialization of the wireless also took increasing numbers. As radio became more popular, there was an upsurge of interest in it as well, although the lack of equipment deterred any substantial laboratory work in the subject. The stock market crash in 1929 caused a decline in enrollments since prospects for graduates during the next several years were generally poor. The

exception was in the growing field of commercial radio, although radio facilities in the schools themselves were not good. Even up to 1929, the only experimental station operated by a university in Canada was that at the University of New Brunswick.

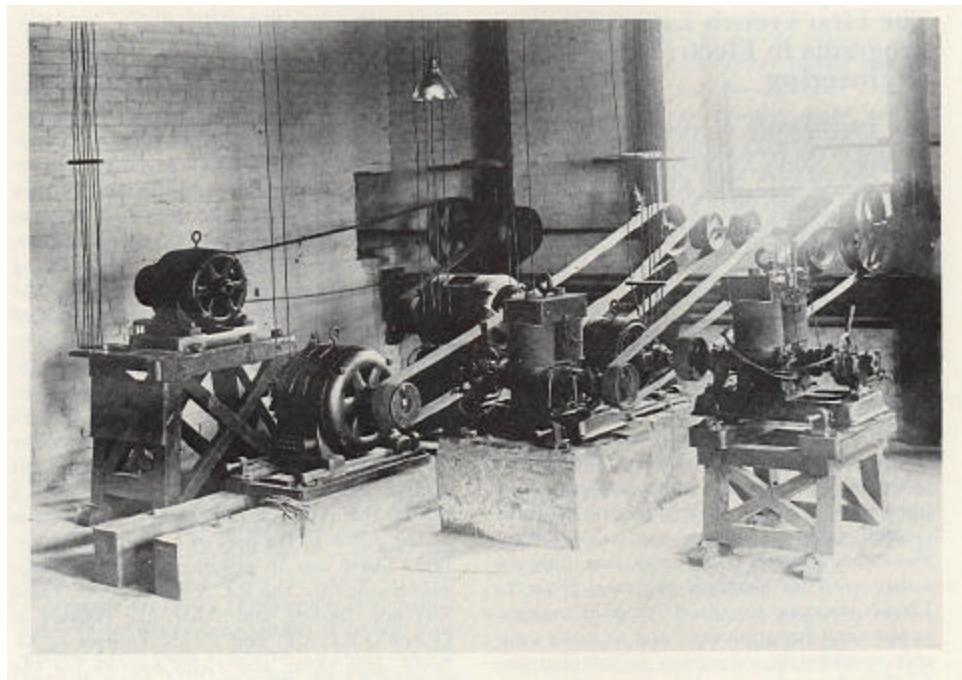
The program at UNB was also enriched by the installation of a commercial radio transmitter on the campus in the late twenties. Space was made available on the top floor of a new Forestry building to operate the transmitter for radio station CFNB. Much of the operation was done with the assistance of the students, together with Alfred Foster Baird, a 1914 graduate of UNB who had returned to take charge of the Electrical Department.

Amateur and educational broadcasting stations were also operating at several Universities across Canada. At Alberta, for example, a University Radio Station, CKUA, went on the air on November 21, 1927. It was used by the Electrical Engineering Department for studies carried out by the students. Dr. George Sinclair, a 1933 graduate, used it in his thesis to develop a method for determining the impedance of an antenna using a counterpoise in place of the traditional ground system. Dr. Ed Jordan was another graduate of Alberta (1934) who, during his thesis work, used the radio station to develop an automatic volume control amplifier for the station—a Canadian first.

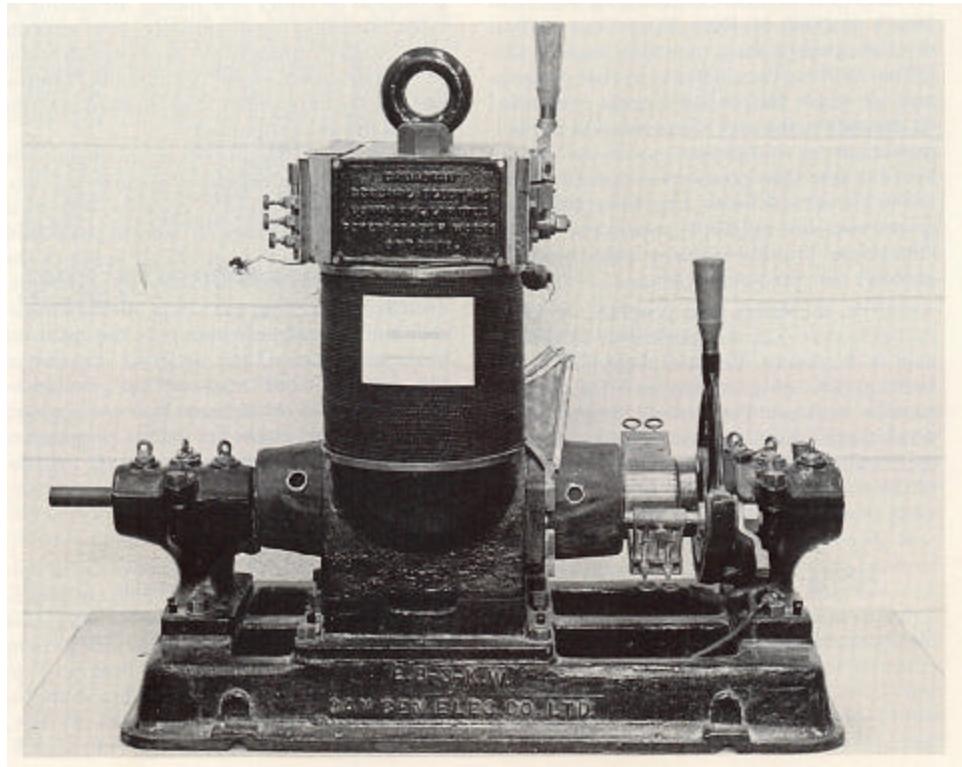
In spite of this new field of endeavour, class sizes did not increase dramatically. Due to world factors such as the Great Depression and the increasing threat of a new war which followed, there was not a great deal of increased interest in electrical engineering career opportunities.



*Work Station Electrical Engineering Power Laboratory, University of New Brunswick, 1918. Photo courtesy of UNB.*



*Electrical Engineering Power Laboratory, UNB, showing 2.32 volt DC machines circa 1880. Photo courtesy of UNB.*



*Restored machine for Power Laboratory, now in Electrical Engineering Museum, UNB.*