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Electrical Engineering

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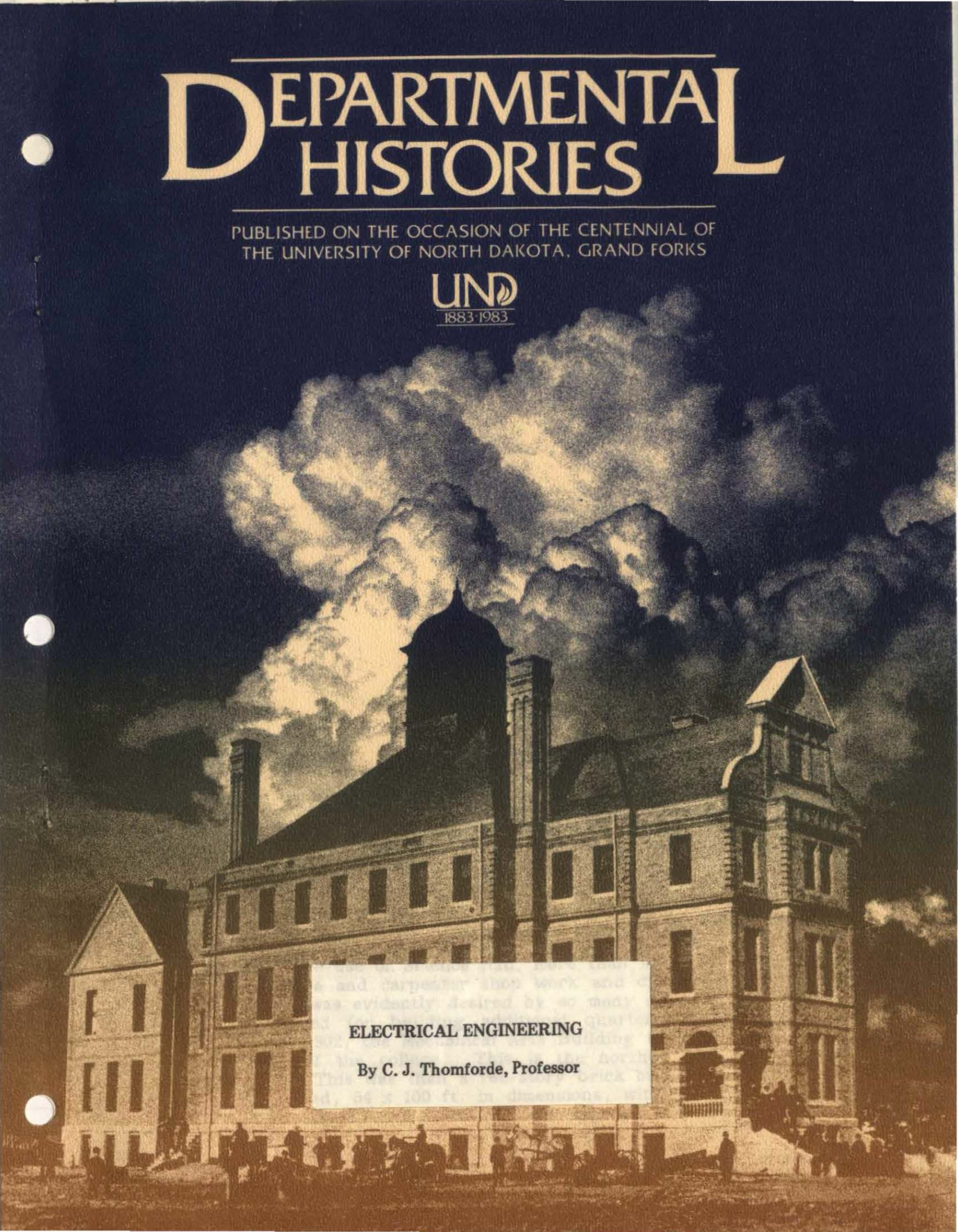
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ELECTRICAL ENGINEERING

By C. J. Thomforde, Professor

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In the spring of 1901, E. J. Babcock, Dean of the School of Mines, University of North Dakota, concluded it to be a suitable time for the announcement of one or more engineering curriculum to be added to the School of Mines. Among the reasons given for this conclusion was that an increasing number of students were apparently interested in "work of such sort", and hence, would likely go to some out of state college if it were not provided here. Space would be no problem as the proposed engineering school could be housed in the new Science Hall. Dean Babcock's recommendation was acted on favorably, and the four year mechanical engineering degree under the College of Mechanical Engineering was initiated.

UND President Webster Merrifield spent considerable time in the spring and summer of 1901 visiting engineering colleges to seek a man who was "well grounded" and successful in some form of engineering, to head the engineering college. He found his man in Calvin H. Crouch, (M.E. Cornell University, 1892), who was then employed by the Baldwin Locomotive Works of Philadelphia. President Merrifield appointed Crouch as Director of the College of Mechanical and Electrical Engineering, which now became a separate college from the School of Mines.

Crouch arrived at the University in the summer of 1901, and immediately began his duties by supervising the construction of the Science Hall, which opened for use just before Christmas, 1901. Engineering occupied the basement, physics and mathematics the first floor, chemistry the second, and biology and the museum the third floor.

E. F. Chandler writes in his history: "Neither of these curriculums as thus first announced was according to the present (1930) standards. Perhaps, neither could really have been called a satisfactory curriculum even for that day. But it was not expected that there would be any students, or merely a single one or two, in the first coming year above the freshman grade, and the freshman year of the proposed curriculums was good enough. Publication of complete courses, even in the preliminary form, was expected to open the door ready for their subsequent amendment and improvement into really good standard form in the following years, before any student reached the upper years of the curriculums. Thus, the official start of engineering college instruction under that title was in September, 1901".

With the beginning of the use of Science Hall, more than half of the basement was occupied for machine and carpenter shop work and drafting room space. But that kind of work was evidently desired by so many students that funds were immediately obtained for building additional quarters for the college. During the summer of 1902, the Mechanical Arts Building was erected for the purely technical work of the college. This is the northeast portion of the present Chandler Hall. This was then a two-story brick building, well lighted and conveniently arranged, 54 x 100 ft. in dimensions, with a one-story wing 54 x 20 ft.

The 1902 Bulletin of the University proudly goes into detail of the building. It states, "On the first floor are located the machine shop, the blacksmith shop, the mechanical laboratory and the locker room, and in the wing adjoining is the foundry. On the second floor are the wood-working shop, the free-hand drawing room, the draughting room, the class rooms, the reading room, and the offices."

The catalog continues for another page listing in detail what appears to be each and every machine in the building. Noticeable by its absence is the lack of any equipment that could be called "electrical" for the use of students who wanted to obtain that degree in engineering.

A description of the course work leading to the degree of Bachelor of Science in Electrical Engineering indicates that a single course entitled "Electrical Engineering" requiring four recitations a week for three quarters was the extent of the electrical coursework taught at this time. The course was described as "Theory of Dynamos, Electrical Machinery, etc. Lectures and recitations, 4 hours per week:.. Other than this course, the work for Mechanical Engineering and Electrical Engineering was identical.

For the next few years, the curriculum for electrical engineering remained unchanged. Professor Crouch was listed as instructor in the course.

By 1907 there were two courses in electrical machinery, one taught to mechanical engineers and one to electrical engineers, each three quarters in length, and both taught by Professor Crouch.

Geiger states in his history, "By 1907 Crouch had arranged with Cornell to accept his students without condition or loss of credit, and he could report with pardonable pride that two of his graduates had given 'entire satisfaction' as teaching assistants at his alma mater."

The first electrical engineering graduate was in 1908, John F. Stevens. The catalog for that year showed that the University had changed to the semester system, and the coursework in electrical engineering had been increased considerably. The courses listed were Dynamo Electric Machinery, Dynamo Laboratory, Alternating Currents, Machine Design (electrical), Electrical Engineering, and Thesis. Professor Crouch was the only instructor listed by name, although another staff position was apparently authorized but had not as yet been filled when the catalog went to press.

By 1909 that position had been filled by Kenneth A. Page, B.S.M.E., Instructor in Mechanical Drawing, who was now teaching the courses in Electrical Engineering with Professor Crouch. The total work in electrical engineering had now increased to twenty-six semester hours. D. Robert Francis received his degree of B.S.E.E. in 1909, the second student to have received that degree from the University of North Dakota.

In 1910, the first instructor in electrical engineering was appointed, Sam R. Rhodes, M.S.E.E. The catalog indicates that he taught all the courses in electrical engineering except for the three electrical laboratory courses taught to mechanical engineering students by Professor Crouch.

The 1910 catalog also lists various equipments for use in the electrical laboratories: "Electric fans, one $8\frac{1}{2}$ kw direct current generator, one $1\frac{1}{2}$ kw direct current generator, one $7\frac{1}{2}$ kw alternating current three-phase generator designed for laboratory purposes and capable of being converted into a direct current generator, rotary transformer, synchronous or induction motor, one $7\frac{1}{2}$ kw three-phase alternating current generator, one $5\frac{1}{8}$ kw direct current generator, one 2 hp single-phase induction motor, three transformers, and instruments, including ammeters, voltmeters, wattmeters, power factor indicators, for measuring both direct and alternating currents". Interestingly, the catalog also states: "It is expected that graduates of this college will in a short time be competent to assume such responsible positions as superintendents, master mechanics, chief designers, consulting engineers, etc., for manufacturing and engineering establishments".

Howard Christie was the third person to receive his B.S.E.E. degree from the college in 1910. Two students received their degrees in 1911, and two in 1912. Raymond Heising, later world known for his work on modulation, was one of the students who received his degree that year. Five students received the B.S.E.E. degrees in 1913 and two in 1914. Harry Nyquist, later world known for his work on amplifiers, negative feedback and control systems, was one of the students who received his degree in 1914. He is listed as having received a degree in 1915 also, apparently the degree of Electrical Engineer. That graduate degree was authorized in 1911. Three students received the B.S.E.E. degree in 1915.

Mr. Rhodes, now Assistant Professor, resigned in 1913, and was replaced by J. Floyd Stevens, B.A., M.E., as Assistant Professor of Electrical Engineering. The 1915 University catalog indicates that Mr. Stevens was teaching all the courses in the Department. This catalog also lists the equipment available in the laboratories as follows: "For the work in Electrical Engineering, the dynamo laboratory is well equipped to give advanced graduate as well as undergraduate work. Among the important pieces of apparatus may be mentioned a 20 hp direct current motor, one $8\frac{1}{2}$ kw D.C. generator, one $7\frac{1}{2}$ hp interpole variable speed D.C. motor, two 5 hp D.C. motors, two $7\frac{1}{2}$ kw alternating current three-phase generators, one of which make it possible to operate as three different types of induction motors. There is also a mercury arc rectifier, a three kilowatt constant current transformer, a small storage battery and several smaller direct and alternating current machines besides a slate switch board 4' x 16' upon which are mounted a large assortment of direct and alternating current instruments. All D.C. machines are provided with suitable rheostats and starting boxes that may be operated either as motors or generators. There is a large assortment of portable instruments with ranges covering anything likely to be needed in the ordinary laboratory work."

With the United States about to become involved in the World War, a six semester hour requirement in a foreign language was initiated in the electrical engineering coursework. Either French, German or Spanish was acceptable, at that time, 1916. In 1918, the requirement had been increased to 8 semester hours, but, as was stated, "If two units of modern language were offered for entrance, other language or technical subjects may be substituted with the approval of the Dean".

Stevens left the department in 1919 and was replaced by David R. Jenkins, B.S.E.E., E.E., Colorado University, as the Professor of Electrical Engineering, and who was to remain with the department until his retirement in

1945. Jenkins brought with him Ernest F. Peterson, B.S.E.E., Colorado University, as Instructor in Mechanical and Electrical Engineering. Jenkins taught all the courses offered by the Department except the Dynamo Laboratory taught to both the electrical and mechanical engineering students by Peterson.

The foreign language requirement had now been dropped, initiated only three years previous. The course work was still very heavy in dynamos, another name for rotating electrical machinery, but it is noticed that Jenkins had initiated a required course in Telephone Engineering as well as Illumination and Photometry. The introduction of these two courses seem important to the writer as they are the first in the electrical engineering curriculum that are not a "Dynamo" type course.

The number of electrical engineering students graduated during the war years fluctuated considerably: 5 students in 1916, none in 1917, 7 in 1918, 1 in 1919, and 2 in 1920.

In the 1919-1920 University catalog, the familiar description regarding electrical and mechanical engineering coursework continues: "The courses in mechanical and electrical engineering are similar for the first three years, but during the fourth year the student specializing in electrical engineering devotes more time to work in the dynamo laboratory. In the 1920-21 catalog, the curriculum describing electrical engineering now stands by itself. The work in the senior year included a study of the design of electrical machinery, transmission and distribution lines, and systems of electric traction and communication. A fifth year of Electrical Engineering is listed with a requirement of thirty-six semester hours, which led to the awarding of the Master of Science in Electrical Engineering degree.

Peterson left after one year and was replaced by D. C. Choate, M.S.M.E., Kentucky University, as Instructor in Electrical Engineering.

In 1921, Choate left to be replaced by Thomas Matthews, B.Sc., Colorado, and M.Sc., Cornell, as Instructor in Electrical Engineering. The following year, he was advanced to the position of Assistant Professor.

For some time, there had been considerable interest at the University in radio and radio broadcasting. In 1923, the Electric Construction Company of Grand Forks was in the process of building a small 100-watt radio station. Finding the expense of completing and operating a radio station excessive, the University was able to secure \$750 for the purchase of the partly completed station and a small amount of studio equipment. A license was obtained from Washington which assigned a frequency of 1,310 KHz to the station with call letters KFJM. The installation was completed in the Mechanics Arts building and some test programs were broadcast in June but it was decided to defer the formal opening of the station until fall.

It was planned to have Matthews serve as the licensed operator of the station, but just before the opening of the University in September, Matthews resigned to accept a position in Iowa.

Ellis O. Erickson, who had just graduated from the department the preceding June with the degree of B.S.E.E., was persuaded to return from a position with Westinghouse to serve as Instructor in Electrical Engineering and chief

operator of KFJM for two years, then returning to his position with Westinghouse in 1925.

The station went on the air October 22, 1923, and was the only station on the air in the Grand Forks area. The station broadcast regular weekly programs of talks and music during the academic year. Football games were broadcast from the field, play by play, and likewise, basketball games from the armory. During the first year of operation, musical programs from the city auditorium and other places downtown were broadcast. During the second year of operation, dinner hour music from the Dacotah Hotel was broadcast daily.

In the March, 1926, issue of the North Dakota Engineer, D. R. Jenkins, Professor of Electrical Engineering writes: "The programs offered by the hotel orchestras are mainly representative of the "jazzy" type of music, and the many requests that come in for the repetition of the least desirable numbers raises the question whether the radio public really cares to listen to good music. The mixed program of talks and music that we give on Thursday nights, although almost uniformly good, does not, for some reason, inspire many of the radio fans to write their appreciation." And adding, "Some of our electrical engineering students have become proficient in the operation of the station and in announcing. Later, when place can be found in the curriculum, one or more courses in radio engineering will be offered for credit."

In 1925 Erickson was replaced by Orval Settles as Instructor in Electrical Engineering. Settles came with a B.A., Wabash, and B.S.E.E., Case School of Applied Science. Also added to the staff was Earl A. Garard as Graduate Assistant and Chief Operator of KFJM. Garard was a graduate (B.A.) of Carthage College.

In 1921 there were two graduates from the department, in 1922 there were six, including R. B. Witmer, who became Dean of the College of Liberal Arts in 1949. Witmer was appointed Graduate Assistant in the Physics department, but continued graduate studies in the electrical engineering department and was awarded his Masters' degree in Electrical Engineering in 1926. In 1923 there were eight graduates, seven in 1924, five in 1925, and twelve in 1926. The 1926 list included the name of John Hutcheson, who later became Vice-president of Engineering for Westinghouse Manufacturing, and still later, Chairman, Division of Engineering, National Research Council. In 1927, there were fifteen graduates from the department, a number not to be surpassed until 1949.

In 1927, the curriculum, which had remained essentially unchanged since 1920, indicated that the freshman and sophomore coursework for all engineering students were identical. Specialization for a particular field took place in the junior and senior years. It is to be noted that a total of 151 semester hours were now required for graduation, of which 35 hours were in electrical courses.

Under Garard, the radio section of the electrical engineering department became very active. An amateur radio license was obtained in January, 1926, (W9BPM) and the station went on the air with a power of 50 watts. That year communication was held regularly with the Norwegian Whaler, S/S Nilsen Alonso, which for a time was frozen in the ice near the South Pole. This ship was affiliated with the Byrd Antarctic Expedition. At another time a daily early morning schedule was kept for a period of several weeks with the motor yacht Warrior on its way from Hong Kong to New York after having traveled half-way around

the world. In 1929, the power of the amateur station had been increased to 150 watts.

Settles left the department in 1927, and was replaced by Harold F. Rice, B.S.E.E., E.E., Colorado University. By 1928, the department was offering elective courses such as Electrical Communication, taught by Jenkins, two courses in radio engineering, a course in radio station operation, and a course in radio communication, all taught by Mr. Garard. This last course required the ability of transmitting and receiving the International Morse Code, and consisted of the practice of handling the radio telegraph and radio telephone equipment as found at the University radio station. By 1929, the two courses, electrical and radio communication had been combined into a single course.

By 1930, the curriculum still contained such courses as Pattern Making, Foundry and Forge, Surveying and Machine Design. Mathematics through two semesters of Calculus, three semesters of Physics, two semesters of Chemistry, and one semester of Chemical Engineering were required. In 1931, Pattern Making, Foundry and Forge was dropped and Differential Equations was added. Also in 1931, the idea of "Options" was first introduced. The student could now specialize in the fields of: Radio Engineering and Advanced Circuit Theory, Radio Engineering and Electric Distribution, or Electric Power and Telephone Transmission. During the depths of the Depression Years, 1932 to 1934, the University Catalog was cut severely in size and the detailed course requirements of the various curriculums were eliminated. When the course requirements were again printed in 1935, the requirements had remained essentially unchanged.

As was stated previously, the 100-Watt radio broadcast station, KFJM, went on the air in 1923, with technical operation under the jurisdiction of the electrical engineering department. The first antenna consisted of a parallel, six-wire Marconi antenna on top of Chandler Hall. This was later discarded in favor of a higher single wire antenna strung between the chimney of the old power plant (then a part of Chandler Hall) and Davis Hall, the girl's dormitory. In 1929, President Kane of the University leased the programming of the station to a downtown Grand Forks business man, Dalton LeMasurier, who operated the station in a commercial fashion, and paid the University for the use of the time. The University retained broadcast time of some two hours per day. Operating hours were increased now to approximately 60 hours per week, and the money from the lease enabled the equipment to be maintained and improved.

Technical changes continued to be made by the department, however, by 1934 it was felt that the transmitter had outlived its usefulness, and it was decided to construct an entirely new unit. The radio committee on the campus meanwhile applied to the Federal Communications Commission for an increase in power and a different antenna location. The new transmitter was to operate with 250 watts of power, and after a number of changes in frequency since 1923, on 1,410 KHz. Most of the equipment had been assembled when word was received that KFJM had been granted authority to use 1,000 watts of power.

This completely altered the original plans and it was decided to purchase a complete 1,000 watt transmitter. A transmitter building was constructed on a knoll across from the coulee. It contained two main transmitter rooms, one for the broadcast installation, and the other for amateur work. The equipment which had been assembled for the 250 watt transmitter was now used as an

amateur transmitter. In addition, there were living quarters in the basement of the building for the operators. The 1,000 watt station went on the air on November 7, 1936. A vertical antenna tower was also constructed nearby.

In 1936, Garard left to be replaced by Elwin J. O'Brien, B.S.E.E., M.S.E.E., University of Iowa. He was advanced to Assistant Professor in 1937. The curriculum for the 1936-1937 year shows quite a few changes: a new course is now offered to sophomore electrical engineering students, Electric and Magnetic Circuits. The "Option" selection is defined more clearly, and the student can now select either the Power Option, or the Communications Option. A total of 30 different courses were now being offered by the department.

In March, 1936, the Engineer's Council for Professional Development (ECPD) informed President West that it was going to begin inspections of engineering schools for accrediting the following fall. The council believed that accrediting by a united agency such as ECPD was necessary to insure the quality of engineering education of the various engineering departments in the United States.

In October, 1937, Dean Harrington received notice from the ECPD that the Electrical Engineering Department had been granted accreditation. It was hoped that this action would serve to guide prospective engineering students in the selection of a suitable school for their education. The Department of Electrical Engineering is proud of the fact that in 45 years, it has never lost its accreditation.

In 1928, eleven students were graduated, one of which was the Master of Science degree, eight in 1930, eight in 1931, six in 1932, and nine in 1933 of which three were with the Master of Science degree. The department was not to equal this number of Master of Science degrees in one year again until 1959. In 1934, eight students received their degrees, ten in 1935, eight in 1936, eight in 1937, five in 1938, and nine in 1939, of which one was the Master of Science degree.

After the 1936-37 catalog, the curriculum showed little change until 1947, after World War II. Professor Rice became quite ill in 1939, and his work was taken over by a number of temporary instructors. Records show that he was on leave of absence the second semester of 1940-1941. Charles W. Rook, B.S.E.E., Colorado University, was appointed Instructor in 1941. O'Brien was advanced to Associate Professor in 1942, but went on leave of absence to enter military service in 1943. Rook was advanced to Assistant Professor in 1944. Jenkins retired from the University in 1945, which left Rook the only instructor in the department that following year.

In 1940 seven students received their Bachelor's degree in Electrical Engineering, ten in 1941, eleven in 1942, seven in 1943, one in 1944, two in 1945, and none in 1946. Most eligible students as well as faculty were now in the war effort.

In September, 1946, Chester H. Buchanan, B.S.E.E., Vermont, and M.S., Pittsburgh, was appointed Professor and Head of the Department. Rook left the Department in February, 1947. At that time, Joseph C. Hogan, B.S.E.E., Washington University was appointed Instructor, and Clifford J. Thomforde, B.S.E.E., University of North Dakota, 1941, was appointed Assistant Professor. Thomforde remained with the University until his retirement in May, 1982, a period of over thirty-five years.

A number of changes had occurred in the operation of the University's radio station, KFJM, since the pre-war years. The frequency of operation was now 1,440 KHz. After the departure of O'Brien from the University, the engineering and maintenance of the station essentially transferred from the electrical engineering department to the downtown operator of the station, LeMasurier, who appointed Arnold Petrich as chief operator. LeMasurier had been granted a separate license, KILO, for the commercial segment of operation of the station, and the station now operated from 6 a.m. to midnight, with two hours of operation, 3 to 5 p.m., allocated to the University's programming and under the call letters of KFJM, as previously assigned. The programming of the two-hour segment was assumed by the Speech Department of the University. Thomforde was appointed chief operator of KFJM, primarily because he was properly licensed, but the duty was mostly advisory.

The "Options" in the curriculum were now eliminated, and much of the work in Dynamos had now been replaced by courses such as Electronics, and Electric Transients, taken by all electrical engineering students, and electives, Electric and Magnetic Fields and Ultra High Frequency Techniques. Thomforde is listed as instructor in all of these courses.

Buchanan left after one year and Hogan after one semester in the summer of 1947. They were replaced by Keith B. MacKichan, B.S.E.E., M.S.E.E., M.B.Ad., University of Michigan, as Professor and Head of the Department, and Neith J. Pollard, B.S.E.E., E.E., University of Michigan, as Instructor. A choice of six semester hours of Technical Electives continued as part of the program, and the list of electives available has now increased to six courses, which included in addition to those above, Economics of Design, Industrial Electronics, Symmetrical Components, and Advanced Electrical Engineering Problems. Four of the courses carried five hundred numbers, that is, they were graduate division courses.

Four students were graduated in 1947 and six in 1948. Enrollment was increasing again after the conclusion of the war, and it was necessary to increase the staff with the addition of an additional instructor. Robert G. Brown, B.S.E.E., M.S.E.E., Notre Dame, became a member of the staff in September, 1948. This was the first increase in staff size (now four) since 1928. Pollard left in 1949 and was replaced by Robert C. Huntington, B.E.E., M.S.E.E., University of Minnesota. That year, 1949, also saw the introduction of a new course, Servomechanisms, initiated by Brown, who later in collaboration with George Thaler of Notre Dame, published a textbook in 1953 entitled "Servomechanism Analysis". The book was well accepted throughout the country.

In 1949, the number of graduates had increased to twenty-one. This was the largest graduating class since 1927. In 1950, the number of graduates swelled to thirty, but by 1951, the number had dropped to twelve, and in 1952 to ten.

Huntington left in 1950 and was replaced by Raymond Berg, B.S.E.E., and working toward his Master's at Iowa State College. Brown left in 1951, which reduced the number on the staff back to three. It remained at this size for a few years.

Plans for a new engineering building had been discussed for some time with the increased enrollment taking place after the conclusion of the war. The building request was finally approved by the State Board of Higher Education in 1948,

and approved by the legislators in 1949. Plans were begun immediately. Plans were approved and construction begun in 1951, with the building occupied in the 1952-53 session.

Electrical Engineering had offices on the first and second floors, and an amateur radio room on the third floor. The electrical laboratories were also on the first and second floors of the building.

Amateur radio never became the dynamic force in the new building that it had reached during the 1925-1935 period under Garard, when, for example, the group had kept daily contact with the Byrd Antarctic Expedition. The field of amateur radio had become less an experimental area and more of a hobby-craft, and in the 60's, the amateur radio was moved from the engineering building and Electrical Engineering Department's jurisdiction to the Student Union Building.

Berg left the department in 1953, and was replaced by John D. Dixon, B.E.E., University of Minnesota, and M.S.E.E., University of Missouri. Dixon is Chairman of the Department at the present time (1982). In 1954, MacKichan left the department to set up a consulting engineering firm in Grand Forks, and Thomforde, now with a M.S.E.E., Iowa State College, was named Professor and Head of the Department. Kenneth S. Vig, B.S.E.E., University of North Dakota, and Maurice J. Stoughton, B.A., Harvard, M.S., Princeton, were added to the department. Stoughton left after one year.

The enrollment remained fairly constant during this period, with fourteen students receiving their degrees in 1953, nine in 1954, thirteen in 1955, and eleven in 1956.

To 1946, the previous 15 years had seen little change in the curriculum, but a considerable change had been made in the post-war ten years. For example, freshman electrical engineering students were no longer required to take such courses as surveying and engineering materials. Options such as Illumination, Power, Electronics, were no longer being offered; the pre-dominance of power oriented courses was no longer the case. Six credit hours of technical electives in any area the student selected, such as electrical power, microwaves, automatic control, advanced circuit analysis, electronics and television was available.

Roger Brandt, B.S.E.E., 1956, University of North Dakota was appointed Instructor that year, which brought the number of the staff to four. Then in 1957, Melvin M. Orseth, B.S.E.E., University of North Dakota, was appointed Instructor which added one more member to the Department. Both continued graduate work toward their Masters' degrees.

Vig left in 1957 and was replaced by James W. Hill, B.S.E.E., M.S.E.E., California Institute of Technology. Hill left in 1959, and was replaced by Jack N. Krueger, B.S.E., M.S.Ag.E., University of Minnesota. Krueger is a present member of the Department (1982) and has attained rank of Professor.

Also leaving in 1959 were Brandt and Orseth, who had now earned their M.S.E.E. degrees together with another student, Paul Scheibe. No graduate degrees had been granted since 1941, then received by Orville Mundt. Three students had received their Masters' degrees in 1933, a number which had now been equalled.

Paul Scheibe, who had just received his M.S.E.E., University of North Dakota, was appointed Assistant Professor, and William A. Bares, who had just received his B.S.E.E., University of North Dakota, was appointed Instructor and continued to work on his Masters' degree.

The number of students now receiving their degrees had now increased to 19 in 1957, to 26 in 1958, to 34 in 1959, and to 32 in 1960.

Scheibe left after one year, in 1960, and was replaced by Gerald W. Neudeck, who had received his Masters' degree from North Dakota University that June. Carroll N. Day was added as an Instructor at that time, and he too, continued to work on his Masters' degree. Both Bares and Day completed their graduate work, were awarded the M.S.E.E. degrees in 1961, and left the Department at that time.

To replace Bares and Day, Donley J. Winger and Larry P. Segar were appointed Instructors in 1961. Both had received their B.S.E.E. degrees from the University, and continued to work toward their Masters' degrees while teaching in the department.

The amount of effort required to maintain the laboratory equipment continued to increase over the years. Carroll Day was devoting part of his time--away from his teaching--to keep the equipment in repair. With his leaving in 1961, it was felt to be a proper time to have a full time technician for the laboratory, and Robert Miller, a graduate from the Wahpeton School of Science was employed for his position.

Professor Dixon was awarded a grant of \$11,000 for undergraduate equipment by the National Science Foundation in 1962. The funds were used to purchase Analog Computer equipment for the laboratory.

In May, 1962, the honorary Electrical Engineering fraternity, Eta Kappa Nu, was established at the University. This fraternity accepts applications from junior and senior electrical engineering students in the upper third of their class, promotes scholarship, and continues to this day to be active in furthering experimentation, research and paper writing among the students in the Department.

Winger received his Masters' degree in 1963 and left. Added to the Department at that time were Thomas F. Krile and Paul G. Tumms, both having received their B.S.E.E. degrees from the University, and both working toward their Masters'.

Neudeck left in 1964 to continue work toward the PhD. degree at Purdue. He was replaced by John R. Viger, B.S.E.E., North Dakota, who continued to work toward his Masters' degree.

Professor Thomforde was awarded a grant of \$6,500 for undergraduate equipment by the National Science Foundation in 1965. The funds were used to purchase laboratory equipment for engineering students not majoring in electrical engineering.

Krile received his Masters' degree in 1965, and left to continue work toward his PhD. degree. Added to the Department at that time were Conrad Kopala,

M.S.E.E., Pennsylvania State University, and Kung-chi Wang, PhD., Northwestern University.

The staff now consisted of seven members: Thomforde (Chairman), Dixon, Kopala, Krueger, Tumms, Viger, and Wang. The number of graduates from the Department were generally increasing during this period: 34 in 1961, 23 in 1962, 21 in 1963, 51 in 1964, and 49 in 1965. The number of Masters' degrees granted by the Department were 3 in 1959, 2 in 1960, 3 in 1961, 2 in 1962, 5 in 1963, 3 in 1964, and 8 in 1965.

The large increase in students graduating toward the end of this period was due to a contract that the University had with the Air Force Institute of Technology (AFIT) to accept approximately seventy-five officers into the Engineering College, and to offer them work leading to the Bachelor of Science degree. This essentially doubled the number of classes taught during this period, and in fact, during the summer of 1963, a full semester's work was offered by the Department. A number of the AFIT students stayed on to work toward their Masters' degrees, and five of the eight students receiving the Masters' degrees in 1965 were AFIT students.

The curriculum had undergone several changes in the past ten years. For example, students now entering engineering were expected to go directly into calculus rather than spend a full year in Engineering Mathematics in preparation for the calculus sequence. Actually, less than half of the students were qualified at that time to enter calculus directly from high school, but it was hoped that this would encourage high schools to improve their mathematics sequence. Six to eight hours of Humanities were now required to all Freshman. Computer Programming was a required course in the Sophomore year. The course in Nuclear Physics, new in 1956, had now been replaced by two courses in physics, Modern Physics and Solid State Physics. The course in D.C. Machinery and Laboratory had now been deleted and additional course work in electrical circuits had been added. A greater selection of electives were available which included such courses as Nuclear Instrumentation, Semiconductor Circuits, Semi-conductor Electronics, Digital Computer Logic together with those electives listed in the 1956 catalog.

Kopala left in 1966, and was replaced by Chien Chow, PhD., University of New Mexico. Ronald D. Moe, B.S.E.E., University of North Dakota, M.S. (physics), UND, M.S.E.E., University of Washington, was also added to the staff.

In 1967, Tumms, Viger, and Wang left the Department. They were replaced by Sheng Y. Hwang, PhD., University of Texas; Robert Rust, B.S.E.E., University of North Dakota, and William A. Bares. Bares had left in 1961 after earning his Masters' degree from UND. He had now earned the E.E. degree from Stanford University, and was completing work toward the PhD. at the University of Wyoming. He was awarded that degree in 1968.

In 1968, the University began to participate in a large research project called "Man-In-The-Sea", or High Pressure Life Laboratory, (HPLL), which essentially was an investigative project involving the maintenance of life functions in the deep sea atmosphere and was designed to pave the way for increased utilization of undersea resources. It was sponsored by the U.S. Office of Naval Research and the original grant and subsequent renewals amounted to several million

dollars. It involved the Departments of Electrical Engineering, Mechanical Engineering, and Physiology and Pharmacology. Bares was particularly involved in the project with his expertise in the field of computer process control together with others from the department. Several published papers resulted from this research as well as research papers for Masters degrees.

In 1968, Rust left, having earned his Masters degree, and was replaced by Dennis Hodges, B.S.E.E., UND. Chow left and was replaced by Shih-mei Ching, PhD., University of Illinois, who stayed only one semester.

In 1969, Moe went on leave of absence to work toward the PhD. at the University of Kansas. New this year were Joallen Hootman, PhD., Iowa State University, and Thomas Trenkle, M.S.E.E., Purdue University, and well on the way toward the PhD., Iowa University. He received the PhD. in June, 1970.

In 1970 Hodges received his Masters' degree, departed and was replaced by Wilfred Bertelt, B.S.E.E., UND, also working toward his Masters' degree. One year later, 1971, Bertelt was awarded the Masters' degree and left. Moe returned from Kansas, and for the first time in years, the staff was made up of instructors, none of whom were working toward an additional degree at the University. The staff consisted now of the following: C. J. Thomforde (Chairman), W. A. Bares, J. D. Dixon, J. Hootman, S. Y. Hwang, J. N. Krueger, R. D. Moe, and T. Trenkle.

There were no changes in staff then to 1974. At that time Thomforde resigned as Chairman of the Department after twenty years, continued as Professor, and W. A. Bares was appointed Chairman. The Electrical Engineering offices were moved to the first floor of the new Engineering Building, Upson Hall II, and for the first time in the history of the Department, all of the faculty offices were adjacent and the secretary-receptionist could serve the entire electrical engineering faculty.

In June of that year, Professor Hwang was awarded a Research Grant by the National Science Foundation in the amount of \$20,900. The funds were used, in part, to sponsor Graduate Research Assistantships and Computer Time in his advanced circuits area.

The number of graduates during the past ten years were: 27 in 1966, 27 in 1967, 25 in 1968, 38 in 1969, 44 in 1970, 30 in 1971, 21 in 1972, 20 in 1973, 18 in 1974, and 24 in 1975. Of these, the number receiving Masters' degrees were 4 in 1966, 4 in 1967, 0 in 1968, 2 in 1969, 6 in 1970, 3 in 1971, 2 in 1972, 3 in 1973, 2 in 1974, and 7 in 1975.

If one compares the 1975 curriculum with the 1965, it is seen that the curriculum continues to evolve to reflect the changing science in the field of Electrical Engineering. The physics sequence now begins the second semester of the freshman year, and continues for five semesters. Chemistry has been reduced to a single semester. The course work in Electromechanical Energy Conversion (previously called Electrical Machinery, and earlier, Dynamos) has now been changed from five hours required to three hours required and three hours elective. The number of electives in the curriculum has been increased from six credit hours to twelve credit hours. New courses introduced as electives are: Computer Hardware Logic, Computer Hardware Organization, Electronic Computer Systems and Real Time Filtering. Most of the previously listed courses were still available.

There were no staff changes in 1975, but in 1976, Bares resigned as Chairman, continued as professor in the Department, and Sheng Hwang was appointed Chairman. Trenkle left, and was replaced by Lindsey Hess, PhD., Physics, University of Illinois as a temporary replacement.

In 1977, Hootman was awarded a Faculty Developmental Leave by the National Science Foundation, and spent a year's leave of absence with the Motorola Company. John Fossum and Mark Holle, both M.S.E.E., University of North Dakota, 1975, returned to instruct for a year.

In 1978, Hootman returned after the year's leave. Bares resigned from the Department, and John Nepple, B.S.E.E., UND, was appointed Instructor for the year.

In 1979, Hwang left the Department and John D. Dixon was appointed Chairman. Nagy N. Bengiamin, PhD., University of Calgary, and Donovan L. Moorehead, PhD., University of California-Berkeley were added to the staff. Nepple continued for one more year as a half time instructor. Moorehead remained for two years and in 1981 was replaced by Banmali Rawat, PhD., Sri Venkateswara University. For the 1981-82 academic year the staff consisted of Dixon (Chairman), Bengiamin, Hootman, Krueger, Moe, Rawat, and Thomforde, instructors; Mrs. Pat Haag, secretary, and David Poppke, laboratory technician. At the end of that academic year, May, 1982, Thomforde retired after thirty-five years in the Department, and was to be replaced by Saleh M. Faruque, PhD., University of Waterloo, Waterloo, Ontario.

As was stated previously, at the conclusion of World War II, the University's radio station, KFJM, was sharing time with the separately licensed downtown commercial operation, KILO. This arrangement continued for several years, both stations desiring increased hours. Thomforde, as engineering consultant, determined that KFJM could be moved to a new frequency, 1,370 KHz, thereby allowing both stations to increase their hours of operation. This proposal was approved by the Federal Communications Commission in 1956. Thereupon KILO moved their transmitter to a new site, and KFJM began operation from 6 a.m. to sundown, daily. With the increased hours of operation it was necessary for KFJM, now operated by a division of the Speech Department, to have its own technical staff. Thomforde continued as consulting engineer. In 1968, the transmitter was moved to a new antenna site approximately one mile north of the campus, and in 1976, the University's FM station went on the air at the same site. And so, the relationship of the University's radio station and the Electrical Engineering Department has become less and less through the years. In 1923, the station was completely the responsibility of the Department, but in 1982 with the retirement of Thomforde from the Electrical Engineering Department, the areas have become completely separated.

The number of graduates from the Department since 1975 were 14 in 1976, 25 in 1977, 33 in 1978, 36 in 1979, 29 in 1980, 42 in 1981, and 35 in 1982. Of these, the number of receiving Masters' degrees were 2 in 1976, 4 in 1977, 1 in 1978, 1 in 1979, 3 in 1980, 3 in 1981 and 7 in 1982.

Comparing the 1982-84 catalog with the 1974-76 catalog, one notices that the greatest change evident in the curriculum is in the area of liberal studies. The latest catalog indicates a requirement of 21 credit hours while in the 1974-76 catalog, the requirement was 16 credit hours. To accommodate the additional hours, Engineering Graphics has been reduced to a single semester.

Comparing the curriculum in the various catalogs through the years since 1902, one obtains a good picture on how the subject interest in Electrical Engineering has changed. When the Department was first begun, primary interest was in the field of rotating machinery, or "Dynamamos" as they were called at the time. Later, interest began growing in telephone technology. This was about the time of World War I. Later the areas of radio communication and vacuum tube circuit analysis held most of the interest. This high level of interest resulted in the start of a radio broadcast station on the campus and a very active amateur and experimental radio stations. This continued fairly constant up to World War II.

After that war, interest continued high in electronics, but shaded toward automatic control systems, or "Servo-mechanisms", in the 1950's. With the invention of the semi-conductor, interest in electronics, now solid-state electronics, was renewed. Now the greatest interest appears to be in the area of computers seen by the number of new courses added in the last decade.

It is believed that Electrical Engineering will continue to be changing, viable, and always interesting field. Where the next area of interest will lie, it is, of course, impossible to state at this time. But whatever it is, it is believed that the Electrical Engineering Department will meet the challenge.