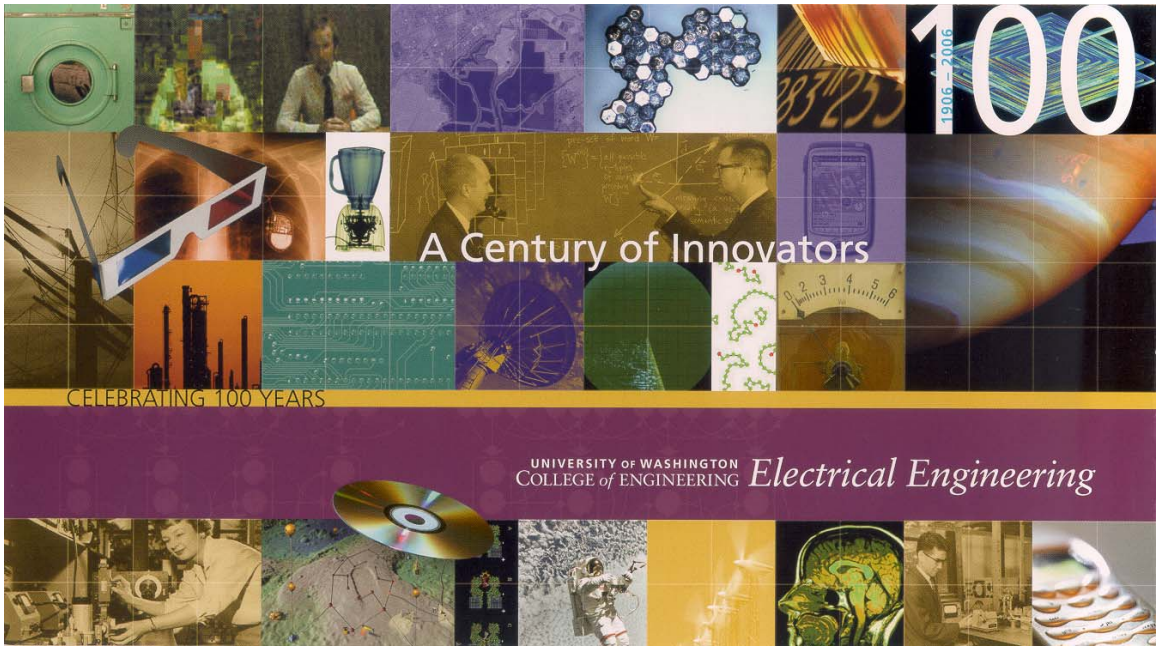

A Century of Innovators

The Centennial History of the Department of Electrical Engineering at the University of Washington 1895-2005

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1895-1905 Prehistory

Figure 1. University Seal from 1896-97 *Catalogue*.

The year 1895 was the middle of the decade known as the Gay Nineties, sometimes called the Mauve Decade after the prevailing color of women's clothing. Perhaps more relevant is its position in the mature years of the Victorian Era of Progress. Progress was both an ideal and a fact, seen in social, moral and especially technical manifestations. The frontier had closed in 1890, and progress in the Western United States was now sought in development rather than expansion.

Washington, a state since 1889, was growing by leaps and bounds. State population would be 518,000 in 1900, an increase of 45% from 1890, and the rate of growth was increasing. The state supported a rising population of college students, so much so that most of the four-year colleges in the state were founded in the period from 1887 (Gonzaga) to 1904 (Evergreen State).

Figure 2. Administration Building in 1895. The first electrical engineering classes were taught in this building, later called Denny Hall. (UW Libraries Special Collections UW19769z)

The University of Washington, which had led a marginal existence from its founding in 1861, benefited from the rise in student population so much that it outgrew its downtown Seattle campus. Despite the depression the country was mired in from 1893-97, a tract in the Interlocken (or Interlachen) district between Lake Union and Lake Washington was acquired for the new University of Washington campus, and a stately, light colored

sandstone and pressed brick building was started in 1894. In September 1895 the faculty and students began their first term on the new campus while the workmen were still busy with the finishing touches. The building was for many years called the Administration Building. Later the large assembly hall was dedicated as Denny Hall, which name finally designated the whole building. Compared to the building on the old downtown campus site, the new one seemed almost palatial.

Figure 3. Left: University President Mark Walrod Harrington. Right: Professor of Physics, Dean of the Faculty and then University President William Franklin Edwards. (UW Special Collections)

Progress in physical structures was matched by progress in academic structures. In the 1894-1895 University of Washington *Catalogue*, which listed courses for the 1895-96 academic year, a new "Department of Instruction" of Electrical Engineering appears. The appearance of electrical engineering may be due to the vision of University President Mark Walrod Harrington, who said in the campus newspaper, the *Pacific Wave*, that Washington was fundamentally an engineering state. It seems clear that the term "Department" meant what we would now call a program, that is, a curriculum of courses leading to a degree in a specific subject, and not an administrative unit. The University boasted 20 departments but only 19 faculty. The Department of Civil Engineering, which also appeared for the first time, owned a Professor and an Assistant Professor, but the Department of Electrical Engineering consisted only of a hopeful announcement that work in the department would be determined after the arrival of Professor William F. Edwards, expected shortly – real soon now, in the modern parlance of software releases.

William F. Edwards earned his B.S. in Physics from Michigan in 1890 and had been an Instructor there. By 1896 he was Professor of Physics at the University of Washington. He was also elected Dean of the Faculty, that is, the senior professor. This is rather remarkable in view of his apparently limited qualifications: a B.S., only six years of experience, and his recent arrival. This indicated the difficulty the University had attracting quality faculty in the early years. Edwards carried a heavy teaching load in physics his first year, but provided at least some guidance on electrical engineering. The Catalogue for 1895-96 lists nine courses in the Department of Electrical Engineering. Eight were mechanical engineering, drawing or shop. One was Design of Electrical

Machinery and Appliances, listed with Edwards as the instructor. The University operated with three terms a year, essentially a quarter system without a summer quarter. The first offering of the Electrical Machinery course was planned for the spring term of 1898.

In 1897 fate intervened with Professor Edwards' plans for Electrical Engineering. In March University President Mark Walrod Harrington resigned after a new governor named four new regents. The old regents, and Harrington, had played partisan politics in support of the old governor, a Republican. Harrington's wife later claimed he had been struck by lightning on campus, which fits nicely with electrical engineering but seems improbable. The Regents turned to the Dean of the Faculty, and Professor Edwards became University President.

Edwards was a lousy President. He almost destroyed the Pharmacy department, increasing their curriculum from two to five years without consulting them, thus driving away all their students. He pushed two professors out of the university because they had Doctor of Divinity degrees and Edwards was concerned that they were teaching religion in the classroom. Although Edwards had some student support for his position, the conflict got into the press, which claimed Edwards had declared himself an agnostic. Motions of censure passed the Presbyterian Synod. Enrollment dropped. When Edwards picked another fight with a Professor of Physical Education, the Regents voted to dismiss him 4-2. His term as President lasted seven months. He never taught an electrical engineering course.

One lasting positive legacy of Edwards' presidency was a reorganization of the University into Colleges, including a College of Engineering with a Dean. Faculty were listed in multiple colleges, as well as multiple departments. A department usually had one senior Professor (often referred to as occupying a chair) and some junior instructors.

A new Professor of Physics and Electrical Engineering was duly hired. Theodore E. Doubt received the B.S. in Physics from Nebraska Wesleyan University in 1892 and the A.M. from the University of Nebraska in 1896, where he also taught physics. He was appointed Instructor of Physics at the University of Washington in 1897 and taught most of the physics classes in the 1897-98 academic year.

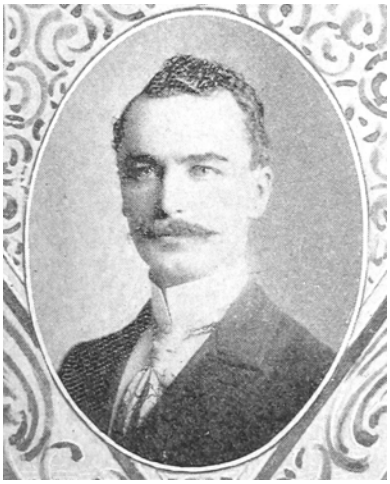


Figure 4. Thomas Eaton Doubt, Professor of Physics and Electrical Engineering, 1897-1902. Professor Doubt probably taught the first electrical engineering class at the University of Washington, and graduated the first B.S.E.E. (1901 *Tyee* photograph)

The 1896-97 Catalogue announced a five-year curriculum, with electrical engineering courses appearing in the last two years, leading to a B.S. degree. Civil and Mechanical Engineering B.S. degrees with five-year curricula appeared in the same catalogue. This curriculum was primarily the work of Almon H. Fuller, Dean of the College of Engineering and a civil engineer. Electrical engineers were to have one year of English, three years of mathematics, a year of chemistry, two and two-thirds years of Physics, two years of German or French, 19 engineering courses, of which nine were electrical, including a three-course Electrical Laboratory sequence, and a thesis. The electrical engineering courses included AC Machinery, Design of Electrical Machinery and Appliances, Electrical Lighting and Telephone and Telegraph. Among the non-electrical engineering courses were Blacksmithing and Foundry Practice. A time schedule indicates that no electrical engineering courses were offered in 1897-98. No student ever graduated from this curriculum, and it is possible that none of the courses were ever taught. Still, this curriculum was the starting point from which future curricula were developed.

Professor Doubt was promoted to Professor of Physics and Electrical Engineering in 1898 and is subsequently listed in the catalogue as one or the other, or both. Given his change in title, he might have offered electrical engineering courses starting in the 1898-99 school year. He was assisted with both physics and electrical engineering by David Kelly and James Moran. Kelly was a senior hired as a Tutor in Physics and Electrical Engineering. Moran was the University Engineer, in charge of the heating and generation plant in the University's powerhouse, and other University facilities. He had industrial experience but no formal higher education. He was designated Assistant in Electrical Engineering, probably the equivalent of a laboratory technician today.

With Prof. Doubt's dual title, the Physics and Electrical Engineering Laboratories were of course one and the same, and boasted a wide array of equipment detailed in the catalogue, including the motors and meters in the powerhouse.

A major curriculum change appeared in the 1898-99 catalogue. Electrical engineering and other disciplines would now be a four-year degrees. The five year curriculum had planned three courses a term. Now there would be six. There would be two years of mathematics, a year of chemistry, two years of physics, a year of French, German or Spanish, two years of rhetoric, two years of drawing, two years of shop, a year of mechanics, one political science course, two hydraulics courses, two terms of thesis work and 19 electrical engineering courses, including Industrial Electricity, Electricity and Magnetism, Electrical Measurements, Dynamo Electrical Machinery and the Magnetic Circuit, Electrical Laboratory, Electrical Design, Steam Engineering, Alternating Currents, Electro-Chemistry and Telegraphs and Telephones. The courses appear with short course descriptions, credit hours, including the classic three hours of laboratory equals one credit hour relationship, and prerequisites. It was a well thought out, intensive curriculum.

The entire College of Engineering had been reorganized on a four-year basis with six courses a quarter, so the credit for this decision probably belongs to the Dean. The electrical engineering portion of the curriculum is more likely due to Professor Doubt. This curriculum would graduate the first B.S.E.E. at the University or Washington.

In is instructive to look back on this first well-developed electrical engineering curriculum from the perspective of a century of curricular development. The curriculum progresses from mathematics and science fundamentals to engineering courses, a constant feature of engineering curricula. It expects engineering students to work hard, another constant feature. It has no interest in a broad education. It is focused exclusively on preparing students for engineering careers. Even the small humanities content of the curriculum is functionally focused, for example on teaching engineers to communicate. Indeed, the catalogue states:

> The aim of instruction in this department is to fit young men for filling responsible positions in the engineering profession by giving them a thorough knowledge of phenomena and principles and of the various applications of electricity.

Skills necessary for engineering practice such as engineering drawing and shop appear early in the curriculum. Hands-on laboratory work appears in every term. The engineering courses are focused on application rather than principles. There are no electives, due to the small number of faculty and students, and the narrowness of the area of electrical engineering at this early date. The thesis provided some freedom to explore topics of interest, but only for a short time.

No co-op work or internships appear in the curriculum, but the catalog stated that:

> Engineering students are strongly advised to devote their vacations to work in factories, repair shops, electric light, and railway stations, to obtain commercial experience and a better appreciation of the relation of technical training to practical work.

Notable differences in the modern curriculum include the addition of a liberal arts component of humanities courses emphasizing education for its own sake, radically increased choice among areas within the much broader field of electrical engineering, and choice even among courses in those areas, and the absence of the undergraduate thesis and the foreign language requirements. Within engineering courses, the focus has shifted towards principles and away from applications, and there is a concomitant decrease in hands on laboratory work. Shop and drawing skills have departed from the curriculum, replaced only in part by programming skills. The absence of the connection to engineering that drawing and shop provided in the early curricula remains an unresolved problem in modern curricula.

With this B.S. curriculum change, the master's degree was announced for the first time. The civil engineering master's degree was also announced in similar terms. The degrees would be conferred by the Graduate School, and no other requirements are listed.

The announcement appears to conflate the professional degree of Electrical Engineer (E.E.) with the Master of Science in Electrical Engineering (M.S.), saying that the master's degree, which it implies is the E.E. degree, would be awarded. This may reflect either the early history of graduate engineering degrees, or a lack of familiarity with accepted practice. By 1905, the M.S.E.E. was typically awarded for one more year of academic work plus a thesis. The E.E. degree, called a professional degree, typically represented three years of practical work in industry plus a thesis. The Ph.D. does not yet seem to have been awarded in engineering.

In 1900 James Moran left the University and was replaced by Jacob Duttenhoeffer, who had a similar practical background and a similar job, as University Engineer and Assistant in Electrical Engineering. James Gilchrist arrived as Assistant Professor of Mechanical and Electrical Engineering. Both men left the University after only a year. One suspects the Nome gold rush, which was in full swing at this time.

The turn of the century also saw the organization of the Electrical Engineers' Club, President Harold Baker, Secretary E. Duffy, Vice President Thomas Gunn and Treasurer Ralph Johnson. The club, supervised by Professor Doubt, mounted an exhibition on May 11, 1900, featuring wireless telegraphy, X-rays, electric heating and welding, lighting, electrostatic and induction effects. It mounted another exhibition in 1901.

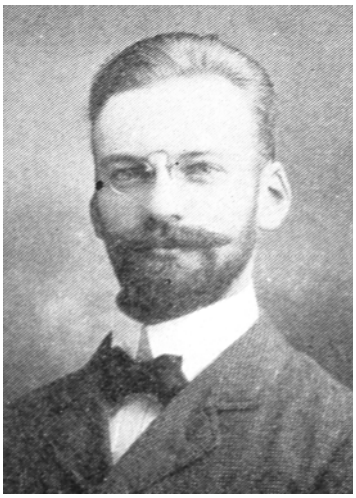


Figure 5. Rudolph Ernst Heine (1902 *Tyee* photograph)

For the following academic year, David Kelly was promoted to Assistant Professor of Physics and Electrical Engineering. A new Assistant Professor of Mechanical and Electrical Engineering was hired, Rudolph Ernst Heine. Heine had earned a B.S. degree in Electrical Engineering from the University of Wisconsin in 1899. He worked for the Milwaukee Electric Railway and Light Company from 1898 to 1900, and the Western Electric Company from 1900 to 1901, then came to Washington. He was the first professionally trained electrical engineer on the faculty.

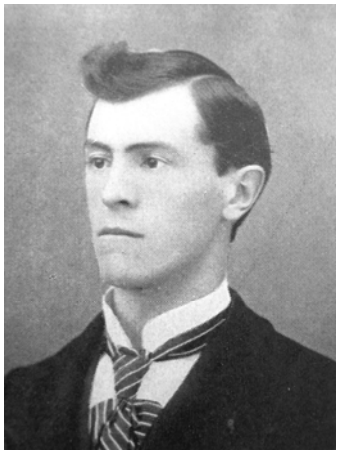


Figure 6. Parker Rowell, recipient of the first B.S. in Electrical Engineering from the University of Washington in 1902. (1902 *Tyee* photograph)

A highlight of 1902, and a major milestone in the electrical engineering program, was the award of the first B.S. in Electrical Engineering to Stephen P. Rowell, who went by his middle name, Parker. He took a job in British Columbia.

Figure 7. Science Hall (Later Parrington). (UW Libraries Special Collections UW567)

In the same year, in a major addition to the university infrastructure, Science Hall (now Parrington) was completed at a cost of $70,000. The Department of Physics remained in the Administration Building, with the Physical and Electrical Laboratory in the basement, although classes were often held in Science Hall.

A lowlight of 1902 was the departure of Professor Doubt. The catalogue enigmatically states that his term expired. Professor Doubt can be credited with making the notion of an electrical engineering program conceived by Professor Edwards into a reality, and with the first graduate from that program. Yet Doubt's primary interest was undoubtedly physics.

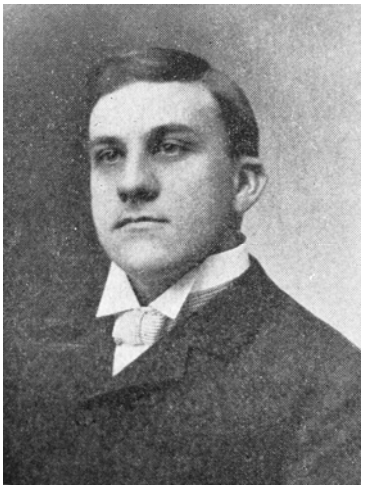


Figure 8. Frederick A. (Tubby) Osborn, Ph.B., third Professor of Physics and Electrical Engineering. Tubby ran the Electrical Engineering program from 1902-1905, and continued as a physics professor for many years thereafter. (1902 *Tyee* photograph)

Another new Professor of Physics and Electrical Engineering was hired. Frederick A. (Tubby) Osborn received the Ph.B. (yes, "B.") from Michigan in 1896 and was a graduate student there from 1900-1902, leaving without an additional degree. He had instructed in physics at two different high schools, was Professor of Physics at Olivet College in Michigan from 1896-1902, and then came to Washington. Professor Osborn was the senior faculty member in both Physics and Electrical Engineering, and also Director of the Physical and Electrical Laboratories, which were one and the same.

Much of Professor Osborn's efforts in Electrical Engineering in the 1902-03 academic year, assisted by Professor Heine, must have been devoted to reorganizing the curriculum as the University switched from three terms a year to two semesters. This curriculum would last, with minor changes, until the University reverted to the quarter system in 1918. Its basic structure lasted well beyond 1918.

Compared to the 1897 curriculum, English was cut from two years to one course. The foreign language requirement was dropped. A Physical Culture requirement was added. In the fundamentals, Mathematics remained at two years, Physics dropped to a year and a half, and Chemistry from two years to one year. Drawing, and the related skills of surveying and descriptive geometry, stayed at two years. Shop increased from one year to two. The mechanical area added courses in Metallurgy and Kinematics. The electrical courses dropped Design and the Electricity and Magnetism course, and incorporated the electrical laboratories in the Dynamo (DC) and AC courses. Notable additions were courses in Power Transmission, Electric Railways and Commercial Testing. The thesis was cut from two terms to one term.

The new semester system ended the work week on Fridays instead of Saturday at noon. In 1903 there were no electrical engineering graduates, but half of the 26 students in the freshman engineering class chose electrical engineering as their major. Assistant Professor David Kelly departed for graduate work at Clark University, leaving Professors Osborn and Heine to teach electrical engineering. Heine became simply Assistant Professor of Electrical Engineering. A new powerhouse was built, furnishing all the heating and electric power to the University, and acting as a laboratory resource for Electrical Engineering. AC generation was 95 kW at 1,100 V, DC 75 kW at 500 V. The old carpenter shop in the Administration Building (Denny Hall) was converted to a dynamo laboratory with a switchboard designed by Professor Heine. A Marconi wireless telegraphy system was also available.

A teaching schedule from this year indicates that Osborn taught almost all physics courses, despite having an assistant, while Heine carried the electrical engineering teaching load. Heine left in 1904 after three years at the University. In his last year there were four B.S.E.E. graduates of a total class of 65, roughly double the percentage of the graduating class that EE enjoys in 2005. Heine can claim much of the credit for Glendower Dunbar, Leroy Frisbee, Clinton Lantz and Karl Van Kuran.

To cover the electrical engineering teaching load after Heine's departure, Professor Osborn asked Instructor in Physics Henry L. Brakel, A.B. of Olivet College, who had

come to Washington in 1902, to help a new Associate Professor teach Electrical Engineering courses. That new Associate Professor was Carl Edward Magnusson.

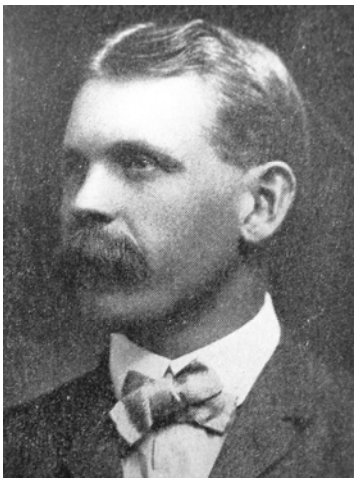


Figure 9. Carl E. Magnusson, Ph.D., as Associate Professor of Electrical Engineering in 1905 (1906 *Tyee* Photograph)

Magnusson was born on a Minnesota farm to parents who had emigrated from Sweden. He attended a one-room school. At the University of Minnesota he earned the degrees of B.S. and M.S. in Electrical Engineering and at the University of Wisconsin a Ph.D. in Physics in 1900. His thesis title was "Anomalous Dispersion of Cyanin," a form of dye. Despite his thesis topic, Electrical Engineering proved to be his true professional interest.

In 1900 the Ph.D. was exclusively a teaching degree. Magnusson taught a year at a Minnesota high school, two years at the University of New Mexico as Professor of Physics and Mathematics, and a year at the New Mexico School of Mines as Professor of Physics and Electrical Engineering before coming to Washington in 1904.

The succession of short faculty tenures had made progress in electrical engineering a series of fits and starts. Carl Edward Magnusson's appointment as Associate Professor of Electrical Engineering finally provided a fully qualified, well-educated faculty member dedicated solely to electrical engineering. His academic credentials were impressive — the first Ph.D. associated with electrical engineering at Washington — and in 1905 he emphasized them, and also his commitment to electrical engineering, by completing the Electrical Engineer degree at Minnesota. The Electrical Engineer degree was a professional degree obtained after the M.S., requiring several years of practical work and submission of a thesis. Although no one knew it at the time, Magnusson would spend the rest of his career in the electrical engineering department at the University of Washington and play a central role in its growth and development.

From 1895 to the summer of 1905 the Electrical Engineering program at the University of Washington had progressed from vaporware to a functioning program. Electrical engineering had a curriculum, faculty, students, and a shared laboratory. It produced a handful of graduates, thanks to the labors of the instructors who carried most of the teaching load, notable Rudolf Heine. The Professors of Physics and Electrical

Engineering who had supervised this development, William Edwards, Theodore Doubt and Tubby Osborn, deserve great credit for their willingness to embrace a new technology. Yet their primary interest in physics was clear. Further development of the program needed dedicated leadership from an electrical engineer. That leadership was about to be emphatically provided by Carl Edward Magnusson.

1905-1915 Building a Program

The turn of the century did not mark a major change in western thought. The Era of Progress continued, with technical progress in the forefront. Marconi had demonstrated transatlantic radio telegraphy in 1902. The Wright brothers had flown in 1903. The seeds of future technologies were planted. Fleming invented the vacuum tube diode in 1904. In Zurich an obscure 26 year old patent examiner was in the middle of publishing five papers that would eventually win him the Nobel Prize and revolutionize physics and electrical engineering.

Figure 10. University Seal, 1905.

The State of Washington was in the middle of the fastest growth spurt in its history. State population would almost double between 1900 and 1910, reaching 1.1 million. The University of Washington had recovered from the turmoil of the Harrington and Edwards presidencies and was growing right along with the state.

Electrical engineering, which had since 1895 been controlled by Professors of Physics, taught by Assistant Professors and Instructors, and suffered from turnover, had achieved a critical mass of students and acquired a key human asset in Carl Edward Magnusson, Ph.D. His academic credentials placed him head and shoulders above everyone else around electrical engineering in the informal academic pecking order, and it was no surprise when he was named to head the Department of Electrical Engineering in 1905. This appointment marks the birth of the Department as a separate, independent academic entity at the University of Washington. 2005-2006 is thus the Centennial Year for the Department.

Tubby Osborn, Professor of Physics and Electrical Engineering from 1902-1905, became simply Professor of Physics and Director of the Physical Laboratory, perhaps with a sense of relief. Instructor Henry Brakel, who had helped instruct in electrical engineering in 1904-05, returned to physics full time. By 1945 he would be the Chair of the Physics Department. Frank E. Johnson, B.S. in Electrical Engineering, University of Minnesota, 1900, was hired as an Instructor in Electrical Engineering. Johnson had been in industry since graduating.

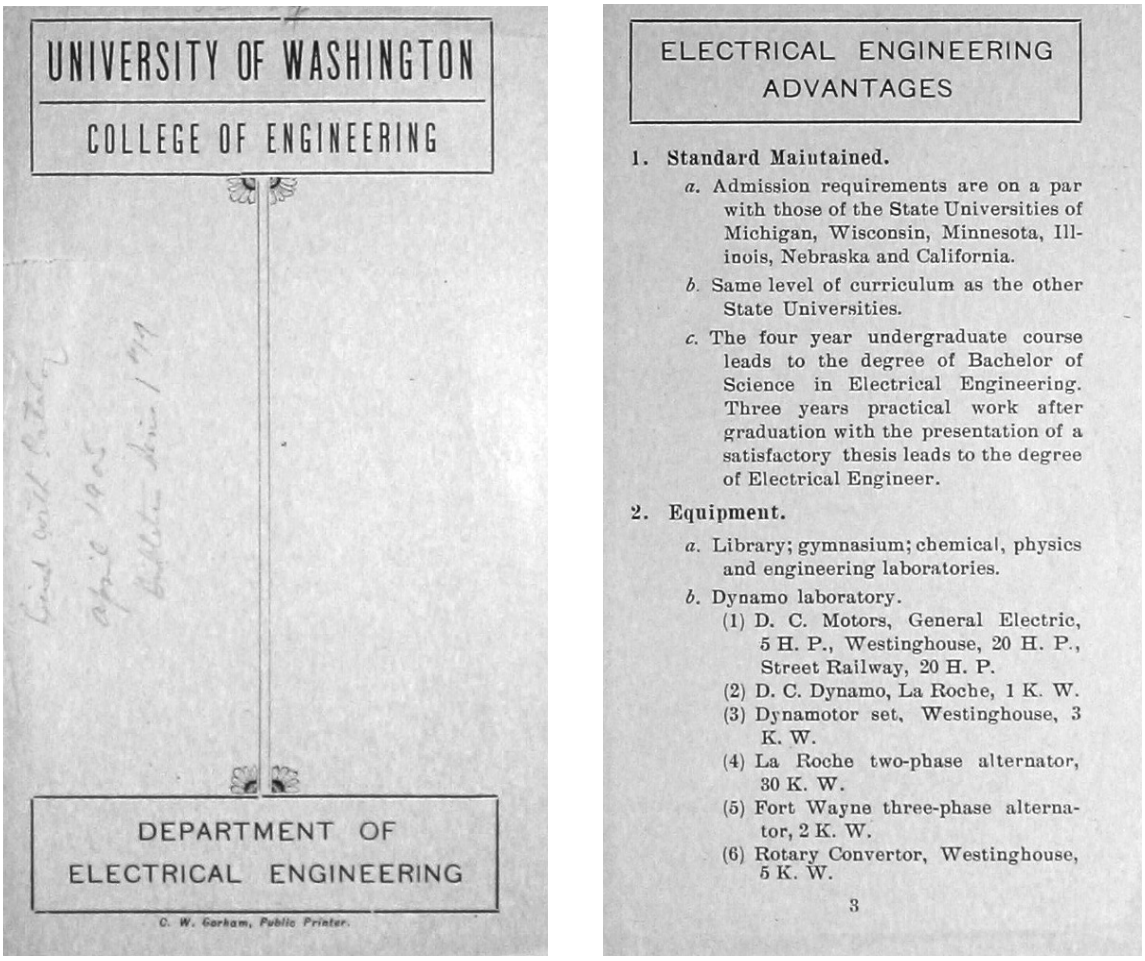
Professor Magnusson immediately obtained funding to upgrade the dynamo laboratory. Five dynamos and $1500 worth of metering equipment were ordered. Frank Johnson was named Director of the Electrical Laboratory and installed the equipment when it arrived in September.

In May 1905 Magnusson organized the first in what would be a long line of electrical engineering field trips. He and five students took a railroad handcar on a two-day trip to

Electron, Washington, a distance of 40 miles, to tour the Puget Sound Power and Light Company's new hydroelectric power plant on the Puyallup river.

Figure 11. The first EE field trip, conducted by railroad handcar to Electron, Washington near Puyallup. From left: Henry H. Thedinga '05, Uichi Kuniyusa '05 (barely visible), Henry G. Cordes '05, John R. King '06, Edward M. Brooks '06, Unknown, Professor Magnusson (back, in cap), Guide. (UW Special Collections Magnusson Collection)

Dr. Magnusson was very ambitious. He had dreams and plans to develop an excellent electrical engineering institution. He was enthusiastic, innovative and strongly of the opinion that industries and colleges needed each other. He moved swiftly to involve industry in the Electrical Engineering Department. Two graduates from 1904 were placed in apprenticeship programs at General Electric and Westinghouse, and a similar commitment was obtained for 1905. Magnusson then recruited senior engineers from local electrical industries to lecture to electrical engineering students. His approach was adroit and effective. J.D. Ross, Chief Engineer of Seattle City Light, lectured on central station power. Elbert G. Allen, Chief Electrical Engineer of the Seattle Electric Company, discussed electric traction systems. John Harrisberger, Chief Electrical Engineer of the Seattle-Tacoma Power Company (which by merger operated the Snoqualmie Falls Hydro Plant) lectured on electric power transmission.



UNIVERSITY OF WASHINGTON

COLLEGE OF ENGINEERING

DEPARTMENT OF
ELECTRICAL ENGINEERING

C. W. Gorham, Public Printer.

ELECTRICAL ENGINEERING
ADVANTAGES

1. **Standard Maintained.**
   - *a.* Admission requirements are on a par with those of the State Universities of Michigan, Wisconsin, Minnesota, Illinois, Nebraska and California.
   - *b.* Same level of curriculum as the other State Universities.
   - *c.* The four year undergraduate course leads to the degree of Bachelor of Science in Electrical Engineering. Three years practical work after graduation with the presentation of a satisfactory thesis leads to the degree of Electrical Engineer.
2. **Equipment.**
   - *a.* Library; gymnasium; chemical, physics and engineering laboratories.
   - *b.* Dynamo laboratory.
     - (1) D. C. Motors, General Electric, 5 H. P., Westinghouse, 20 H. P., Street Railway, 20 H. P.
     - (2) D. C. Dynamo, La Roche, 1 K. W.
     - (3) Dynamotor set, Westinghouse, 3 K. W.
     - (4) La Roche two-phase alternator, 30 K. W.
     - (5) Fort Wayne three-phase alternator, 2 K. W.
     - (6) Rotary Convertor, Westinghouse, 5 K. W.

3

Figure 12. Pages from Professor Magnusson's 1905 publicity brochure for the Department of Electrical Engineering (UW Libraries Special Collections)

Next Magnusson wrote a small booklet to publicize electrical engineering at the University of Washington. It is earnestly and forthrightly promotional. The full time faculty consisted only of Magnusson and Johnson, who functioned as a laboratory instructor. To impress the reader with the size of the Electrical Engineering Department, Magnusson started the faculty list in the booklet with the President of the University and then listed Professor Osborn as Director of the Physical and Electrical Laboratory. After his own name and Johnson's, Magnusson completed the list with the industrial lecturers.

The booklet leads off with a section on Electrical Engineering Advantages. The first was "admission requirements on a par with those of the State Universities of Michigan, Wisconsin, Minnesota, Illinois, Nebraska and California" and the "same level of curriculum." Magnusson listed the extensive electrical laboratory hardware available, lauded the proximity of the electrical industry in the Seattle area, and closed by noting that the entire senior class (all three of them) already had jobs with Westinghouse and General Electric. These themes, comparison to peer universities, well equipped laboratories, interaction with local industry and excellent job prospects, as well as a

certain promotional leeway in departmental brochures, remain important positive components of electrical engineering at the University of Washington today.

Magnusson's selection of lecturers from the electric power generation and traction industries was typical of the times and clearly the best choice for an electrical engineering department in Seattle. Electric power offered revolutionary improvements in safety, cleanliness, convenience and efficiency compared to the boilers, shafts and leather belts it replaced. Electric power was the most complex of the electrical technologies of the period. It boasted an established yet growing industry, offering the highest potential for growth, and the highest potential for employment. Electric power was the key technology aiding rapid development of the economy of the Pacific Northwest. Telegraphy and telephony were not neglected in the curriculum. In 1907 Clarence E. Fleager, plant superintendent of the Sunset Telephone Company, joined the other industrial lecturers. However, the focus was definitely on power.

In 1906 Magnusson's energetic and innovative leadership of the Department was recognized by promotion to full Professor of Electrical Engineering. Frank Johnson was promoted to Assistant Professor. Magnusson showed an entrepreneurial streak. With Professor T. C. Frye he started a small factory in Ballard to manufacture imitation citron made from seaweed kelp. The factory was managed by E.M. Magnusson, Carl's brother.

Considering the effort Professor Magnusson put into developing the Electrical Engineering Department in other areas, it is a bit surprising that the curriculum he inherited from Professor Osborn remained essentially unchanged. Since Magnusson would be aware of curricula at established programs, this is a testimony to the 1903 curriculum developed by Professors Doubt and Heine. There were minor credit hour adjustments on a yearly basis. In 1907 a single two credit elective appears in the senior year. In 1908 the Dynamo Machinery course was renamed Electrical Engineering. This may be a sign of a slow shift from studying applications to studying theory, with a syllabus moving towards DC circuit theory.

By December 1907 it was known that the Alaska-Yukon-Pacific Exposition would be held on campus in 1909, and that permanent buildings for chemistry (the original Bagley Hall, now the Architecture Building), engineering, an auditorium and a new power house would be build for the Exposition and turned over to the University afterwards, in exchange for partial state funding for construction. No doubt a dignified scramble for space ensued. The Electrical Engineering Department needed a better home for its nine DC machines sized from 2 to 20 kW, its eight AC generators with a total capacity of 70 kW, and its 25-cell 15-Ampere storage battery, and would benefit from the Exposition.

A theme that would recur in the coming years first appears in 1908. Professor Magnusson, a faculty member of obvious Scandinavian origin, was approached by three students, Andrew Anderson, O.R. Karlström, and R.C. Stone, interested in having Swedish taught at the University of Washington. Magnusson encouraged them in their endeavors, as he seems to have done with everyone he encountered. The students formed a Scandinavian Club. The Club circulated petitions on campus and among the

Scandinavian population of Seattle, and the eventual result was the formation of the Department of Scandinavian Studies by state law in 1909. Scandinavian Studies was the first department that Electrical Engineering played a role in founding. Other departments would follow, their founding less coincidental and more closely related in subject area.

In March 1909, electrical engineering students met to organize the Steinmetz Club, with the object of enabling students to meet and discuss their work, and to hear prominent engineers whenever possible.

Figure 13. Advertising post card for the Alaska-Yukon-Pacific Exposition held on the University of Washington campus in 1909. Electrical engineering would occupy one of the exposition buildings from 1909-1948. (UW Libraries Special Collections AYP232)

The big news of the 1908-1909 academic year was the Alaska-Yukon-Pacific Exposition. The university gave up the lower campus to the exposition, which was open between June and October, 1909. The noise of construction and operation, the excitement of having the exposition right next door, the traffic and the crowds it drew must have interfered with teaching and scholarly work. But the physical fabric of the University would benefit from the disruption in the long term. The Exposition left behind familiar campus features like the Rainer View axis, the frosh pond, what is now the Architecture Building and the statue of George Washington that watches traffic on I-5 from the west entrance. While most of the exposition buildings were temporary structures, Machinery Hall on the southeast perimeter would become Engineering Hall (later Old Engineering Hall) and the first long term home of the Electrical Engineering Department.

Professor Magnusson's interaction with the business community continued. Jacob Furth was President of the Seattle Electric Company, and a dynamic, masterful, commanding force in molding it into a larger utility company, the Puget Sound Traction, Power and Light Company. Furth needed engineers, so he awarded prizes for top graduates of the College of Engineering.

Figure 14. Illegal immigrant and Furth prize winner Frederick Kurt Kirsten graduated magna cum laude in 1909. Kirsten would go on to become Professor of Electrical Engineering, then Professor of Aeronautical Engineering at the University of Washington. (1909 *Tyee* photograph)

The first winner of the Furth Prize of $100 was Frederick Kurt Kirsten, who graduated magna cum laude in 1909 with a degree in Electrical Engineering. Kirsten was the first notable alumnus of the department. He was born in Germany and graduated from *Realschule* (high school) there in 1902. Lost paperwork kept him out of the German Navy and put him in the German Merchant Marine. His training cruise brought him to Puget Sound in 1903. Kirsten claimed to have been drugged in a bar in Tacoma, shanghaied onto a China-bound ship and then escaped, but not before his own ship left.

In fact, Kirsten had had enough of the German Merchant Marine. His voyage to Seattle had been one of considerable hardship, including bitter cold while rounding Cape Horn, time spent becalmed while running out of food and a drunken captain. Kirsten decided that continuing the cruise to China would probably be the death of him He in fact tried to jump ship in Tacoma, been caught and brought back, then jumped ship again as his ship left for China.

Marooned in Tacoma, penniless, speaking only German, Kirsten was warming up in a bar when he met a German hop farmer from just south of Tacoma. Kirsten was hired on the spot. Two years later, an illegal immigrant, he started at the University of Washington, receiving an "A" in freshman English, majoring in Electrical Engineering and taking the Furth prize. Before leaving for work with Stone & Webster on hydroelectric power plants and transmission lines in California, Kirsten assisted Magnusson and Johnson in wiring up the new Electrical Laboratory in Engineering Hall. He also married the farmer's

daughter. Kirsten would later return to Washington as a professor, first of electrical and later of aeronautical engineering.

Figure 15. Machinery Hall at the Alaska-Yukon-Pacific Expostion, 1909. Later Old Engineering Hall, home of Electrical Engineering from 1909-1948. (UW Libraries Special Collections AYP178)

Engineering Hall, later Old Engineering Hall, the building inherited from the Alaska-Yukon-Pacific exposition and where Kirsten was wiring the new Electrical Engineering Laboratory, was located about where the present day Mechanical Engineering Building sits. The catalogue of 1909-10 describes the electrical laboratory in Engineering Hall as an 80 x 110 foot portion of the south half of the first floor. The lab contained two separate testing panels, each with connections to varying voltage supplies, motors and generators. The laboratory supply of DC power was from a 35-kW 110-volt generator and a 75-kW 500-volt generator. The latter was obtained from the old powerhouse. A suitable motor of 2200 volts AC drove each DC generator. A transformer supplied AC voltages from 90 to 240 volts to each test panel.

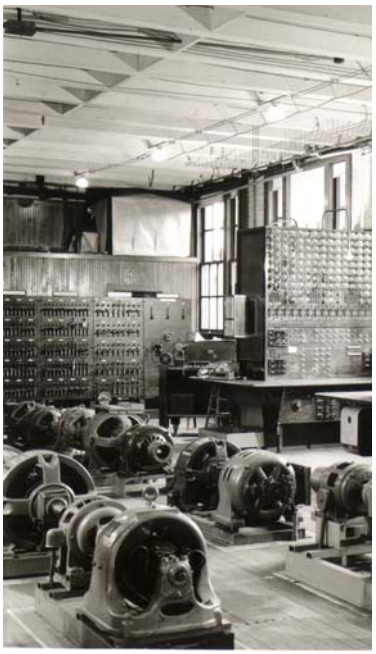


Figure 16. Electrical Laboratory in Old Engineering Hall (UW Special Collections)

According to Professor George S. Smith, “Dr. Magnusson was very ambitious and thrilled to develop an excellent electrical engineering institution. He was assisted in alterations for the laboratory by Instructor Frank E. Johnson, a man with more ability in practical work than Magnusson, and by Frederick K. Kirsten, who was the key worker in wiring, arranging and even in helping design new equipment.” Though hard work, it was creative labor.

Smith commented further, “The type of jacks designed for the front of each test panel were made of cast brass with tapered holes, into which flexible cables with tapered plug terminals would be plugged for connections. They proved simple to make and in use only a slight twist would make a perfect fit. Other laboratories, some in the commercial field, have copied this design. Nearly forty years later the same type were used in the then new Machine Laboratory in the present (1948 – ed.) Electrical Engineering Building.”

South of the laboratory, there were five separate rooms: an instrument repair department, a workshop with lathe and bench, an instrument storeroom, a telephone laboratory, and an electrolysis and special problem room.

Figure 17. Edgar A. Loew, 1906, in a low-resolution scan from the Wisconsin *Badger* yearbook. Loew would become Dean of Engineering from 1935-1952. (Digital image from the University of Wisconsin Digital Collections Center)

Arriving in 1909, but apparently not in time to work on the laboratory wiring work, was new Instructor in Electrical Engineering Edgar A. Loew. Loew had received a B.S. in Electrical Engineering in 1906 from the University of Wisconsin, and had been an Instructor there for the next three years. His senior thesis was a study of lightning arresters. Loew would prove to be the second key hire for the department. The short-term effect was to spread the teaching load.

Magnusson and Loew, both long-serving professors of electrical engineering, offered students a contrast in teaching style. Magnusson carefully prepared his material and proceeded methodically through the lesson plan. Deviations annoyed him, and when they occurred he would strive to regain his pre-planned lesson. In contrast to his yearbook, which said “Takes life too seriously,” Loew was more casual. When a diversion arose he would try to work from fundamentals to address the point in contention. If he did not succeed in one class, he would readdress the point in the next one. The modern student of pedagogy will recognize the learning styles: Magnusson was a sensor and Loew an intuit. Moreover, Loew had a deep interest in literature, and was wont to surprise his students in a class on transmission line design with, “You are doing well, so today may I entertain you with anecdotes and poems of Robby Burns?” And he would!

Electrical engineering enrollment had not responded instantly to Magnusson’s 1905 promotional efforts. Degrees awarded continued in the single digits until 1910, when 10 electrical engineers graduated. However, total electrical engineering enrollment that year was 115 and this growth was starting to reach the upper level courses.

Starting in 1910 a change was made in offering advanced degrees. The master’s degree, Master of Science (M.S.) was distinguished from the professional degree, Electrical Engineering (E.E.) The M.S. degree was offered in each of the engineering departments for one additional year of graduate academic work after attaining a B.S. degree. The E.E.

degree was offered for three years of acceptable practical work in the engineering field plus a thesis, after graduating with a B.S. degree, or two years of practical work plus a thesis after attaining an M.S. degree. The E.E. degree can be seen as an advanced M.S., or as not quite a Ph.D. Magnus T. Crawford, B.S. '07, received the first E.E. degree in 1910. By 1913, he was superintendent of power transmission for Puget Power, and also was a Lecturer at the university.

Figure 18. Magnus T. Crawford received the first professional Electrical Engineer degree from the University of Washington in 1910. He received the B.S.E.E. in 1907. This is his 1907 graduation photograph. (1907 *Tyee* photograph)

Figure 19. Johnson concrete lampposts in service on campus. Left: in front of Home Economics Hall (now Raitt Hall), 1919. Right: near Parrington Hall, 2005. (Left: Engineering Experiment Station Bulletin No. 6, *Ornamental Concrete Lamp Posts*, 1919. Right: Rich Christie photo, 2005)

Frank Johnson had been in charge of campus lighting since his arrival in 1905. In 1911 he designed and constructed seventy ornamental concrete lamp posts for the campus. In 1914, a second set of ninety lamp posts was constructed. Carl Magnusson published

an Engineering Experiment Station Bulletin describing them in 1919. Some are still in service on campus, on Memorial Drive between Denny and Parrington Halls.

With the Electrical Engineering Department now settled in to Engineering Hall, and with its own laboratory facilities, Magnusson was able to leave the department in the capable hands of Edgar Loew and Frank Johnson, with temporary instructor Charles E. Mallery, B.S. University of Washington 1909, and take a sabbatical leave of absence. In 1911-1912 he worked with Charles Proteus Steinmetz at the research department of the General Electric Company in Schenectady, New York. Steinmetz was perhaps the leading electrical engineer of the time, the acknowledged genius of alternating current power systems. Magnusson at first worked beside some of his recent alumni on the testing of new electrical machinery and later directly with Steinmetz on the problem of transients caused by short circuits, faults and lightning strikes on AC transmission lines. Magnusson incorporated this state of the art knowledge into the curriculum when he returned.

While Magnusson was away, a foreign language requirement was added to the engineering curriculum. It seems likely that the requirement was imposed by the University rather than sought by the College. In electrical engineering, the 16 semester credits devoted to languages was accommodated essentially by rolling the last semester of the senior year into the first semester of a one-year graduate curriculum. There was some credit expansion in the AC courses, and a Structural Materials course was added. The senior thesis was dispensed with. A graduate thesis and electives rounded out the MS curriculum. While the language requirement may not have been welcome (lasting only a year), it at least had the side benefit of establishing an actual graduate curriculum. Another change was the replacement of Physical Culture with Military Drill.

On his return from General Electric in 1912, Magnusson brought with him not only his own newly acquired knowledge but also a new faculty member. Leslie F. Curtis had received the B.S from Tufts College in 1910 and worked for the General Electric Company in their testing and other departments until Magnusson lured him away. Curtis was hired as an Instructor in Electrical Engineering. Also in this year, a student branch of the American Institute of Electrical Engineers (A.I.E.E.) was organized, with student George Tripple as the first chair. The A.I.E.E. was the professional association for electrical engineers. It would eventually become the IEEE.

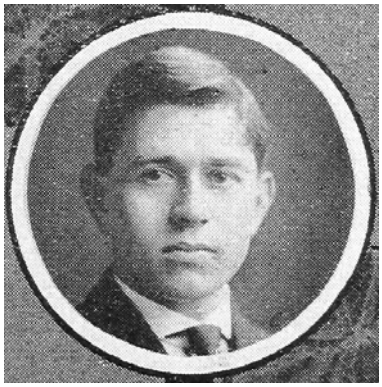


Figure 20. Eric Therkelson, first M.S. in Electrical Engineering from the University of Washington, 1913. Eric received the B.S.E.E. in 1910. This is his 1910 graduation photograph. (1909 *Tyee* photograph)

In 1913 Eric Therkelson, B.S. ’10, received the first M.S. in Electrical Engineering degree from the University of Washington. Professor Magnusson was well aware of the benefits of a graduate program and promoted research in the department, in contrast to Mechanical Engineering, so he was undoubtedly pleased with this sign of progress.

General Electric had no hard feelings about Professor Magnusson luring Curtis away. After Magnusson’s return to the University, the company donated an electric oscillograph, a device that produces an image of an electrical waveform, sort of like a photograph of an oscilloscope screen. Magnusson immediately added a course in electric transients to the curriculum. It was probably the first time that such a course was offered in an American university.

Magnusson’s Transients course was part of a major curriculum overhaul. The language requirement was replaced by a significant elective component. The electives were a three- credit freshman elective to be selected from a foreign language, economics, U.S. history, sociology or geology, and 12 credits of senior electives to be selected from a Group A list of technical electives and a Group B list of humanities. The electrical engineering department recommended 8 credits of Group A and 4 of Group B. The AC courses in the graduate curriculum in 1912 were rolled back into the senior year. The senior thesis reappeared. Central Stations, Power Transmission, Telephones, Meters, and Electric Railways became technical electives.

A new B.S./M.S. track was proposed, but it differed little from the B.S.E.E. track. Students were required to take exactly the same courses, except for 8 more credits of electives in the B.S. track. Then for the M.S., the two electrical engineering courses omitted from the B.S. track reappeared as requirements for B.S./M.S. candidates. The net effect was that M.S. recipients would have exactly the same set of courses whether they arrived by the B.S./M.S. track or the B.S.E.E. track. For the B.S.E.E. recipient, the graduate curriculum now included Professor Magnusson’s Transients course, technical electives, general electives, and a thesis.

A long tradition in the College of Engineering is the Engineering Open House. The first was held in 1913, and the practice has continued to the present day.

The end of the Era of Progress in the western world resulted from the assassination of an obscure Austrian nobleman in Sarajevo. This started a train of events that caused nations that thought of themselves with good reason as the most civilized on earth to turn on each other with eager enthusiasm, for no particularly good reason. The technologies that progress had brought forward were now used for slaughter. In one aspect progress continued, and indeed accelerated. Every modern war spurs technological innovation. The Great War had its primary effect on aircraft, chemistry, and radio communications.

In the 1914-1915 academic year, both positive and negative aspects of the Great War were far away from the Washington campus. Difficulties with the Germans over submarine warfare broke into the headlines in May when the ocean liner Lusitania was sunk with significant loss of American lives, and debate over entering the war intensified. For the Electrical Engineering Department, however, it was business as usual.

In 1914 the undergraduate curriculum now offered a new BS/MS track. The undergraduate portion of the curriculum had about two thirds of a year more general studies and some reduction in technical courses. This option lasted only a few years.

In 1915 Assistant Professor Frank Johnson died. His contributions over ten years as Instructor and Assistant Professor included supervising the Electrical Laboratory, which was a major component of the curriculum, and the improvement of campus lighting. His departure left Carl Magnusson, Edgar Loew and Leslie Curtis to carry the department forward into a future with dark clouds on the eastern horizon.

1915-1925 War Clouds

In Europe in 1915 massive armies faced each other across no man's land. For most in the United States the Great War was something far away that the United States was well out of.

Figure 21. University Seal from 1915 *Catalogue*.

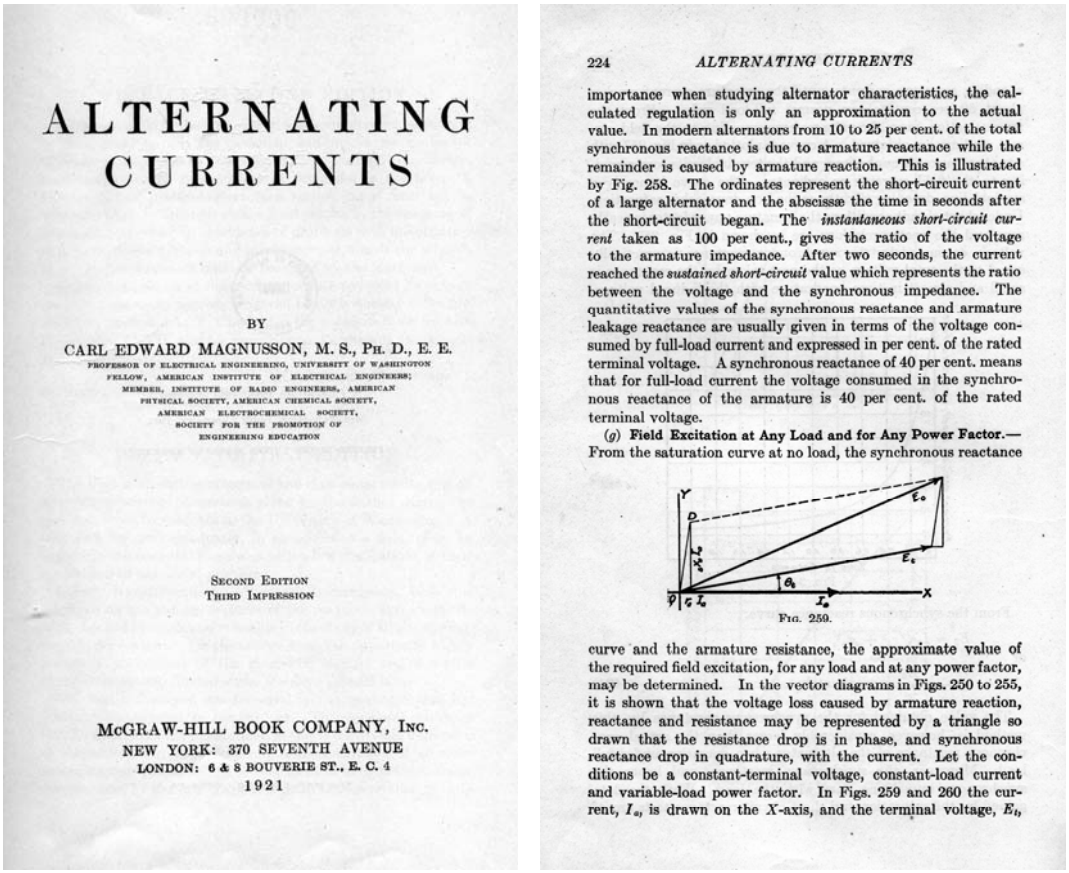
Technological advances in the last decade included underwater listening devices (sonar), the first amplifying vacuum tube, the triode, developed by Lee De Forest in 1906, and voice transmission on AM radio. Bakelite, the first plastic, invented in 1909, would become a common insulating material in electrical equipment. The first talking motion picture was demonstrated by Thomas Edison in 1910, and consumer battery sizes were standardized in 1912. The first bra was patented in 1913. The first gas mask was patented in 1914.

In the State of Washington, population growth had slowed from the dramatic doubling of the previous decade. From 1.1 million people in 1910, population would only grow to 1.3 million in 1920. In 1914 the Smith Tower was completed as the tallest building west of the Mississippi, a distinction it would hold until 1962.

At the University of Washington, the Department of Electrical Engineering looked to its own to replace Frank Johnson. Frederick Kurt Kirsten, B.S.E.E. 1909, winner of the Furth Prize, was hired as an Assistant Professor of Electrical Engineering. Since obtaining his degree, Kirsten had risen rapidly at Stone & Webster. He had just completed managing the project that installed underground distribution cables on the new Massachusetts Institute of Technology campus. Kirsten had also obtained the professional E.E. degree from Washington in 1914. He and his wife were happy to return to the Puget Sound region.

In 1916 Boeing was incorporated in Seattle. Bill Boeing donated money for a six by six foot wind tunnel (now the small wind tunnel) to the University of Washington. Professor Frederick Kirsten was active in planning and supervising the operation of the wind tunnel. The donation may have been what aroused his interest in aeronautics, or it may have predated the wind tunnel. Kirsten would have a consulting relationship with Boeing as the company developed.

In the same year, McGraw-Hill published Professor Magnusson's textbook *Alternating Currents*. The text covered AC circuit theory and machinery. It was used at Washington and at other universities for many years. One of the responsibilities of the Ph.D. is to teach others, and another is to publish. With his textbook Professor Magnusson combined both and set an example of scholarship for the rest of the electrical engineering faculty.



ALTERNATING CURRENTS

BY

CARL EDWARD MAGNUSSON, M. S., PH. D., E. E.

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1921

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importance when studying alternator characteristics, the calculated regulation is only an approximation to the actual value. In modern alternators from 10 to 25 per cent. of the total synchronous reactance is due to armature reactance while the remainder is caused by armature reaction. This is illustrated by Fig. 258. The ordinates represent the short-circuit current of a large alternator and the abscissæ the time in seconds after the short-circuit began. The *instantaneous short-circuit current* taken as 100 per cent., gives the ratio of the voltage to the armature impedance. After two seconds, the current reached the *sustained short-circuit* value which represents the ratio between the voltage and the synchronous impedance. The quantitative values of the synchronous reactance and armature leakage reactance are usually given in terms of the voltage consumed by full-load current and expressed in per cent. of the rated terminal voltage. A synchronous reactance of 40 per cent. means that for full-load current the voltage consumed in the synchronous reactance of the armature is 40 per cent. of the rated terminal voltage.

(*g*) **Field Excitation at Any Load and for Any Power Factor.**—From the saturation curve at no load, the synchronous reactance

FIG. 259.

curve and the armature resistance, the approximate value of the required field excitation, for any load and at any power factor, may be determined. In the vector diagrams in Figs. 250 to 255, it is shown that the voltage loss caused by armature reaction, reactance and resistance may be represented by a triangle so drawn that the resistance drop is in phase, and synchronous reactance drop in quadrature, with the current. Let the conditions be a constant-terminal voltage, constant-load current and variable-load power factor. In Figs. 259 and 260 the current, I_a, is drawn on the X-axis, and the terminal voltage, E_t,

Figure 22. Title page and page of text from Magnusson's textbook *Alternating Currents*. The right hand page is the well-known synchronous generator phasor diagram.

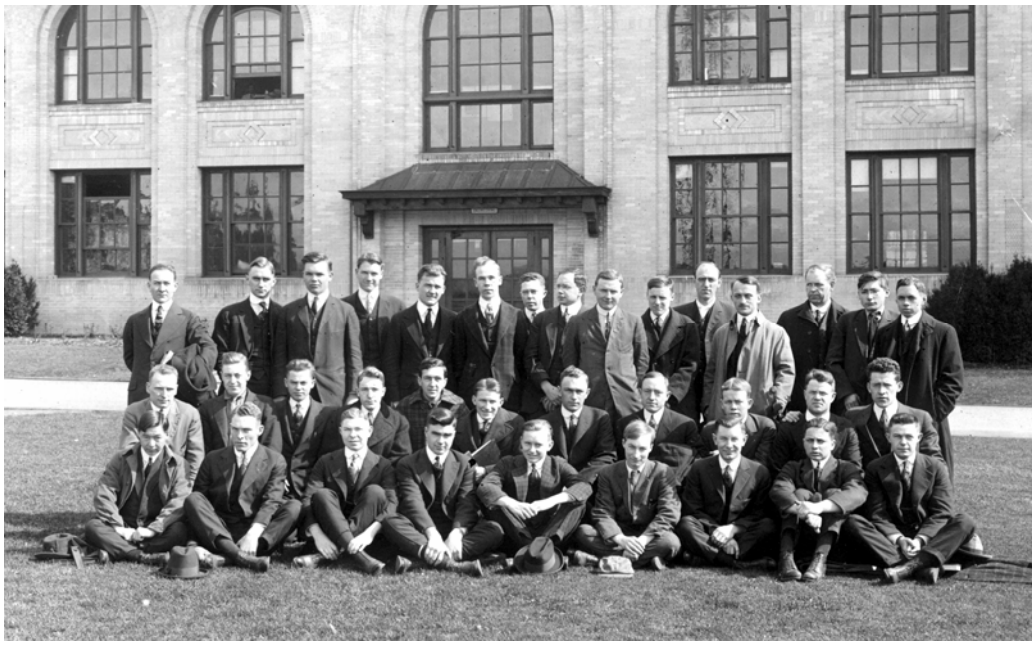


Figure 23. Electrical Engineering Seniors and Faculty in front of Engineering Hall, 1916.

Concerns about the war, and potential United States involvement, slowly mounted. The summer of 1916 brought news of unprecedented casualties on the Western Front. Submarine warfare policy was the principal cause of friction between Germany and the United States. In early 1917, the Zimmerman telegram was intercepted, decrypted by the British, and published. In it, the German foreign minister advised the Mexican government that Germany would shortly break a promise made to the United States and embark on unrestricted submarine warfare. Anticipating a United States declaration of war, Germany promised Mexico parts of Texas, New Mexico and Arizona if Mexico would also declare war on the United States. Public furor in the United States led to a declaration of war against Germany in April, 1917.

The U.S. declaration of war against Germany in April 1917 had a profound and manifold effect on the University of Washington. In June the University shifted to a four-quarter system, permitting a full summer quarter and encouraging students to engage in technical and engineering training that would be in great demand during the war. Dean of Engineering Almon H. Fuller departed, and Professor Carl E. Magnusson was named Acting Dean, while remaining head of the Electrical Engineering department.

The college created a common curriculum for freshman and delayed the choice of major until the beginning of the sophomore year. Three new freshman courses involved the solution of engineering problems (primarily civil topics) by mathematical means. and the courses were taught by the Civil Engineering department. Credit requirements in math, chemistry, drawing, and electives were adjusted and curriculum appears stripped of educational luxuries and focused on producing functioning engineers. The B.S./M.S. curriculum was removed from departments and became a general engineering B.S. administered by the College of Engineering.

Figure 24. Barracks of the Student Army Training Corps (SATC) on the UW campus in 1918. The photograph was probably taken from Engineering Hall, in which case the barracks occupy the location of the current Electrical Engineering Building. (1919 Tyee photo)

Beyond the revised regular curriculum, the Electrical Engineering Department offered War Courses, specially designed to address wartime needs and students. A five-credit course for electricians was offered, with a syllabus geared to industrial needs. A course for naval Ensigns taught electrical principles used on naval vessels to junior officers. (The Navy's newest battleships had all-electric propulsion.) Professor Kirsten taught both courses, and also a course on Naval Aviation. Professor Curtis taught a war course on Elementary Radio, including vacuum tubes. This course would remain in the curriculum post-war, taught by a wide variety of instructors including Professors Magnusson and Loew. The Telephones course was also taught as a war course. The University was so busy that night courses in AC and DC were scheduled and two new instructors were hired. Enrollment in the regular program fell as students rushed to enlist or departed for war industries. Barracks sprang up on the current site of Sieg Hall and elsewhere for the Student Army Training Corps.

To complete the year of frantic activity, in 1917 the Engineering Experiment Station was organized within the College of Engineering. While it directed some engineering research, its main function was to provide an avenue for publication of engineering research results from around the campus. Research was a controversial topic on campus in 1917. Dean Magnusson, as befitted a Ph.D., supported research, performed research himself, and encouraged other faculty to do research. Professor Kirsten also was an enthusiastic proponent of research, and prided himself on his research accomplishments.

In 1918, Gordon R. Shuck, with an EE degree from Minnesota, was appointed Instructor. An excellent teacher and a capable researcher, he came to Washington from engineering work in Alaska. He would be a long-term faculty member.

When the war ended in 1919, most of the barracks on campus were quickly torn down. A few were used for mechanical drawing. Conditions were at times grim. Once the heat supply was blocked and the drawing ink froze!

Despite the challenges, enrollment increased rapidly. In 1919 University enrollment was 4600 students, and 400 freshmen were registered in engineering. Total electrical engineering enrollment grew to 155 and required a growth in faculty.

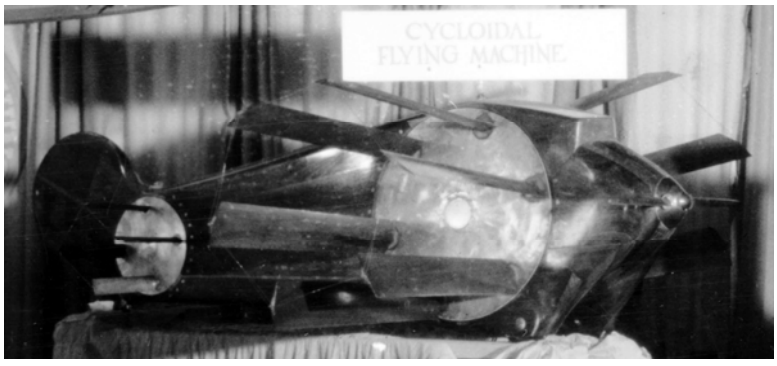


Figure 25. Aircraft model with cycloidal propellers in place of wings and tail exhibited at the 1936 Puyallup fair. (UW Libraries Special Collections Magnusson Collection)

Magnusson, made permanent Dean, asked Kirsten to teach aeronautical engineering courses, following up on the commitment made to Bill Boeing in 1917. Kirsten was happy to oblige. He pursued the new topic area with enthusiasm, especially his pet idea, the cycloidal propeller. By 1921 he had talked Bill Boeing into investing in the Boeing-Kirsten Propeller Company, and was building a prototype. A negative review from the United States Navy in 1923 resulted in the demise of the company in 1928, but not Kirsten's interest in or commitment to the idea. Cycloidal propellers are now used on a few tugboats, where their ability to generate thrust in any direction provides perfect maneuverability.

Edgar Loew started studying the costs and experience with electric residential heating in Tacoma, which had recently commissioned some economical hydro plants. His work would result in Experiment Station Bulletins entitled *Electric Heating in Residences* in 1921 and 1923. His basic conclusion was that electric heat cost about the same as coal, while being cleaner and taking less work. Electric residential heating would be a staple in the Pacific Northwest until the 1980s.

In 1920 electrical engineering enrollment more than doubled to 363. Even with Loew's return, more faculty were needed. In 1920 George Lisle Hoard, B.S.E.E. 1917 from the University of Washington, and a Great War veteran, was appointed Instructor. He would remain with the faculty for the long term. He initially worked in the power area, but would eventually take up electronics. He was an excellent teacher, but reported to sometimes be a little "tough" on the students.

Figure 26. George S. Smith, future EE professor, graduating with a B.S.E.E. in 1916. (1916 *Tyee* photo)

In 1921, three more Washington graduates were hired as Instructors. Jack Roderick Tolmie, B.S.E.E. and Albert Kalin, B.S.E.E. 1919, went to work helping Magnusson with a book project. George S. Smith, B.S.E.E 1916, was also appointed Instructor would become a long-term faculty member and the author of a 1965 history of the department on which much of this early history is based.

Scholarly work in the department in the period 1921 to 1925 centered on hydroelectric development. Dean Magnusson was working on a variety of studies of hydro-electric development, and a textbook on transients, while Professors Kirsten and Loew consulted and studied the mechanical and electrical features of transmission line design. New faculty were incorporated into the projects as they arrived.

A significant alumnus from 1923 was L. V. Bewley. After graduation Bewley worked in the General Electric Test Department and in other positions in up to 1940. In 1933 he authored a well-known textbook, clearly associated with his coursework in transients at Washington, *Traveling Waves on Transmission Systems*. In 1940 Bewley moved to head of the Electrical Engineering Department at Lehigh University, then served as Dean from in 1954 to 1962

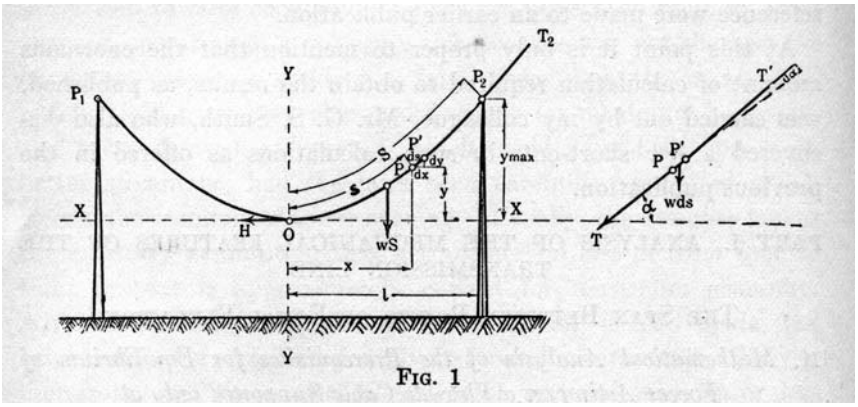
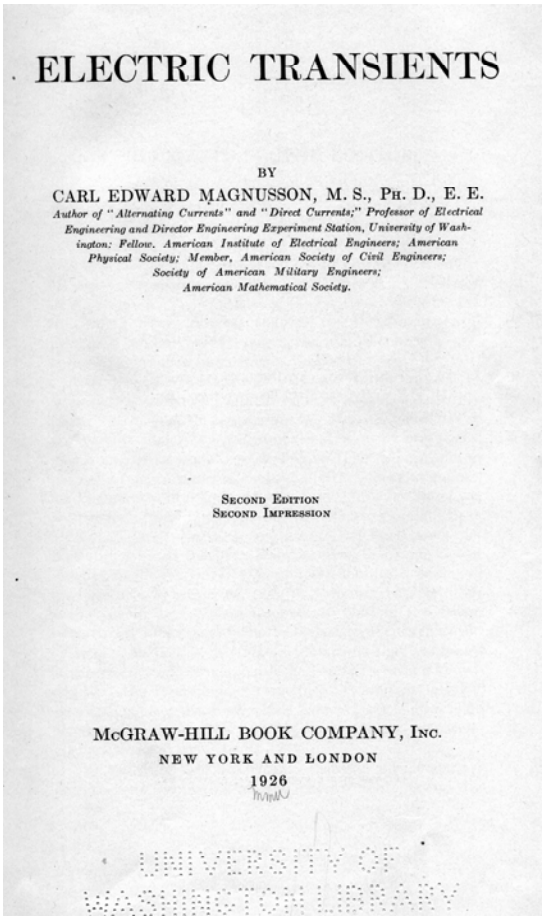


Figure 27. Illustration from Kirsten's 1923 Bulletin *Transmission Line Design: Design of Spans with Supports at Equal Elevation*.

In 1923 Frederick Kirsten was promoted to full Professor of Electrical Engineering. Although Kirsten taught aeronautical engineering and his primary research attention was to the cycloidal propeller, he nevertheless worked on power transmission issues. In 1923 he published the Engineering Experiment Station Bulletin *Transmission Line Design Part I, Mechanical Features – Design of Spans with Supports at Equal Elevation*. George Smith became Director of the Electrical Laboratory.



ELECTRIC TRANSIENTS

BY

CARL EDWARD MAGNUSSON, M. S., PH. D., E. E.

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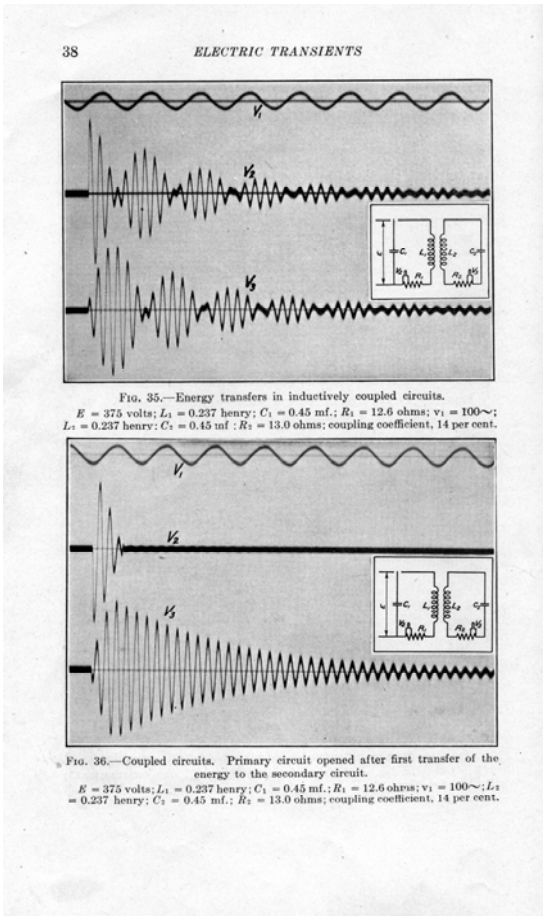


FIG. 35.—Energy transfers in inductively coupled circuits.
E = 375 volts; L_1 = 0.237 henry; C_1 = 0.45 mf.; R_1 = 12.6 ohms; v_1 = 100~; L_2 = 0.237 henry; C_2 = 0.45 mf; R_2 = 13.0 ohms; coupling coefficient, 14 per cent.

FIG. 36.—Coupled circuits. Primary circuit opened after first transfer of the energy to the secondary circuit.
E = 375 volts; L_1 = 0.237 henry; C_1 = 0.45 mf.; R_1 = 12.6 ohms; v_1 = 100~; L_2 = 0.237 henry; C_2 = 0.45 mf.; R_2 = 13.0 ohms; coupling coefficient, 14 per cent.

Figure 28. Title page and an oscillogram from Carl E. Magnusson's textbook *Electric Transients*. This is the second edition of 1926, so the oscillograms are the work of Professor George Smith.

In 1924 Dean Magnusson published the first edition of his advanced textbook, *Electric Transients*, as lead author with two other faculty members. The text was far less mathematical than later texts on the same topics, deriving the time domain solutions for voltage and current transients initially from energy and rate of change and only secondarily from differential equations, but it served well for undergraduate instruction. Magnusson used it for the rest of his teaching career, and it was also used in several other universities. Continuing a banner year for his scholarship, in 1924 Dean Magnusson published an Engineering Experiment Station Bulletin entitled *Hydro Power in Washington*, and served as a member of the American Committee at the World Power Conference.

George Smith completed Kirsten's work on transmission lines, publishing the Engineering Experiment Station Bulletin *Transmission Line Design--Mechanical Features of Towers at Unequal Elevation* in 1924.

In the boom times of the 1920s money for faculty salaries was not hard to obtain. Two more instructors were hired from among the UW graduates, 1922 B.S.E.E. classmates Roy Lindblom and Austin V. Eastman. Both would be long-term faculty.

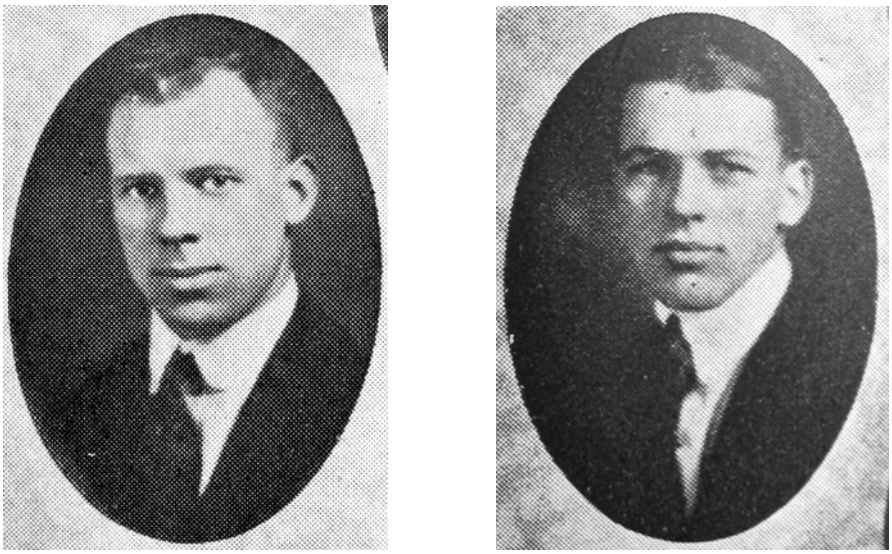


Figure 29. Roy Lindblom (L) and Austin V. Eastman (R) graduating in 1922. Both were future EE Professors, and Eastman was a future EE Chair. (1922 *Tyee* photos)

Of Roy Eric Lindblom, George Smith said: "He was probably the best teacher the department ever had, always well prepared, thorough, and although demanding of his students, he was very popular with them. Lindblom was unusually capable of planning, designing and carrying to completion his many ideas of improvements, especially improvements of the laboratory equipment."

After graduating from Washington, Austin Vitruvius Eastman had worked for General Electric for two years working with vacuum tube electronics. He would become the leading proponent of electronics in the department, and eventually become department chair after Magnusson.

In 1925 Dean Magnusson formalized what had become the de facto process of choosing an engineering major. Since the curricular reform of 1918, students had been permitted, nay encouraged, to defer a choice of major until the sophomore year. The curriculum had been arranged so that each department had the same freshman year to facilitate this process. Now a Department of General Education was created and given charge of the freshman year and the freshmen themselves. The School of Mines also participated in the common freshman year. The General Engineering department was given the Engineering Drawing courses and the Engineering Problems courses that had previously been taught by Civil Engineering. The Engineering Problems courses retained their strong civil engineering flavor, so the objective of acquainting students with a range of engineering majors may not have been completely met. Still, the General Engineering Department endured until the early 1970s.

As he started his twentieth year as department chair, Carl Magnusson could look back over the accomplishments of the last decade with great pride. The faculty had grown from three to eight. Undergraduate enrollment and graduation had similarly increased,

especially after the war. The number of B.S.E.E. degrees granted increased from 16 in 1920 to 38 in 1923. Department response to the crisis of the war had been timely and substantial. A research program in electric power transmission was well established. The department was making broad intellectual contributions in the form of research reports and textbooks. Progress was back, and seemed likely to continue.

To modern eyes, the succession of six Washington graduates hired as faculty in this seems unusual. Concerns about intellectual inbreeding engender caution in hiring from one's own graduates unless they have proven themselves successful at other institutions in graduate school or as faculty. There are two possible views of this hiring pattern, one positive and one negative.

The negative view is that it was difficult for Professor Magnusson to find qualified instructors willing to move to Seattle because opportunity abounded in California and the East. The positive view is that Washington graduates of the era were, in fact, the best electrical engineers available and were highly regarded by General Electric and Westinghouse, the two major electrical engineering companies in the United States. They were eagerly hired and rapidly advanced to responsible positions, such as George Smith's rapid rise to the high position of Head of Test at General Electric. On February 14, 1924, *The Daily* reported "B.A. Travis, graduate of the University of Washington in 1922, now with Westinghouse Electric and Manufacturing Co., stated that he doubted that any university can show a better record than Washington for men (with an electrical engineering degree) who have been out of school for an equal length of time." This record provides confirmation of the quality of Washington graduates.

1925-1935 Surviving the Depression

Figure 30. UW Seal, 1925 (adopted 1916).

It was the middle of the Roaring Twenties. Prohibition had been passed in 1919, setting off an explosion of bootlegging, rum running and organized crime. In Chicago Al Capone took control of gang activity. Seattle's rum king, Roy Olmstead, ran his operation more like a business than a crime syndicate. He was a radio station owner, and in 1926 would be done in by a wire tap, although he took his case against this new technology all the way to the Supreme Court.

Olmstead's radio station played songs like "Yes Sir, That's My Baby" using Edwin Armstrong's 1912 regenerative circuit in its transmitter and his 1918 super heterodyne circuit in the parlor and table top radio receivers. Broadcast radio started in 1920 and was an instant success. It made Armstrong a millionaire. By 1925 Armstrong was enmeshed in a patent fight with AT&T which he would lose in 1934 when the Supreme Court misunderstood the technical facts of the case.

The first long distance telephone call was made in 1915, the first electric filter was built in 1917. Some recent new technologies that would take more time to make their mark were the flip-flop circuit of 1919, Farnsworth's scanning electron tube of 1922 (the TV camera) and Zworykin's cathode ray tube of 1923 (the TV set). Despite the excitement in electronics, it was really the Era of Aviation. Charles Lindbergh would fly the Atlantic in 1927.

After student and faculty growth at the end of the Great War, the Electrical Engineering Department settled in to a more stable situation. The faculty first did the fundamental work of educating electrical engineers for the Northwest and the nation. Beyond that, the young faculty like Eastman and Hoard embraced the new technologies of electronics and radio. The adventurous Kirsten taught and invented in the hot field of aeronautics. The senior faculty like Magnusson and Loew, and Kirsten too, together with some of the junior ones brought their work on electric power transmission to fruition, with occasional detours into other interesting topics.

Figure from Engineering Experiment Station Bulletin 32, *Transmission Line Design Part II, Electrical Features - The Line of Maximum Economy* by Professors Kirsten and Loew.

An early indication of the maturity of the transmission line work was the 1925 publication of the Engineering Experiment Station Bulletin *Transmission Line Design Part II, Electrical Features - The Line of Maximum Economy* by Professors Kirsten and Loew. Part I had consisted of three bulletins on the mechanical design of transmission lines, and the work had now moved on to electrical and economic design issues.

Figure 31. Guggenheim Hall in 1931. Guggenheim was built in 1929 with a grant won by a proposal written by Professor Frederick Kurt Kirsten, then Professor of Electrical Engineering. (University of Washington Special Collections CFT0223)

In 1926 Professor Kirsten wrote a proposal for a grant from the Daniel Guggenheim Fund for the Promotion of Aeronautics to further aeronautical engineering at the University of Washington. The grant was formally signed by President Suzzallo and Dean Magnusson. The proposal leveraged Kirsten's work on the cycloidal propeller, despite the negative opinion the concept had received from the United States Navy in 1923. The University of Washington was one of six universities in the nation to obtain a $290K grant, which built the Guggenheim building in 1929.

In 1927 Professor Kirsten and C. M. Briggs published the Bulletin *Transmission Line Design Part III – A 500 Mile Transmission Line*. The long-distance transmission line concept anticipated the transmission lines that now run up and down the West Coast interconnecting power systems from Mexico to British Columbia. The work may have marked the last electrical efforts of Professor Kirsten. Busy with the construction of the Guggenheim building, Kirsten also embarked this year on a very active public speaking career, addressing in general issues of society and technology. He would be a popular public speaker for the remainder of his career.

Hints of the future can be found in Instructor Austin Eastman's expansion of the Radio course into two courses, roughly divided into vacuum tube electronics and antennas, although still centrally concerned with how radios work.

Bulletin No. 212 of the University of Washington, January 1928, provides a look at attitudes towards Electrical Engineering in this decade. "Electrical Engineering is one of the newer engineering professions. From the very beginning however, the electrical industry grew very rapidly, and we find after only fifty years of development, to have attained a stature so phenomenal, that the age in which we live is frequently called the 'electrical age.' Even the wisest prophet cannot foretell at the outset what a particular individual trained, let us say, as an electrical engineer, will be doing to earn a living twenty years after graduation. The pay check for his first month is somewhere between $100.00 and $150.00."

While the pay scale has changed a bit, the themes of growth, social significance and career change remain features of electrical engineering today.

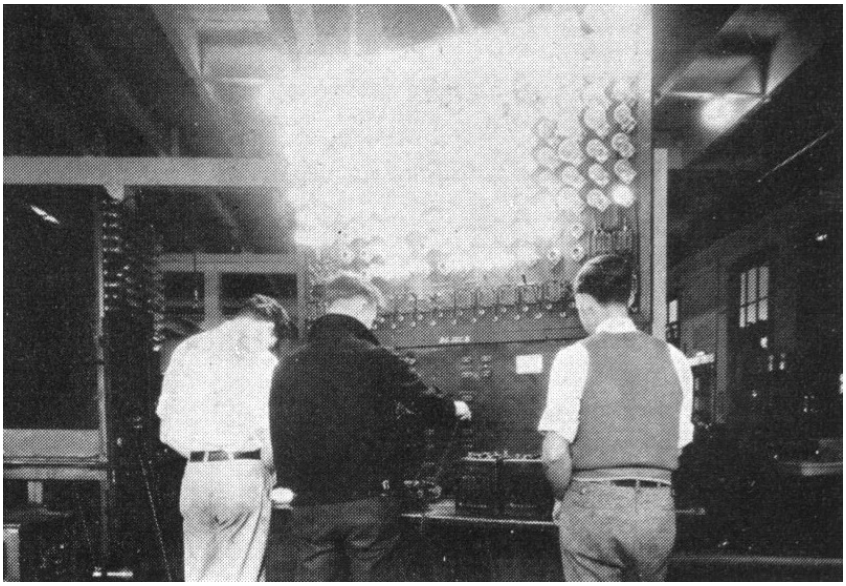
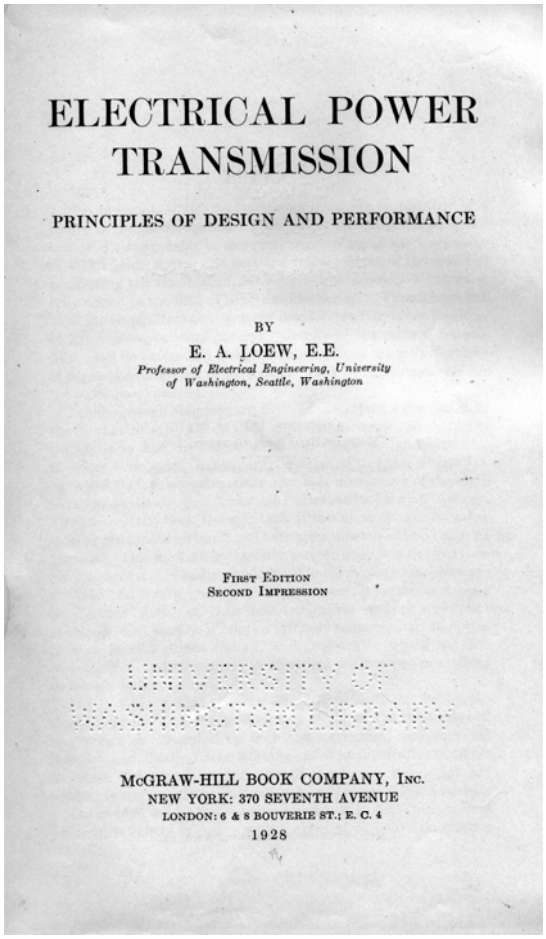


Figure 32. Students in the Electrical Laboratory in 1934. (*Tyee* photo)

During this period, Roy Lindblom became the Electrical Laboratory Director and would supervise the lab until his death in 1960. He had an unusual ability to design and construct very suitable, dependable and rugged equipment for laboratory use, equipment that was not commercially available. Much of the construction was done by students, providing useful practical experience.



ELECTRICAL POWER TRANSMISSION

PRINCIPLES OF DESIGN AND PERFORMANCE

BY

E. A. LOEW, E.E.

Professor of Electrical Engineering, University of Washington, Seattle, Washington

FIRST EDITION
SECOND IMPRESSION

McGRAW-HILL BOOK COMPANY, INC.
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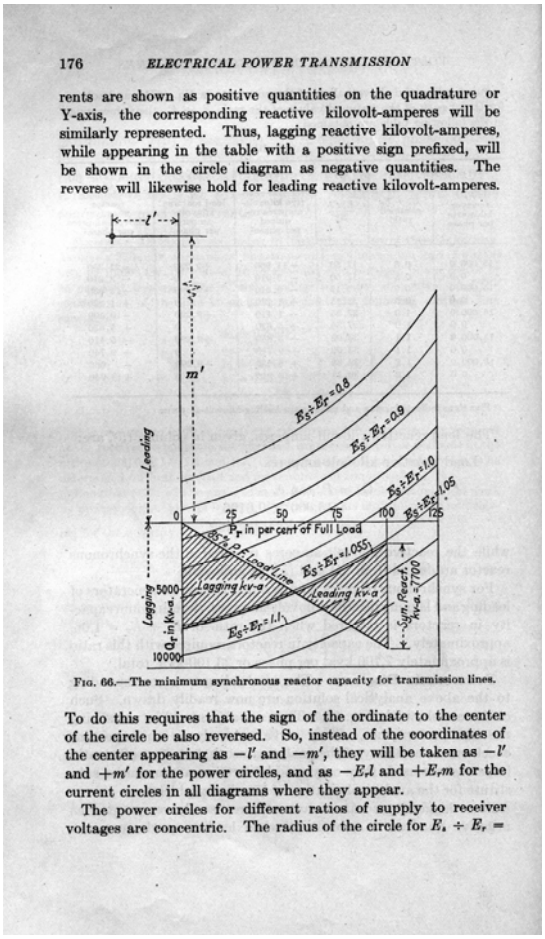
1928



rents are shown as positive quantities on the quadrature or Y-axis, the corresponding reactive kilovolt-amperes will be similarly represented. Thus, lagging reactive kilovolt-amperes, while appearing in the table with a positive sign prefixed, will be shown in the circle diagram as negative quantities. The reverse will likewise hold for leading reactive kilovolt-amperes.

FIG. 66.—The minimum synchronous reactor capacity for transmission lines.

To do this requires that the sign of the ordinate to the center of the circle be also reversed. So, instead of the coordinates of the center appearing as $-l'$ and $-m'$, they will be taken as $-l'$ and $+m'$ for the power circles, and as $-E_r l$ and $+E_r m$ for the current circles in all diagrams where they appear.

The power circles for different ratios of supply to receiver voltages are concentric. The radius of the circle for $E_s \div E_r =$

Figure 33. Cover page and a page of text from Edgar A. Loew's 1928 textbook *Electrical Power Transmission*. The book drew on previously published Engineering Experiment Station bulletins about transmission lines, as well as Loew's teaching notes.

Continuing the instructional theme, Professor Edgar A. Loew published his textbook *Electrical Power Transmission* with McGraw-Hill. Loew had developed the textbook from his teaching notes for transmission line design classes, and the various Bulletins on electric power transmission authored by Loew and others. L.V. Bewley, a Washington alumnus, and later Professor and Dean at Lehigh University, pronounced the book the best available on the subject. In the same year, Professor Hoard introduced an elective course on Electric Public Utilities, but the course was short lived. Finally, still another Washington graduate was hired as faculty. John Weir, with a 1925 B.S.E.E., was appointed Instructor. Like Bergstrom, the previous hire, Weir only stayed for a year.

1929 was an eventful year for the Electrical Engineering Department as well as the world. It opened well when both Roy Lindblom and Austin Eastman were awarded M.S.E.E. degrees from the University of Washington. Edgar Loew continued the series of publications on transmission line design with the Bulletin *Transmission Line Design - Part IV, Choice of Line Voltage and Conductor Size*. The Guggenheim building was

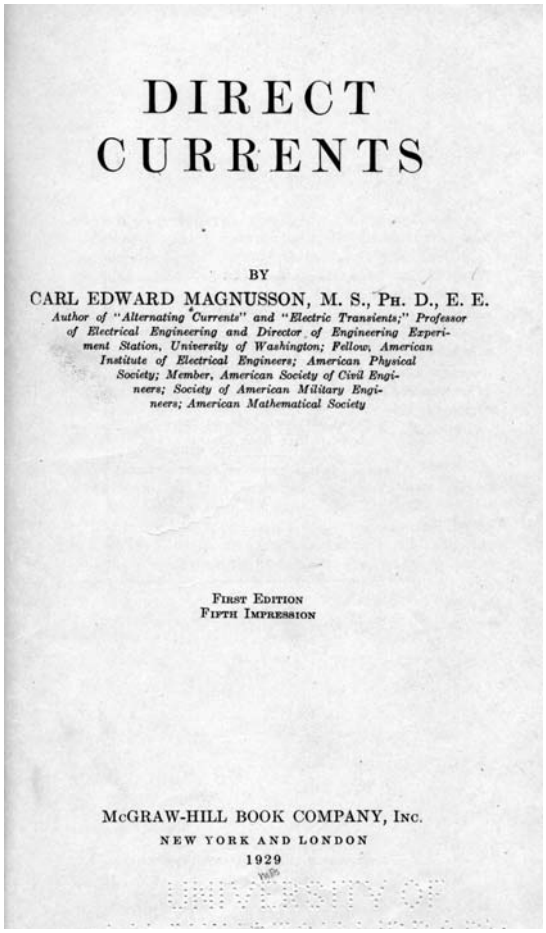
completed, and Professor Frederick Kirsten formally departed the Electrical Engineering Department for Aeronautical Engineering.

At about the same time, Professor George Smith prevailed on his brother-in-law, Edward Shelton, a Washington EE graduate working at Pittsfield, to induce General Electric to donate some forty surplus high-voltage condensers, a DuFour cathode ray oscillograph and auxiliary equipment to the University. Smith established a “moderately” high-voltage laboratory with a surge generator in one of the high-ceilinged rooms with a skylight, formerly used for drafting, in Engineering Hall. The equipment was used by students as well as for research for several years. Dr. Magnusson later obtained funds to purchase uprated condensers, permitting Smith to upgrade the lab to 600 kV.

Figure 34. Carl E. Magnusson, Ph. D., Professor of Electrical Engineering and Dean of the College of Engineering. (Information Services Photograph)

During this era, leadership of the college changed. Dr. Magnusson resigned as Dean but continued to lead Electrical Engineering. His tenure as Dean had opened in 1917 with a massive reorganization of the engineering curriculum to shift from a semester system to a quarter system, and to add war emergency courses, all done in a rush to respond to wartime conditions. The reorganization was so well done that the resulting curriculum remained intact in all major respects until at least the Second World War. Magnusson then dealt with the post-war increase in enrollment and faculty through 1923. He ended his deanship by landing the major grant that built Guggenheim Hall. During his tenure Two new engineering departments were founded during his tenure, General Engineering and Aeronautical Engineering. Few other Deans have done as well.

Richard Gaines Tyler, who earned his B.S. in civil engineering at MIT, concurrently served as Dean of the college and head of Civil Engineering from 1929 to 1935.



DIRECT
CURRENTS

BY

CARL EDWARD MAGNUSSON, M. S., PH. D., E. E.

Author of "Alternating Currents" and "Electric Transients;" Professor of Electrical Engineering and Director of Engineering Experiment Station, University of Washington; Fellow, American Institute of Electrical Engineers; American Physical Society; Member, American Society of Civil Engineers; Society of American Military Engineers; American Mathematical Society

FIRST EDITION
FIFTH IMPRESSION

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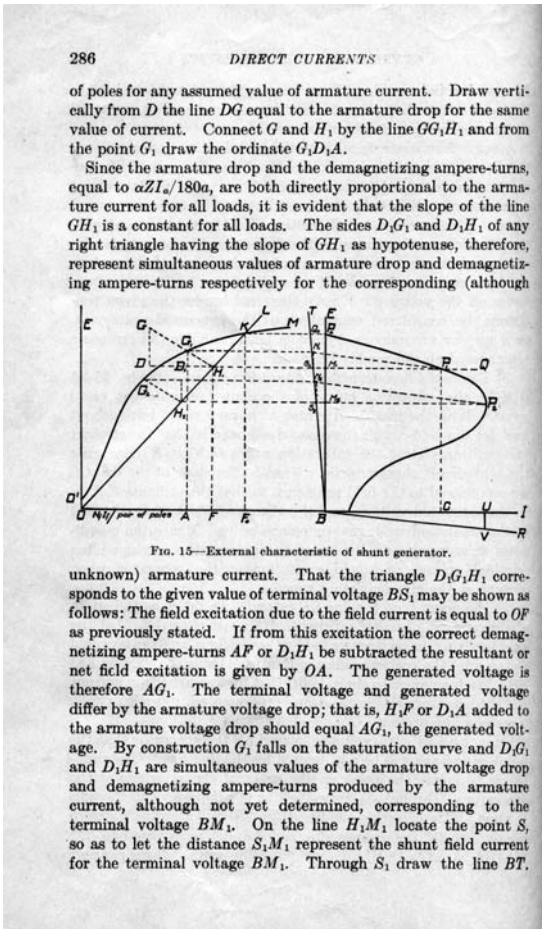


286 DIRECT CURRENTS

of poles for any assumed value of armature current. Draw vertically from D the line DG equal to the armature drop for the same value of current. Connect G and H_1 by the line GG_1H_1 and from the point G_1 draw the ordinate G_1D_1A.

Since the armature drop and the demagnetizing ampere-turns, equal to $aZI_a/180a$, are both directly proportional to the armature current for all loads, it is evident that the slope of the line GH_1 is a constant for all loads. The sides D_1G_1 and D_1H_1 of any right triangle having the slope of GH_1 as hypotenuse, therefore, represent simultaneous values of armature drop and demagnetizing ampere-turns respectively for the corresponding (although

FIG. 15—External characteristic of shunt generator.

unknown) armature current. That the triangle $D_1G_1H_1$ corresponds to the given value of terminal voltage BS_1 may be shown as follows: The field excitation due to the field current is equal to OF as previously stated. If from this excitation the correct demagnetizing ampere-turns AF or D_1H_1 be subtracted the resultant or net field excitation is given by OA. The generated voltage is therefore AG_1. The terminal voltage and generated voltage differ by the armature voltage drop; that is, H_1F or D_1A added to the armature voltage drop should equal AG_1, the generated voltage. By construction G_1 falls on the saturation curve and D_1G_1 and D_1H_1 are simultaneous values of the armature voltage drop and demagnetizing ampere-turns produced by the armature current, although not yet determined, corresponding to the terminal voltage BM_1. On the line H_1M_1 locate the point S, so as to let the distance S_1M_1 represent the shunt field current for the terminal voltage BM_1. Through S_1 draw the line BT.

Figure 35. Cover page and a page of text from Carl Magnusson's 1928 textbook *Direct Currents*. The diagram shows a graphical explanation of the effect of magnetic saturation (the non-linear curve on the left) on the operation of a shunt DC generator.

Professor Magnusson now published his textbook *Direct Currents* with McGraw-Hill. The book covered elementary DC circuit theory, generators, and motors, and was based on teaching notes from the first courses taught in electrical engineering at the UW. The book was considered to be an excellent text. Its publication gave rise to two problems.

Professor Frederick Kurt Kirsten departs the Electrical Engineering scene at this point, but he remained in close contact with his friends in the EE faculty, and his subsequent career continues so colorful that a digression is almost mandatory.

Although he had written the proposal that built the building for the new Aeronautical Engineering Department, was a full Professor and had single-handedly carried the aeronautical engineering teaching load for years, Kirsten was not chosen to be the first Department Chair. Instead of Kirsten, Everett O. Eastwood, Head of Mechanical Engineering, was additionally appointed Head of Aeronautical Engineering. Eastwood was a teaching professor while Kirsten prided himself on being a "research man." The two at times had clashed over the value of research but worked well together from 1931

on. Eastwood remained chair of Mechanical Engineering and Aeronautical Engineering until he retired in 1947.

Figure 36. Wind tunnel in 1939. The tunnel was completed in 1938. It was funded with $200,000 in grants won by Professor Frederick Kurt Kirsten, who wrote the proposals when he could not afford $200 a day to test his aircraft design at CalTech. In 1948 the building was named the F. K. Kirsten Wind Tunnel. (University of Washington Special Collections CFT0201)

In 1934 Kirsten asked to test an aircraft design with a cycloidal propeller in the CalTech wind tunnel. He was told it would cost $200 a day, which he did not have. Energized, Kirsten wrote a proposal to build a 250 mph, 8 by 12 foot cross-section wind tunnel, superior in every way to CalTech's, on the University of Washington campus. $200K in funding was obtained, most from the federal Works Progress Administration. Ground breaking was in 1935 and the wind tunnel was operational in 1938. Kirsten then tested his cycloplane for free. The wind tunnel was named for F. K. Kirsten in 1948.

In 1935 or 1936 Kirsten was comparing the merits of smoking pipes with a Chemistry professor over lunch when he realized that neither of them understood what made a pipe a good smoke. Kirsten pondered the matter and then designed a pipe that cooled and filtered the smoke in pipe stem. The pipe made him moderately wealthy. The Kirsten

Pipe Company remains in operation in Seattle, in 1991 managed by Kirsten's son Eugene. The company's web site is http://www.kirstenpipe.com/.

Figure 37. Professor Frederick K. Kirsten, with his pipe, in 1945. (*Tyee* photo)

Kirsten retired in 1951 to the hops farm in Roy and died in 1952. His career was perhaps more that of an inventor than of a scholarly researcher. His entrepreneurial success at fundraising benefited generations of Aeronautical Engineering students and faculty, and he remains a boon to pipe smokers throughout the world.

To cap an eventful calendar year, shortly after the start of the Fall quarter in 1929 the stock market crashed and the world entered the Great Depression. Financial effects on the University were not immediate, but were painful when they finally appeared. The Legislature slashed appropriations and repeatedly cut faculty salaries in 1931 and 1932. Many faculty left the University. Electrical Engineering was fortunate not to lose anyone. In 1933 appropriations rebounded somewhat, and some of the cuts were restored.

Enrollment, counterintuitively, went up for two years as students who could not find a job, or who had lost the one they had, turned to campus to escape from unemployment. The graduation rate in 1930, the first spring of the Depression, dropped precipitously before bouncing back. In 1931 *The Daily* quoted Dean R. G. Tyler as saying that EE was the most popular major in the College, with 149 out of 893 students. (Recall that students were now pre-engineers in the freshman year. About 22% of the declared majors were electrical engineers.)

Despite the depression, research continued in the Electrical Engineering Department, aided by a significant increase in graduate enrollment. Professor Gordon Shuck had been quietly teaching and studying metering issues and the method of symmetrical components used to analyze unbalanced three phase systems, proposed by Fortesque in 1918. In 1930 Shuck published the Bulletin *Kilovolt-Ampere-Hour Meters*. In 1933 he published the Bulletin *Metering Symmetrical Components*.

Professor Magnusson's original interest in electrical transients, which dated back at least to his sabbatical with General Electric in 1911, now led him to the topic of Lichtenberg figures. These are figures caused by the redistribution of charge carriers on the surface of an insulator by the discharge of a capacitor across a spark gap. Discovered by Lichtenberg in 1777, the figures were made by discharging a high voltage capacitor across a spark gap and then through a pointed electrode perpendicular to the center of a glass insulator. Flower of sulfur (finely ground sulfur) and red lead pigment were then sifted onto the surface to reveal the figure. Qualitatively different, and beautiful, patterns were formed when the electrode was sparked from the positive and negative terminals of the capacitor.

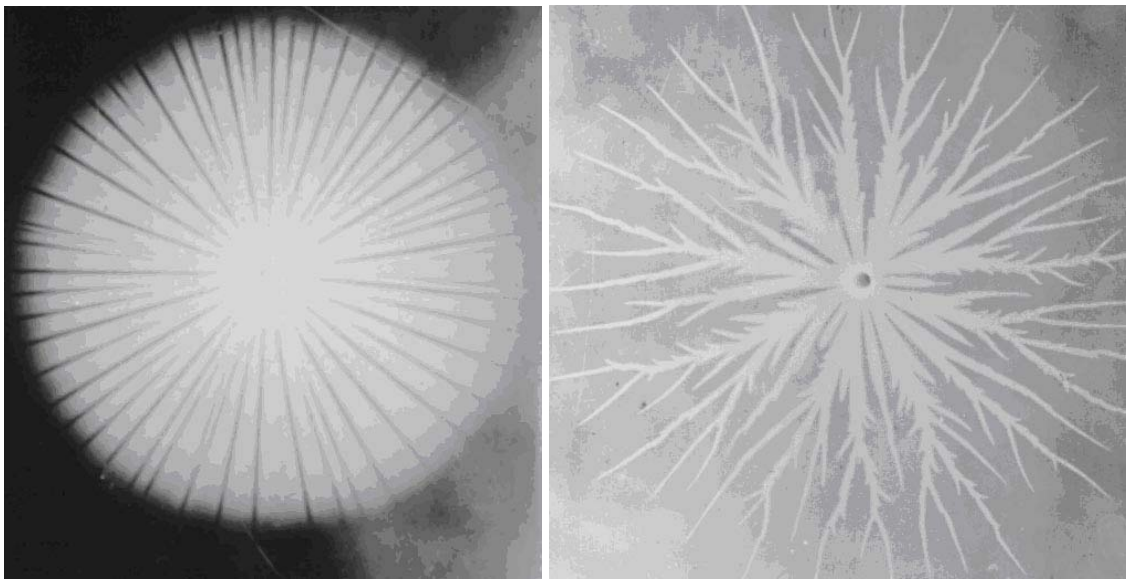


Figure 38. Lichtenberg figures created by discharging the negative terminal (left) and positive terminal (right) of a capacitor through a spark gap. The difference in the appearance of the figures gave rise to the theory that the negative terminal emitted negative charges (electrons) and the positive terminal emitted positive charges (ions). Professor Magnusson demonstrated that negative charges were emitted in both cases.

J. F. Peters at Westinghouse discovered how to reveal Lichtenberg figures on photographic film in the mid-20's or before, calling the result a klydonogram. He suggested that they could be used to study voltage surges in electrical equipment. Dr. Magnusson must have come across them in discussion with his students working at Westinghouse or General Electric.

One theory current at the time held that the difference in the figures was due to a difference in the type of moving charge. Sparking from the negative terminal was thought to result in moving negative charges, i.e. electrons, while sparking from the positive terminal was thought to result in moving positive charges, i.e. ions.

Magnusson's contribution was to test this assumption by creating Lichtenberg figures while the photographic plate was placed in a magnetic field. The magnetic field would cause electrons in motion to spiral in one direction, while positive ions would spiral in the

opposite direction. The spirals should show up in the patterns. Magnusson conclusively proved that negative charges, i.e. electrons, did all the moving in both the positive and negative terminal cases. He published this result in 1932 in an Engineering Experiment Station Bulletin entitled *Electric Discharges No. 1, Effects of the Magnetic Field on Electric Figures in Air*. *The Daily* of February 1932 reported "Magnusson wins international fame with studies in Lichtenberg figures. He disproves theories of European scientists Toepler and Pitziram that the positive ions are projected from the positive electrode in such figures. Magnusson proved by using the effects in a magnetic field that the reverse is true."

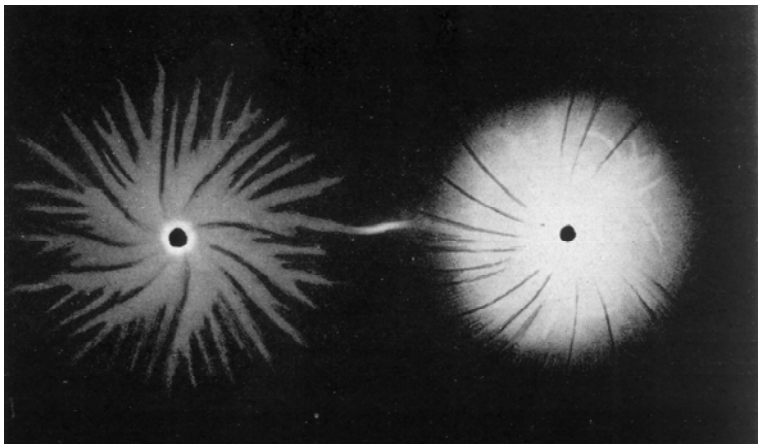
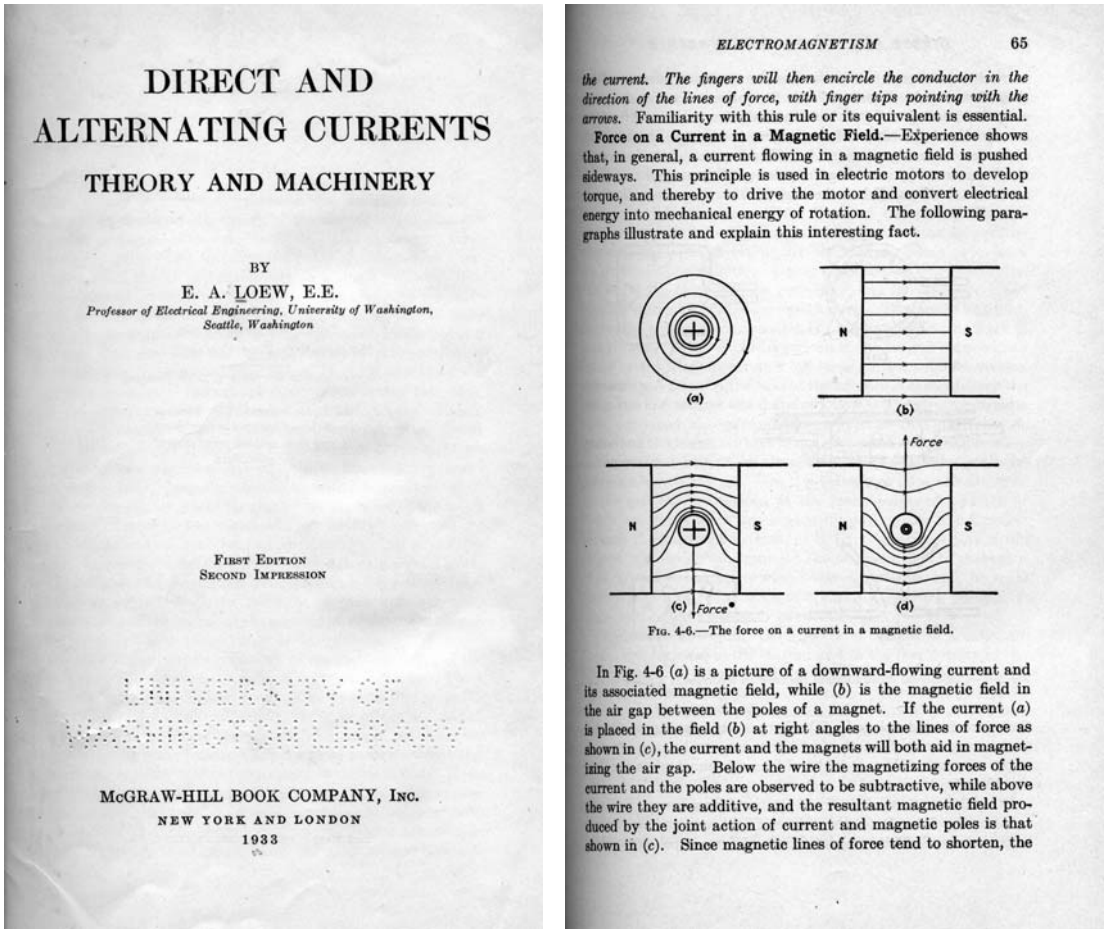


Figure 39. This figure from Magnusson's report *Electric Discharges No. 1, Effects of the Magnetic Field on Electric Figures in Air* illustrates his main finding. Both positive (left) and negative (right) Lichtenberg figures are created simultaneously on the same photographic plate, placed in a magnetic field. The streamers in each figure spiral in the same direction, indicating that they are made by charges with the same polarity, i.e. electrons. If the positive figure were made by the motion of positive charges, the spiral of the positive figure would be in the opposite direction. The magnetic field is into the page. (Figure from *Electric Discharges No. 1, Effects of the Magnetic Field on Electric Figures in Air*)

Magnusson's results drew immediate reaction. A famous scientist (we may hope it was Toepler or Pitziram) sent him a letter severely criticizing his reports and papers. Magnusson was greatly disturbed. His peace of mind was restored when a subsequent letter from the same scientist apologized for the first letter. The scientist had repeated the experiments himself and confirmed Magnusson's results. The work with Lichtenberg figures created something of a fad for them in the department. Professors Smith and Lindblom examined the effects of barriers on the figures. Undergraduate Arthur Kramer designed a magnet for Professor Magnusson's experiments as a laboratory project, and calibrated its magnetic field. Later, Kramer would do his graduate thesis on fringe effects in Lichtenberg figures, to Magnusson's great satisfaction.

Somewhat lost in all the excitement over the Lichtenberg figures was the expansion of the radio courses from two to three. The first lost its direct connection to radio and became simply Vacuum Tubes, the first pure electronics course in the curriculum. The

second course retained the Radio name. It now included the topic of television, although this was dropped after a few years, perhaps when it became apparent that the concept was not quickly catching on. The third course was Telephone Transmission, and dealt with signal propagation on long transmission lines.



DIRECT AND
ALTERNATING CURRENTS

THEORY AND MACHINERY

BY
E. A. LOEW, E.E.
Professor of Electrical Engineering, University of Washington, Seattle, Washington

FIRST EDITION
SECOND IMPRESSION

McGRAW-HILL BOOK COMPANY, INC.
NEW YORK AND LONDON
1933

the current. The fingers will then encircle the conductor in the direction of the lines of force, with finger tips pointing with the arrows. Familiarity with this rule or its equivalent is essential.

Force on a Current in a Magnetic Field.—Experience shows that, in general, a current flowing in a magnetic field is pushed sideways. This principle is used in electric motors to develop torque, and thereby to drive the motor and convert electrical energy into mechanical energy of rotation. The following paragraphs illustrate and explain this interesting fact.

FIG. 4-6.—The force on a current in a magnetic field.

In Fig. 4-6 (*a*) is a picture of a downward-flowing current and its associated magnetic field, while (*b*) is the magnetic field in the air gap between the poles of a magnet. If the current (*a*) is placed in the field (*b*) at right angles to the lines of force as shown in (*c*), the current and the magnets will both aid in magnetizing the air gap. Below the wire the magnetizing forces of the current and the poles are observed to be subtractive, while above the wire they are additive, and the resultant magnetic field produced by the joint action of current and magnetic poles is that shown in (*c*). Since magnetic lines of force tend to shorten, the

Figure 40. Cover and a page of text from Edgar A. Loew's 1933 textbook *Direct and Alternating Currents*. The page illustrates the machinery-oriented nature of the text.

In 1933 Professor Loew published his textbook *Direct and Alternating Currents* with McGraw-Hill. After Magnusson had beaten him to the publication of a text on direct currents, Loew revised his goals and wrote this abbreviated text for non-electrical students in engineering. It was a "most excellent" text, according to George Smith, and was adopted even for electrical engineering majors in many colleges. Although his textbook was at a basic level, Loew introduced two elective courses called Advanced Circuit Theory this year. The first covered operational calculus applied to ac circuit analysis, and the second covered symmetrical components. This was also the last year Professor Magnusson attended the World Power Conference.

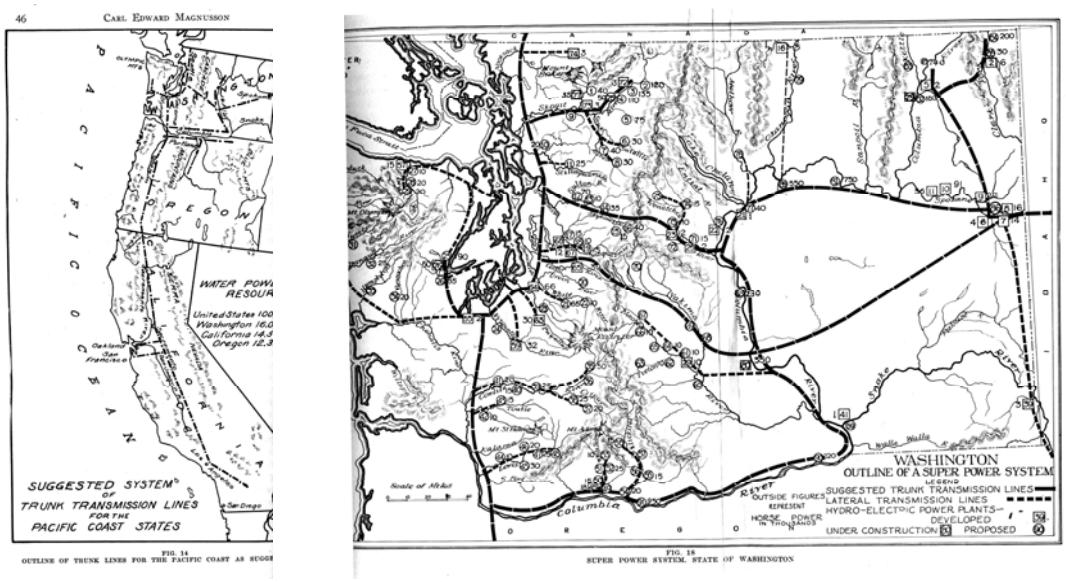


Figure 41. As early as 1919, Carl E. Magnusson had envisioned a transmission system extending from Seattle to California (left). By 1925 he had developed a detailed plan for a "Super Power System" in Washington State (right) based on the locations of undeveloped hydro resources. The transmission system in the state today is in most respects similar to the one Magnusson envisioned. These figures are from Magnusson's Engineering Experiment Station Bulletin No. 26 *Hydro-Electric Power in Washington Part I. A Reconnaissance Survey*.

In 1933 ground was broken for the Grand Coulee Dam. Professor Magnusson was very involved in consulting on the dam, and in advocating its construction. A major issue was the height of the dam. The initial decision was to build a low dam, one that would back water up only to the Canadian border. Magnusson, and others, advocated a higher dam that would make maximum use of the available hydro resource. At the time, there was a significant excess of hydroelectric generation in the Pacific Northwest, and most analysts could see no possible future use for the excess of electric power that would result. Magnusson foresaw a transmission system interconnecting the Northwest and California, similar to the one in existence today, and argued forcefully for the high dam. His position prevailed when Congress authorized construction of the high dam in 1935. On completion in 1941, Grand Coulee, which had been built primarily for irrigation, with electricity generation as a secondary priority, was immediately operated to produce maximum hydroelectric power output to supply the war effort. The demand for electric power created the Northwest Power Pool in 1942, interconnecting eleven power systems in Washington, Oregon, Idaho, Montana and Utah much as Magnusson had foreseen.

Somewhat remarkably, considering that it was the middle of the Great Depression, in 1934 Lyall B. Cochran, B.S.E.E. 1923, University of Washington, was hired as an Instructor. Cochran had been an Instructor from 1923-1924 while Austin Eastman was on sabbatical. He had then worked for General Electric, the telephone company in Everett, and finally for the State Department of Washington before returning to the University. George Smith says "Cochran, a very excellent teacher … always gave a great deal of his time to what might be called extra-curricular activity with the students and with the

public." Cochran worked with Eastman and Lisle Hoard in electronics. He planned the first electronics laboratory in Engineering Hall. He was a popular public lecturer on new advances in electronics and high frequency, and was often quoted in the papers.

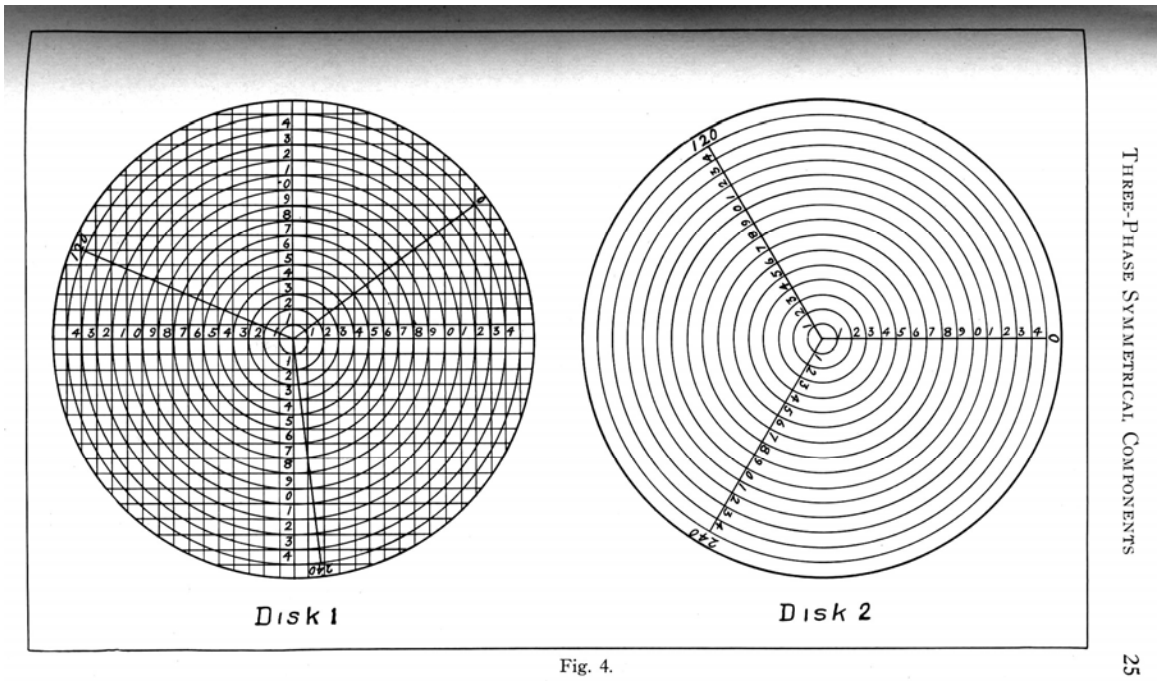


Figure 42. Symmetrical components circular slide rule appearing in Gordon Shuck's Engineering Experiment Station Bulletin No. 84, *Equations for Calculating Three Phase Symmetrical Components.* Disk 2 was to be transparent and superposed on disk 1. The slide rule was used to quickly find the rectangular coordinates of two phasors in a balanced set when the third is known.

In 1935, the last year of this decade, Gordon Shuck completed his work with symmetrical components with the Bulletin *Equations for Calculating Three Phase Symmetrical Components*. This was the most requested Bulletin, for its elegant simplification of the complex problem of symmetrical components in multi-phase AC operation.

A notable undergraduate research project appeared in *The Daily*. Students George K. Barger and Siegfried Hanson designed an electromagnetic sensing device to detect metal tags that the Alaska Bureau of Fisheries had been inserting under the skin of young herring. When the fish were caught later in life, the problem was to identify, from fish passing on a conveyor belt at a rate of 100,000 per hour, the one fish with a tag, so the tag could be recovered. A coil went around the belt and was monitored for changes. When a tag was sensed, relays kicked the fish off the belt. This was one of the more commercially valuable of the many undergraduate research projects of the time.

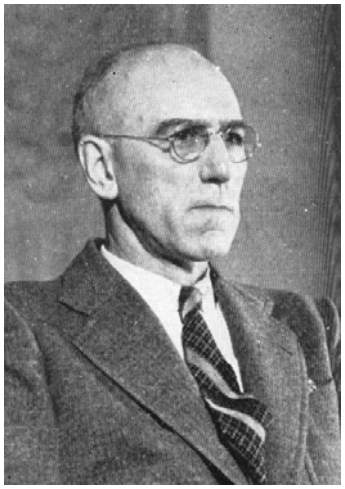


Figure 43. Edgar A. Loew, Professor of Electrical Engineering and Dean of the College of Engineering in 1939. (*Tyee* photo)

Dean Tyler stepped down after six years in office. Still in the middle of the Depression, an internal candidate was necessary, and the choice fell on Professor Edgar A. Loew. His elevation over Magnusson had the potential for difficulty, but the men worked well together into the next decade.

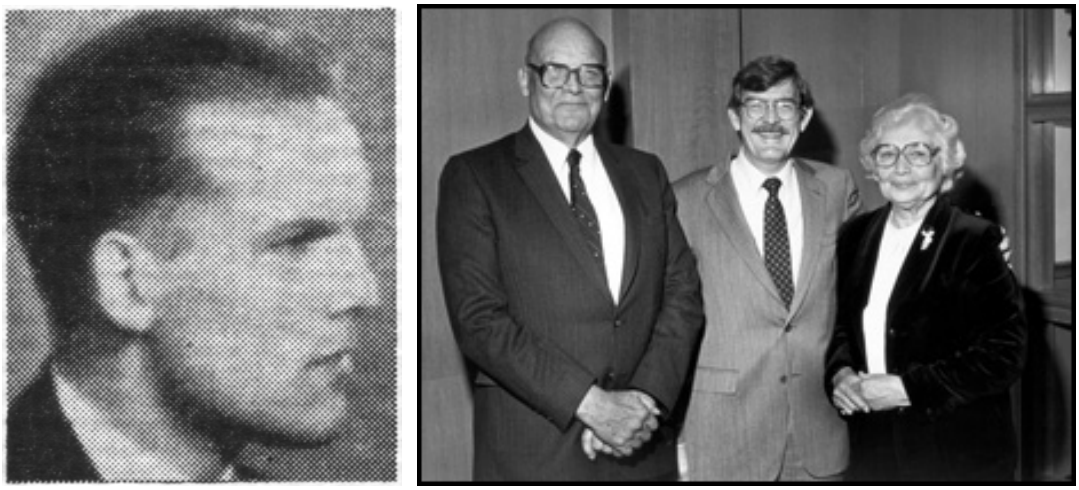


Figure 44. Left: Notable EE alumnus John Fluke Sr., graduating in 1935 as J. Maurice Fluke (*Tyee* photo). John Fluke Sr. (left) with his wife Lyla and Dean J. Ray Bowen in 1982. (UW Alumni photo)

A notable alumnus of the decade, or for that matter of any decade, was John Fluke Senior, who graduated with the B.S.E.E. in 1935. He also obtained a Naval Reserve Officer Training Corps commission, but in the penurious pre-war era was not called to active duty. Fluke then obtained an M.S.E.E. from M.I.T. and in 1936 went to work for General Electric in Schenectady. In 1941 during the pre-Pearl Harbor build up Fluke was called to active duty and assigned to work with Hyman G. Rickover, who at the time was the Navy's top expert on shipboard electric power systems. Rickover was later famous as the father of the Nuclear Navy. Working with him must have been a life-transforming experience.

John Fluke got out of the Navy in 1946 and spent several years in Connecticut as a consultant. In 1948 he started the John Fluke Engineering Company in the basement of his house. By 1952 he had outgrown his basement and was prepared to move "back home." His friend David Packard, of Hewlett-Packard fame, with whom Fluke and roomed while at GE, tried to get him to move to Stanford, and not the "intellectual vacuum" of Seattle. Viewed from an electronics perspective, Packard may have had a case. Fluke, however, let the Rainier factor win, and established his company in Everett. Fluke's company is now an iconic name in electronic meters. Fluke himself served many years on the College of Engineering Visiting Committee, endowed the first chaired professorship in the College of Engineering (alas, not in Electrical Engineering) and contributed significant funds to the Washington Technology Center, whose building now bears his name. His son, John Fluke Jr., was a 1964 graduate of the Electrical Engineering Department.

The Depression caused a slow drop in undergraduate enrollment but a significant increase in graduate enrollment, as students elected to defer graduation or pursue a graduate degree while job opportunities were scarce.

The story of the decade of 1925-1935 is one of sustained effort little affected by the boom of the 1920s or the bust of the Great Depression. Although the Depression caused some dislocation in student plans, it had surprisingly little impact on the faculty. Research productivity improved as long term efforts resulted in publications. The department had established a leading position in electric power transmission, and Magnusson's original expertise in hydroelectric generation also remained an important strength. Thanks primarily to Austin Eastman, the department was at the state of the art in electronics, but had not reached the same level of research contribution as in the power area.

1935-1945 Winning the War

Figure 45. UW Husky, 1930s.

1935 was the middle of the Great Depression. To those living through it, no end was visible. The many recovery programs of energetic President Franklin D. Roosevelt did little to restore the economy or public confidence. Oklahoma became the Dust Bowl. Harbingers of a dangerous future came from Europe. Germany under Hitler renounced the Versailles Peace Treaty to rearm and passed the Nuremburg Laws stripping Jews of German citizenship. Italy under Mussolini invaded Ethiopia while the League of Nations looked on helplessly.

The Second World War opened in September 1939 with the German invasion of Poland. As in the First World War, the United States was neutral, and the country was divided between those who wanted more involvement, and those who opposed intervention. There were even anti-war demonstrations. Presumably the engineering students and faculty were too busy to take much notice.

America was trying to forget its troubles. Talking pictures had debuted in 1927. The car radio ("Motorola") rolled out in 1929. Magnetic recording tape was invented in 1930. On a more serious note, Vannevar Bush's differential analyzer, the first analog computer, filled a room at MIT in 1930. The electron microscope appeared in 1931. Edwin Armstrong, motivated by his court battles over AM radio, invented FM in 1933. And 1935 saw the first radar patent and the first sales of canned beer. The relative importance of these latter two events to electrical engineers is left to the discretion of the reader.

The eight faculty in Electrical Engineering – Dr. Magnusson, Dean Loew, Associate Professors Shuck, Smith, Hoard, Lindblom, and Eastman and Instructor Cochran – continued their work in the last half of the 1930s, although the pace of publication slowed. The construction at Grand Coulee was the most interesting engineering project in the state, especially considering Professor Magnusson's involvement. The dam attracted numerous large field trips from the department.

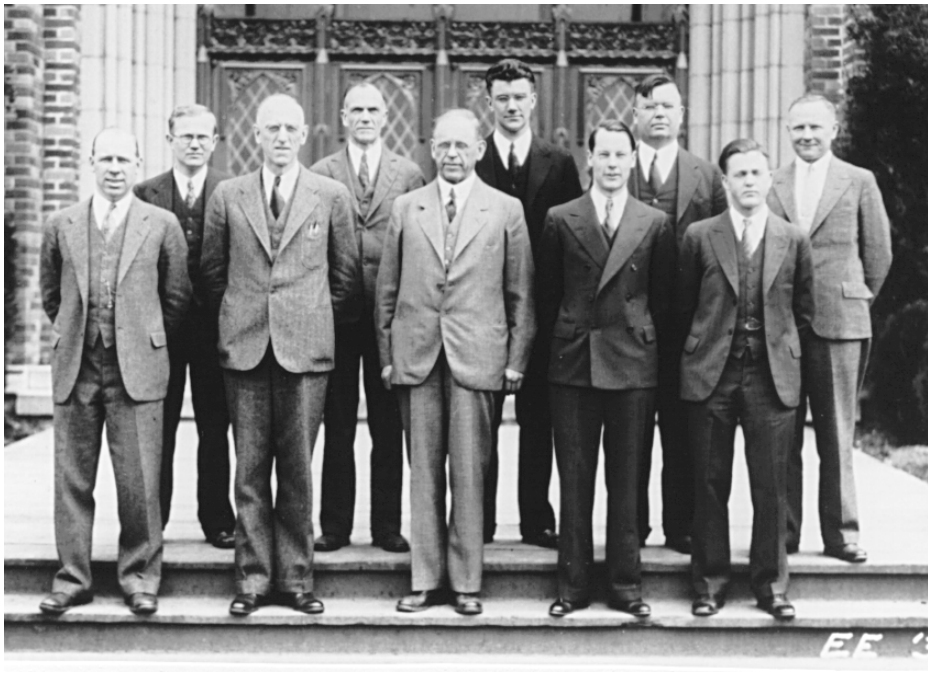


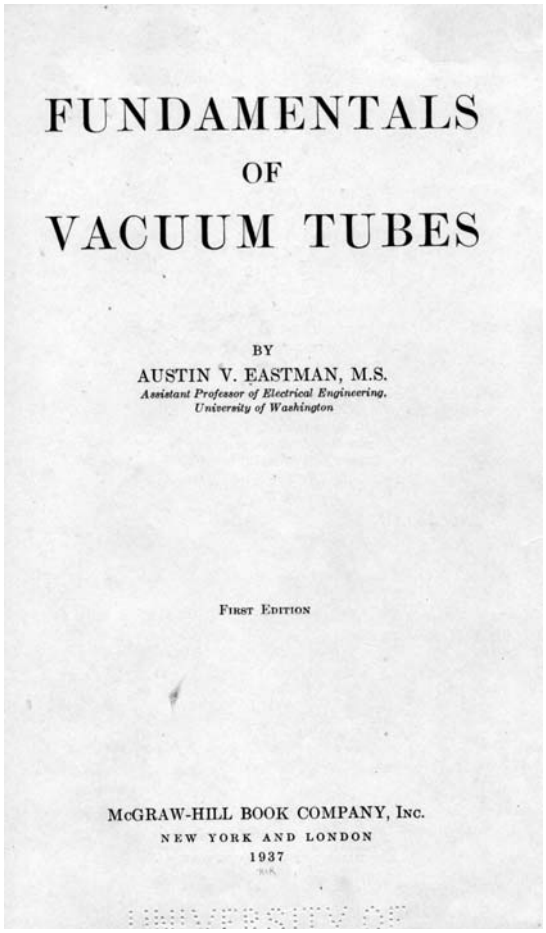
Figure 46. Electrical Engineering Faculty 1936
Left to right: Roy E. Lindblom, John Woodyard, Dean Edgar A. Loew, Gordon R. Shuck, Department Head Carl E. Magnusson, Austin V. Eastman, Lyall B. Cochran, George L. Hoard, Herbert Steen, and George S. Smith (Steen and Woodyard were skilled laboratory assistants.) (UW Special Collections)

Figure 47. The Electrical Engineering exhibit at the 1936 Washington State Fair in Puyallup. This was a one-time exhibit put together by Professor Roy E. Lindblom and students. From left: An early oscilloscope allows fair-goers to see their own voice. A Tesla coil produces a million volts and artificial lightning. A sensor designed by students to detect metal tags in herring, as the fish pass through on a conveyor belt in a processing plant. On the right, light used to transmit sound over short distances. (UW Libraries Special Collections Magnusson Collection)

Figure 48. Researchers examine the first klystron at Stanford University in 1939. Standing L to R Sigurd Varian, David Webster, William Hansen. In front, Russell Varian and John Woodyard, Washington alumnus. (Stanford News Service photo)

One alumnus of this time who left a record is John R. Woodyard, who appears in the Electrical Engineering Faculty photograph of 1936. Woodyard graduated in 1933 with a B.S.E.E. magna cum laude and stayed on for graduate school. In 1935-36 he worked with Magnusson as an Instructor. He then obtained an M.S.E.E. and Ph.D. in Physics at Stanford. Woodyard worked with his Ph.D. adviser, William Hansen, and three other researchers on the klystron, a key radar component, and is sometimes listed as a co-inventor. Later Woodyard worked with E. O. Lawrence on controlling calutrons, part of the isotope separation process used by the Manhattan Project. After the war Woodyard worked on the Stanford Linear Accelerator and later became a Professor of Electrical Engineering at Berkeley.

In 1937 Austin V. Eastman published his textbook *Fundamentals of Vacuum Tubes*. This marked the first electronics book authored in the department, which already had an impressive record of publication in the fundamental machinery and power area. The book is sometimes considered one of the classic texts in electronics. It emphasizes applications, with a thorough discussion of amplifier distortion and intermodulation distortion. It was one of the few books that explained push-pull operation theory in a clear and understandable way. The book is still of interest to vacuum tube hobbyists.

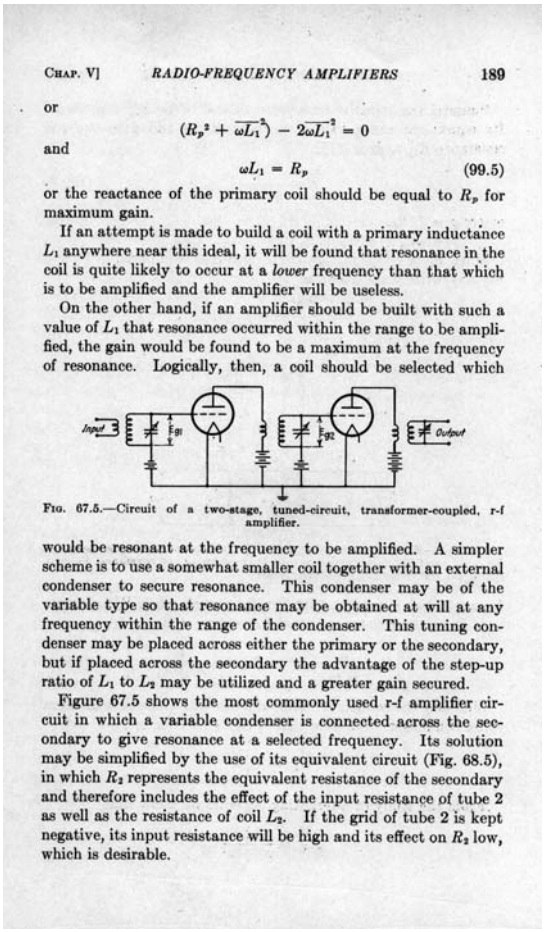


FUNDAMENTALS
OF
VACUUM TUBES

BY
AUSTIN V. EASTMAN, M.S.
Assistant Professor of Electrical Engineering,
University of Washington

FIRST EDITION

McGRAW-HILL BOOK COMPANY, INC.
NEW YORK AND LONDON
1937



CHAP. V] *RADIO-FREQUENCY AMPLIFIERS* 189

or

$$(R_p^2 + \overline{\omega L_1}^2) - 2\overline{\omega L_1}^2 = 0$$

and

$$\omega L_1 = R_p \qquad (99.5)$$

or the reactance of the primary coil should be equal to R_p for maximum gain.

If an attempt is made to build a coil with a primary inductance L_1 anywhere near this ideal, it will be found that resonance in the coil is quite likely to occur at a *lower* frequency than that which is to be amplified and the amplifier will be useless.

On the other hand, if an amplifier should be built with such a value of L_1 that resonance occurred within the range to be amplified, the gain would be found to be a maximum at the frequency of resonance. Logically, then, a coil should be selected which

FIG. 67.5.—Circuit of a two-stage, tuned-circuit, transformer-coupled, r-f amplifier.

would be resonant at the frequency to be amplified. A simpler scheme is to use a somewhat smaller coil together with an external condenser to secure resonance. This condenser may be of the variable type so that resonance may be obtained at will at any frequency within the range of the condenser. This tuning condenser may be placed across either the primary or the secondary, but if placed across the secondary the advantage of the step-up ratio of L_1 to L_2 may be utilized and a greater gain secured.

Figure 67.5 shows the most commonly used r-f amplifier circuit in which a variable condenser is connected across the secondary to give resonance at a selected frequency. Its solution may be simplified by the use of its equivalent circuit (Fig. 68.5), in which R_2 represents the equivalent resistance of the secondary and therefore includes the effect of the input resistance of tube 2 as well as the resistance of coil L_2. If the grid of tube 2 is kept negative, its input resistance will be high and its effect on R_2 low, which is desirable.

Figure 49. Cover and text page from Austin V. Eastman's 1937 *Fundamentals of Vacuum Tubes*. Sometimes described as a classic text in electronics, it is still of interest to today's vacuum tube hobbyists.

The rising importance of electronics was further confirmed by the appearance of the Vacuum Tube course as a required senior course for all electrical engineering students. In addition, Charles M. Wolfe, BSEE 1925 from West Virginia, MS 1929 and Ph.D. 1932 from the California Institute of Technology, was hired as an Instructor. Wolfe was the second Ph.D. hired by the department. His Ph.D. thesis was on an optical oscillograph to investigate lightning. George Smith says that Wolfe was quiet and something of a lone wolf. He started a research project on vacuum tubes.

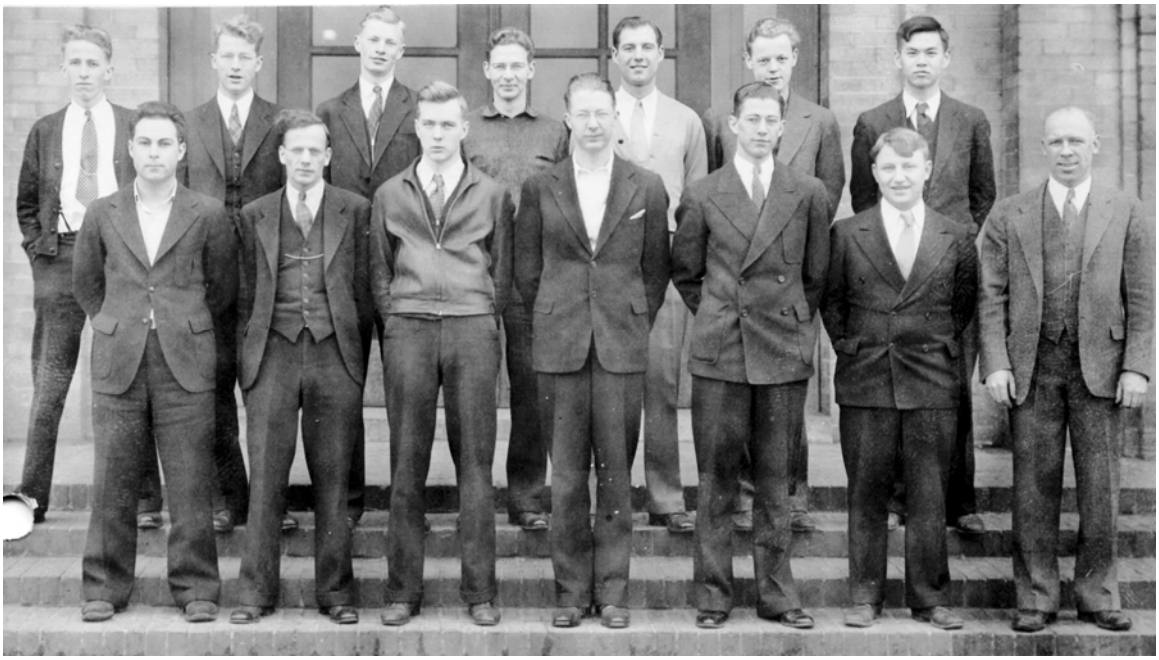


Figure 50. The first in a series of EE class photos running through 1966. 1937 Winter quarter EE 161A class. EE 161 was Alternating Currents, a junior class. Front row from left: S.W. Oliver, C. Burson, C.W. Goodrich, R.W. Griffiths, P.O. Vulliet, E.R. Kennedy, Professor R.E. Lindblom. Top row, from left: B.L. Havens, E.A. Grankull, J.R. Anderson, F.B. Nather, L.D. Bresolin, N.T. Sandstedt, G.K. Nojiri. (EE Department photo)

In 1937 the department, or rather apparently Professor Magnusson, started collecting photographs of specific classes. The habit would continue until 1966. There are far too many to put all of them in this history, but one every five years or so will appear, and others when significant people appear in them.

Despite the depression, or perhaps because of the rise in industry as the war neared, engineering enrollment rose in 1938 and 1939. In February 1938, the *Daily* reported that enrollment in the College of Engineering was 1,277 students; a year later the enrollment rose to 1,328. In November 1939 Dean Loew said "You cannot find a man without a job six months after commencement. We have been looking for men to fill the request by industry and cannot find them."

In 1940 Professor George S. Smith published the Bulletin *Bismuth Bridge Magnetic Flux Meter*. In the early 1930s Smith had wanted to record magnetic transients with a high speed oscillograph, but found there was no well known way of measuring the magnetic field strength with the sensitivity he wanted. Smith recalled from physics laboratory work that the resistance of bismuth changed in a magnetic field, and decided to use coils of bismuth wire in a Wheatstone bridge. The work eventually resulted in a satisfactory meter, publications and a patent. There was some interest in production, but the meter never reached market.

In 1940 Professor Carl Magnusson became seriously ill. Dean Loew assumed the duties of Acting Chair as well as Dean. Magnusson worsened and was confined to his bed. The collapse of the new Tacoma Narrows Bridge, "Gallopin' Gertie," in the same year must have seemed prophetic.

In July Professor Magnusson died. As Department Chair since 1905, he had seen the department grow under his guidance from one faculty member and a handful of students to eight faculty and over one hundred students. His career is an exemplar of educational, scholarly and administrative achievement. His encouragement motivated his students to success. His example created a positive environment for research in the electrical engineering department and inspired his faculty and students to research achievement. He had published papers, reports and textbooks. His research dealt with serious subjects like electric power transmission, in which he proved a visionary, hydroelectric power, electric rates and usage, and the beautiful but not especially useful Lichtenberg figures. His administration had resulted in two new departments in the College. Although he was a power engineer himself, his vision for Electrical Engineering was broader. The growing fields of radio and electronics received an adequate share of departmental resources. His curricular revisions would considerably outlast his career. The Pacific Northwest still benefits every day from the results of his consulting work on hydroelectric development.

Magnusson's loyalty to his students appears in his tendency to hire the graduates of the Washington program as faculty. As George Smith, who was one of these hires, points out, many of these faculty had successful industry experience before returning to the UW. He adds that as faculty from other schools began to be hired, the records of Washington graduates compared favorably with those of faculty with degrees from other schools. If Magnusson's hiring decisions were motivated by loyalty, the cost in quality was minimal.

The accomplishments of the Magnusson era were shared by a core of seven or eight faculty members who worked within the unfunded research paradigm of the times. There were no federal research grants, nor were industrial funds available. Equipment for research came from industrial castoffs, very limited state appropriations or scrounging. Research time was uncompensated. Operating in this environment, the faculty published both peer reviewed technical papers and Engineering Experiment Station Bulletins. The latter have received most of the attention in this history because of their relative accessibility. Four of seven faculty in 1941 were members of the University Research Society. Most of the faculty were or would become Fellows of either the American Institute of Electrical Engineers (AIEE) or the Institute of Radio Engineers (IRE). One was a Fellow of both. This level of professional achievement is not less that that of the current faculty.

Staff also contributed to the success of the department, although not so much is known about them as about faculty. Miss Anderson was the Department Head's Secretary for most of Magnusson's tenure. She carried the administrative load single-handed. She added most of the administration of the pre-engineers when they started to appear in 1925. Miss Northern assumed the task after Miss Anderson left, and continued through the transition to the new Head.

Even during Magnusson's illness, speculation about who would become the new Head of Electrical Engineering was rife, if decently concealed. The recommendation lay with Dean Edgar A. Loew, with the final approval of President Sieg. On Magnusson's death the problem had to be addressed. The first issue was whether an outside candidate should be sought. In 1941 demand for electrical engineers from industry was high, and other universities were offering significantly higher salaries for faculty than the University of Washington could afford. It was therefore clear that an internal candidate would have to be chosen. The viable candidates were Associate Professors Lisle Hoard and George Smith, of roughly the same seniority, and then Associate Professors Roy Lindblom and Austin Eastman, both slightly junior. Magnusson's preference, which may or may not have been communicated to Loew, was for Smith or Hoard. However, George Smith was not especially interested in the job, nor was Roy Lindblom. Lisle Hoard and Austin Eastman, however, were both hopeful of being selected.

Figure 51. Department Executive Officer Austin V. Eastman in 1945. (*Tyee* photo)

Loew's choice fell on Eastman. Both Hoard and Eastman pursued electronics interests, so we cannot credit Loew with a great deal of technical foresight in his selection. Eastman was not heavily involved with research, but had published a textbook. Hoard had not been among the research leaders in the department either. Eastman thus had somewhat better professional credentials, although what bearing these have on the ability to effectively administer a Department of Electrical Engineering remains a debatable point in the present day. Dean Loew must have based his decision on his knowledge of the personalities and abilities of the two candidates, whom he had known for many years. In what was the normal time frame, Lisle Hoard and George Smith were both promoted to full Professor in 1941. It must have been some compensation for Hoard. Dean Loew became the next Director of the Engineering Experiment Station.

The faculty had been debating the issue of hiring from University of Washington graduates since Charles Wolfe had been hired in 1937. A healthy concern about becoming too ingrown was at the root of the discussion. The next hire split the difference.

William Ryland Hill, B.S.E.E. University of Washington, 1934, E.E. Berkeley, 1940, was hired as Assistant Professor. The hire would prove a success.

For some time the engineering faculty had been dissatisfied with the English courses in the curriculum, including Technical Composition in their junior year. Reading between the lines, one gets the impression that the engineering faculty expected the courses to provide students with a certain skill set relevant to the practice of engineering, such as the ability to write coherent reports, while the English department preferred to teach, for example, character development. In 1941 the English Department decided that there were enough engineering students to justify a class of their own, English for Engineers, and appointed Professor Amy Violet Hall to tailor the class to their needs.

In 1941 Professor Lyall Cochran attended a three-week conference on Ultra High Frequency (UHF) radar technology and teaching methods at Massachusetts Institute of Technology sponsored by the armed forces. After a further two-week course in 1942, he implemented two courses on UHF Techniques at Washington starting in 1943. The courses covered various aspects of radar electronics including cathode ray tubes, sweep and trigger circuits, receivers, transmitters, velocity modulated tubes and magnetrons.

The United States had steadily grown more involved in the Second World War, selling, and then Lend-Leasing war materials to the Allies, improving the size, readiness and capabilities of the armed forces, and conducting neutrality patrols in the Atlantic. The Japanese attack on Pearl Harbor still came as a shock to the nation, catapulting it overnight into a global conflict.

The response of the Electrical Engineering Department was similar to its response to the Great War. In 1942 Department Head Austin V. Eastman announced a speed-up program for junior and senior students stressing technical courses. The department established special accelerated courses for training radio and electronics technicians, which were in much higher demand than during the Great War. Many were set up as evening courses, with the faculty teaching up to three evenings a week and on weekends, as well as their regular work. In summer 1943 the College of Engineering shifted to a semester schedule, running from the beginning of November to the end of February, and from the beginning of March to late June. The shift accommodated the Navy's V-12 officer training program. By 1945 almost the entire University was operating on the semester schedule.

Electronics had been slowly gaining credits in the EE elective course list. In 1943, in addition to Professor Cochran's radar electronics courses discussed above, the electronics electives were reorganized and significantly expanded. The old four credit Radio course and two credit laboratory was split into two courses, a four credit course in Vacuum Tube Circuits, dealing mainly with oscillators, and an accompanying two credit laboratory, and also a four credit course in Wave Propagation and Antennas, and accompanying two credit laboratory. The old Telephone Transmission course and laboratory was renamed Communication Networks, to reflect the general nature of the transmission line theory covered in the course. Filters and equalizers now appear in the course description. A two credit course on Radio-Telephone Transmitter Practice that had first appeared in 1939

remained in the curriculum. With the existing required Vacuum Tubes course and laboratory, a thorough education in electronics was now available.

Electrical Engineering faculty also served the country in other ways. Dean Edgar A. Loew served as a consultant field advisor (a “dollar-a-year” man) to the Division of Priorities of the Office of Production Management (OPM), as a regional advisor to the Federal Security program, and a consultant to the Grand Coulee and Bonneville dams. Department Executive Officer Austin V. Eastman, promoted to full Professor in 1942, served on the Seattle Transit Commission. With gasoline and rubber rationing, and a 35 mph speed limit, demand for transit in the Puget Sound region had skyrocketed.

The student body went to war. Barracks again appeared on campus, again across the way from Engineering Hall, and were now complete with Marine drill sergeants. Although enrollment in the special courses and the consequent teaching load was high, enrollment in the degree program dropped precipitously in 1943 and 1944. Most students not close to finishing left for the armed forces or were drafted. Students graduating high school enlisted or were drafted rather than attending college. Japanese-American students disappeared from electrical engineering as they and their families were interned away from the coast in the immediate post-Pearl Harbor West Coast invasion scare.

The increased teaching demands on the department were met in the by now customary way by hiring Washington graduates. Dale G. Sheckels, B.S.E.E. 1938 University of Washington, M.S.E.E. 1940 Massachusetts Institute of Technology, was hired as an instructor in 1942, and served for a year. Vinson Leroy Palmer, B.S.E.E. 1940 University of Washington, was hired as an Instructor in 1943.

Women responded to the war effort by taking factory jobs in large numbers as the men joined the armed forces. The same effect brought women into the Electrical Engineering Department, so far as is known for the first time, although not in such large numbers. Enrollment included two women from 1941 to 1944. One, Alice Johnson, appears in a photograph of a junior class in electrical engineering in 1943. C. Alice Gordon, nee Johnson, graduated with a B.S.E.E. in 1944, becoming (so far as is known) the first female graduate of the Electrical Engineering Department.

John McIntyre, B.S.E.E. 1944, was co-winner of the President’s Medal, given to the top student in the senior class, with a 3.97 GPA. He also played varsity basketball.

Engineering enrollment slowly increased during the second half of the Depression, followed by a radical drop a year after the start of World War II. The students who could not finish quickly left to fight in the war. Despite the drop in enrollment in 1943-44, degree production remained roughly constant. Notably, no graduate degrees were granted during the war.

Figure 52. The EE 161 junior class in Electrical Engineering, in the wartime summer of 1943. Back row, left to right: T.J. Cross, F.C. Bruya, G.R. Rehkopf, M.W. Rosen, I.J. Stampalia, E.F. Magnusson, R.E. Hull, and K.C. Anderson. Front row, Alice Johnson, R. Bacchi, W.J. Smith, D.E. Fisher, M.L. Gibbs, E. Peck, D.C. Rogers, and Professor Gordon R. Shuck. C. Alice Gordon, nee Johnson, was the first female EE graduate in 1944. (EE Department photo)

The decade from 1935-1945 had opened with an electrical engineering department that had achieved intellectual maturity under the long-term guidance of Carl Magnusson. His death was almost coincident with the onset of the major sustained effort required by the war. Any peace time plans had to be put on hold for the duration. Now the war was over, ended with dramatic suddenness by the titanic and horrifying application of the secret technology of the atomic bomb. The advances in technology created by the war, and the war's effect on the student body, would now combine to bring new challenges and opportunities to the Electrical Engineering Department.

1945-1955 The G.I. Bill

Figure 53. Illustration from the cover of the 1953 University of Washington *Catalog*.

World War II ended at the end of the summer of 1945. America promptly turned its energies to bringing the boys (and some women) home. Demobilization was rapid and efficient. Millions of young men and young women who had put career and family plans on hold for the duration were eager to make up for lost time. The baby boom and the Cold War started at about the same time.

The Second World War had created a tremendous incentive to develop and apply technology. Radar, the atomic bomb, cryptography, jet engines, rocketry, guided missiles and the widespread use of penicillin were all consequences of the war. Hints of future technologies also appeared. In 1936 Alan Turing proposed the Turing machine, a stored program computer. In 1937 the photocopier was invented. In 1939 Schottky developed his solid state diode, and in 1940 Russell Ohl discovered the junction diode at Bell Laboratories. 1940 also saw the first color television broadcast. From 1937 to 1942 John Atanasoff labored to build an electronic computer at Iowa State. He was drafted before he got it working. 1943 saw the invention of the slinky and silly putty, and the discovery of the hallucinogenic effects of LSD. In 1945 Grace Murray Hopper coined the term “bug” for a computer programming error – before the first electronic computer was operational – and Vannevar Bush proposed the concept of hypertext.

In the Electrical Engineering Department, the end of the war and the G.I. Bill brought a flood of students through the door. In 1945 student enrollment in EE increased by a factor of eight (!) over 1944. This was more than twice the maximum pre-war enrollment. In 1946 enrollment increased another 50%! Sitting in the aisles of overcrowded classrooms, many living in overcrowded temporary married housing, these students were serious about their studies. They brought a mature approach to college into the classroom. They evidenced a high tolerance for homework and low level of complaint. While faculty always tend to take the view that today’s students are not quite as good as yesterday’s, the virtues of the post-war generation of students were exceptional. Surviving being shot at, or the imminent prospect of same, causes one to grow up quickly.

The burden of meeting the challenge of this abundance of students fell on Dean Edgar A. Loew and Department Executive Officer Austin V. Eastman. The *Tyee* yearbooks from this time contain short self-descriptive comments about each of them. In 1946 Dean Loew is described as “tall and gaunt.” Flowers, “especially those with lots of red” were his hobby. Part of his strategy for coping with the flood of students is found in his description as a believer in all-day and early evening utilization of classrooms, Saturdays included. In contrast, the 1945 *Tyee* describes Austin Eastman as “one professor not interested in gardening. He’d rather take pictures or go hiking.” Eastman’s plans to deal with more students included more faculty, a new building and curricular changes.

The major academic change in 1945 was the immediate discarding of the semester system, which had been put in place to accommodate the Navy V-12 officer training program. The *Catalogue* almost plaintively declared that the University would return to the quarter system as rapidly as possible, and has prevailed ever since.

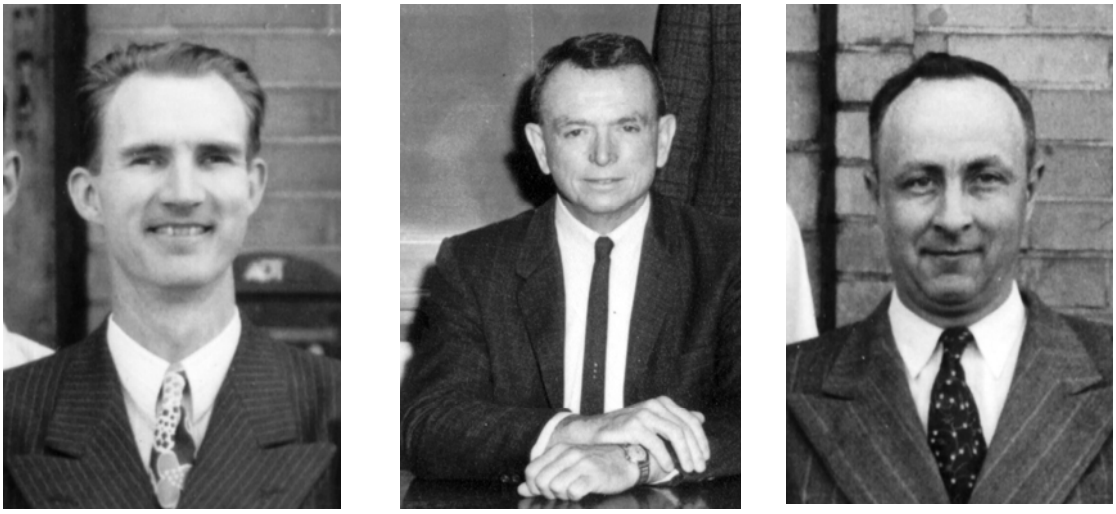


Figure 54. Top Left: Assistant Professor Laurel J. Lewis in Winter 1947. Top Right: Professor Walter E. Rogers in 1965. Bottom: Instructor Floyd D. Robbins in Spring, 1947. (EE Department photos)

While the G.I. Bill students did their learning day and night and Saturdays without complaint, it was obvious that the faculty size would have to be increased to match demand. In 1946 three new faculty were hired. The concerns about having too many of the faculty educated at Washington were resolved by aggressively seeking faculty from elsewhere. Laurel J. Lewis, A.B., 1933, E.E., 1934, and Ph.D., 1937, Stanford University was appointed Assistant Professor. He was the third Ph.D. hired in Electrical Engineering, and the first Ph.D. on the faculty since 1941. His thesis was on high-voltage circuit breakers. Walter E. Rogers, B.S.E.E. 1934 University of California, was hired as an Instructor. He specialized in electric fields. Floyd D. Robbins, UW B.S.E.E. 1925, was appointed Acting Instructor. Robbins had just retired as a staff officer in the U.S. Army. His interest was electric power generation and distribution. Robbins had good rapport with students. He would be advisor to the student branches of the AIEE and IRE for more than 15 years, and an indefatigable leader of field trips to local projects.

English for Engineers, the course started by Professor of English Amy Violet Hall in 1941, was so satisfactory to the College that it she started teaching additional courses to address cultural knowledge relevant to engineering. These in turn were so successful that the College decided to bring them under its administrative control. With Professor Stewart Chapman as chair, Professor Hall formed the Department of Humanistic-Social Studies in the College of Engineering in 1946. The department taught a general non-technical component of the engineering curriculum, covering writing, history and literature as an integral part of the engineering student's professional training. The writing component in the freshman and sophomore year had four one-credit writing

courses, focused on report writing and basic grammatical skills. These can be viewed as the forerunners of technical writing. The history component in the junior year had three courses totaling nine credits that covered the development of Western civilization and society. The literature component, called "Reading," had three one-credit courses in the senior year. A two-credit Hygiene course appeared in the freshman year.

Also in 1946 the electrical engineering curriculum was revised. For the first time circuits were separated from machinery, and the term "circuits" appears in course titles. Electromagnetics also appears as its own topic in the Field Theory course. Electrical engineering started in the first quarter of the sophomore year with DC Circuits, and proceeded through Field Theory, DC machines, AC circuits and machines, vacuum tubes and electronics, and electrical transients. A course in atomic physics appears in the senior year, and in the sophomore year a differential equations course appears for the first time, optional unless the student planned to pursue a master's degree. In 1950 differential equations were encouraged, rather than required, for students pursuing a master's degree.

The new requirements added to the curriculum came at the cost of flexibility. Electives went from 20 EE and 16 free credits to 9 EE and 3 free credits. In the EE elective list, Professor Lisle Hoard offered a new course in Industrial Control, the first time the term "Control" appears in the curriculum. Professor Shuck offered a new course on Symmetrical Components. Associate Professor Hill offered a course on Electro-acoustics, dealing with the electrical capture, storage and creation of sound. Professor Eastman demonstrated his intellectual range by teaching the course on Wave Propagation. Although his specialization was in electronics, he had started teaching in the area when the radio course covered everything from the microphone to the antenna, through the air to the receiver and out the speaker. The Ultra-High-Frequency Techniques courses Professor Cochran had developed during the war now became one graduate course in High Frequency Techniques, still covering radar electronics circuits.

Figure 55. EE 161A from Spring quarter 1947. Front row from left: D.H. Holmes, C.K. Fulton, C.S. Lawrence, R.B. Robinson, M.W. Dickinson, K.G. Eng, H.Y. Wong, D.V. Noren, J.F. Kane, Instructor Floyd Robbins. Back row from left: G.R. Eifrig, L.M. Keene, R.E. Wicks, J.H. Wakefield, H.J. Eck, E.W. Anderson, E.H. Davis, R.M. Lee. (EE Department photo)

Some time soon after the war, the first funded research projects appeared in the Department of Electrical Engineering. During the war, the Bonneville Power Authority, which marketed power produced by dams on the Columbia and built, owned and operated extensive power transmission lines in the Pacific Northwest, had been allocated liberal federal funding to ensure they produced sufficient power for the war effort. Some of the funding had been allocated for research. Bonneville had been too busy during the war to spend most of the research money, and now found itself in the familiar end-of-budget-cycle position of "use it or lose it." Bonneville obtained permission to solicit research proposals from universities.

The University of Washington proposed three projects: 1) a study of electric heat for residential space heating; 2) the effect of conversion of various percentages of houses to electric space heating on the present and future distribution system; and 3) the economic feasibility of using reverse refrigeration, that is, a heat pump, to heat houses. Bonneville agreed to fund the second and third topics. Professor Gordon Shuck worked on the distribution system problem while Professor George Smith worked on heat pumps. The faculty were to plan the research and supervise its conduct by Master's students. Project reports, which could also be M.S. theses, were to be submitted to Bonneville. The heat pump topic proved fruitful for Professor Smith, who obtained additional grants to study ground grids for heat pumps and continued work on the electric heating topic until his retirement in 1960.

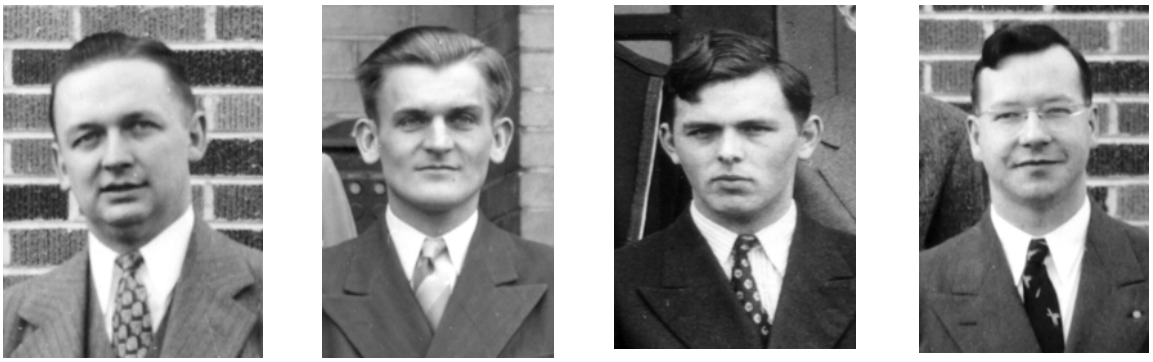


Figure 56. From left: Instructor F. Robert Bergseth, Winter 1949; Instructor Homer G. Rustebakke, Fall 1947; Instructor Andrew B. Jacobsen as a student in 1938; Instructor H. Myron Swarm, Winter 1949. (EE Department photos)

In a room in Philadelphia an electrician's nightmare of vacuum tubes and wires known as ENIAC became the world's first functioning electronic computer. Faculty hiring continued at a comparatively frantic pace. F. Robert Bergseth, B.S.E.E. 1937, University of Washington, S.M. in E.E., 1938 Massachusetts Institute of Technology, was hired as an Instructor. His interests were in electrical machinery. Homer M. Rustebakke, B.S.E.E. 1941, Polytechnic College of England, M.S. 1941, Pittsburgh, was hired as an Instructor. He taught in the power area. Andrew B. Jacobsen, B.S.E.E. 1941, University of Washington, was hired as an Instructor. His talents were in radio, although primarily as a laboratory technician. H. Myron Swarm, B.S.E.E. 1940, University of Washington, was hired as an Instructor. His interests were in microwave electronics. Only one of the four

was not from Washington, but Bergseth had since obtained his graduate degree elsewhere. Their arrival, like that of the new faculty the year before, must have been very welcome to the existing faculty.

Figure 57. 1948 Electrical Engineering Building.

More hopeful signs were present in the construction of a new Electrical Engineering building, which commenced about 1947 diagonally across from overcrowded Old Engineering Hall. Construction was complete in early 1948 at a cost of $953,464. Although habitable, the laboratories were not yet wired. Faculty and students worked happily to set up the laboratories during the summer of 1948. Professor Roy Lindblom designed equipment and controls and led the wiring effort for the power laboratory located in the basement, with its rotating machinery, and for various shops. Professor Lyall Cochran planned and designed equipment for the new electronics laboratory on the first floor, as well as moving equipment across the street. Professor George Smith supervised the installation of his impulse or lightning generator in the new two-floor high voltage laboratory. High voltage power supplies for X-ray equipment discarded by Swedish Hospital were donated to the University and found their way into the lab.

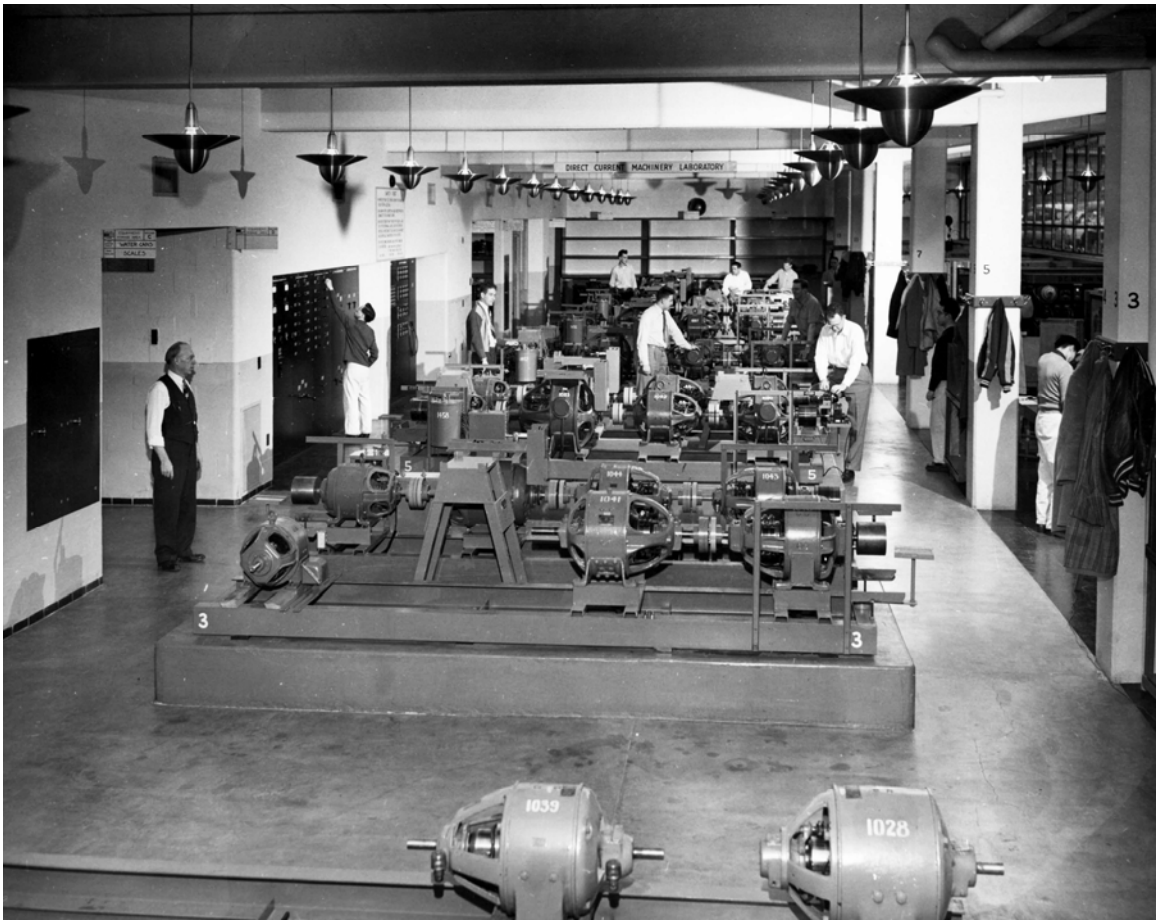


Figure 58. The Electrical Laboratory in the new Electrical Engineering Building, 1948. Professor Roy Lindblom stands on the right. The lab is not yet completed, judging from the machinery in the foreground. (EE Department photo)

Professor Lindblom ran afoul of the electrician's union when the union discovered that faculty and students had been wiring the power laboratory, which the union considered its prerogative. (The union had wired the "house wiring" in the new building.) That the department did not have the budget to hire union labor, or much of any labor, to wire the laboratory was not considered a mitigating circumstance. Fortunately (from the departmental point of view) the laboratory wiring was not far from completion, and the discovery had been made late in the week. Lindblom recruited most of the faculty and as many students as he could find. Working Saturday and Sunday and some evenings, they completed the wiring before the union arrived the next week.

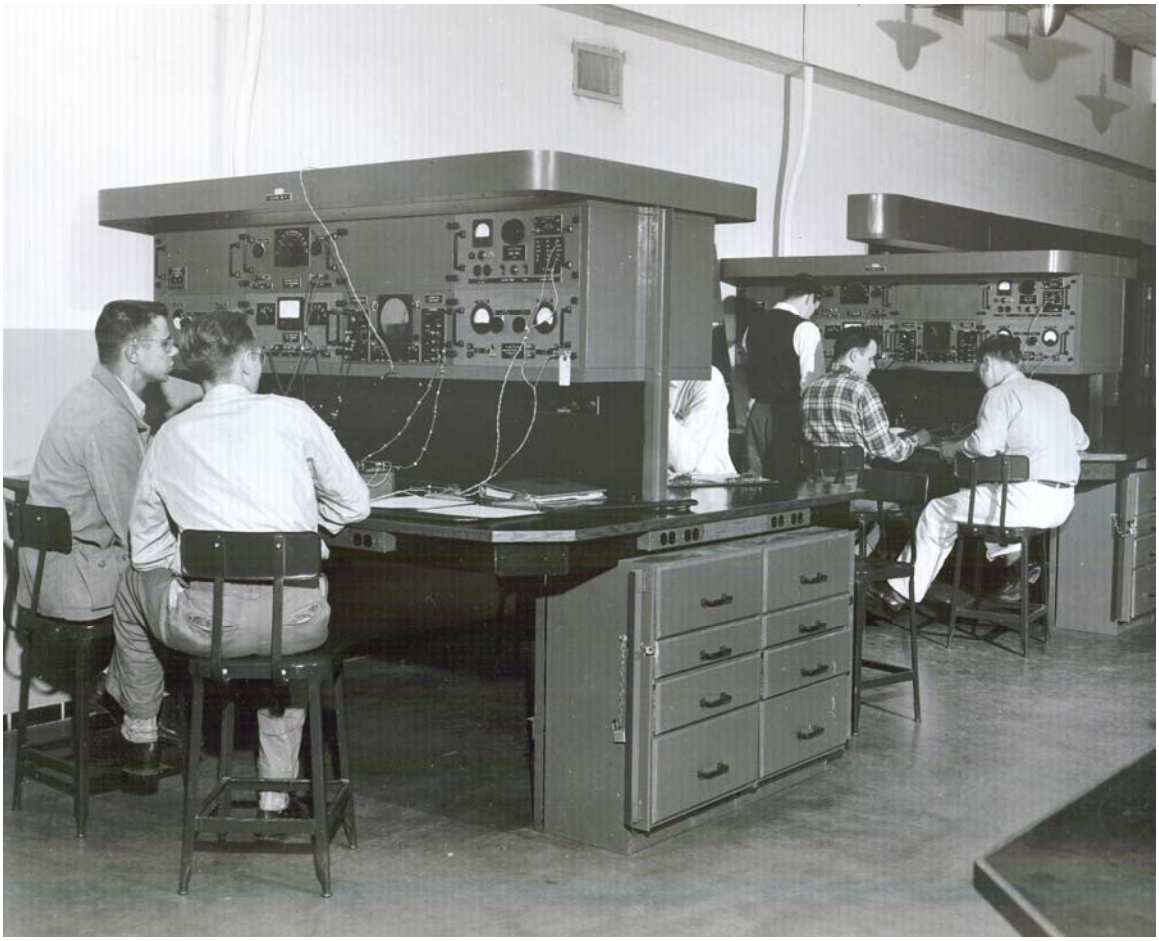


Figure 59. The electronics laboratory in the new Electrical Engineering Building, ca. 1948. (EE Dept. photo)

A unique feature of the new building was the brainchild of Department Chair Austin Eastman. An intercom system was provided with a telegraph key on top of each wall-mounted intercom. Tapping the key produced a Morse Code signal that was broadcast throughout the building. Each professor and staff member was assigned a Morse Code letter. When one heard one's letter, one picked up the phone. The system, of which Professor Eastman was inordinately proud, expressed both the self-sufficiency of the department and, to modern eyes, a certain provincial awkwardness. Users at the time saw (or heard) it differently.

Pete Lauritzen reports "the Morse Code signaling system installed in the EE Building by Austin Eastman worked very well. I was there when it went through an upgrade when Don Reynolds replaced Austin Eastman's vacuum tube audio oscillator with a solid-state one. The system was installed in all corridors, offices and labs, but not in classrooms where it would be disturbing. It was used regularly by those faculty and technicians who were frequently in labs. My personal Morse Code quickly became imbedded in some unconscious layer of my brain so that only I would hear my code and I would never be aware of another person's code. The different codes chirping in the background became part of the general ambience of the EE Building. Use of the

system faded away when the fourth floor of the building was built as the signaling system was omitted in the new floors. With the labs and offices in these new floors inaccessible, the system could not reliably reach people and it faded from use. I used the system regularly to contact technicians and other faculty and I was sorry when it shut down." To the bemusement of newer faculty, pieces of the system remained in place until the building was razed in 2002.

Classes started in the new building in the fall of 1948, migrating gradually from Old Engineering Hall through the academic year. Some classes held their first meeting in Old Engineering Hall, and then ceremoniously carried their chairs across to the new building. The Mechanical Engineering Department expanded into the vacated space and the Department of Humanistic-Social Studies moved in to the top floor.

Figure 60. 1948 Electrical Engineering DuPen bas-reliefs on the Paul Allen Center, 2005 (Rich Christie photo)

The students carrying their chairs into the new building were among the first of many generations of electrical engineering students and faculty to puzzle over the meaning of the artwork on the exterior of the 1948 Electrical Engineering building. Two of the three Indiana limestone bas-reliefs can be seen in the building photograph on the column outside the main doors and on the stairwell wall. They were carved on site in 1947 by University of Washington Assistant Professor of Sculpture Everett DuPen (1912-2005). Dupen came to the University in 1945 after teaching at Washington University of St. Louis. He was apparently not given much direction as to subject matter. The allegorical carvings, while consistent with the overall theme of the strengths of the human race found in DuPen's oeuvre, are not especially relevant to the field of Electrical Engineering. Over the years this has given rise to false rumors of a mix-up with artwork intended for some medical building. Austin Eastman himself is said to have attributed the reliefs to a mix-up with the Medical School. The bas-reliefs are now mounted on the west wall of the Paul Allen Center outside the Electrical Engineering offices.

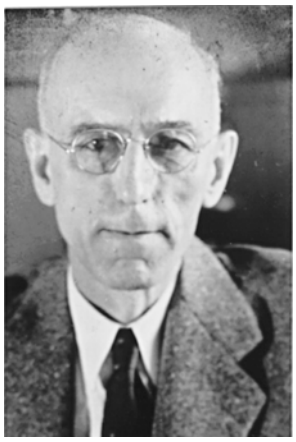


Figure 61. Edgar A. Loew, Professor of Electrical Engineering and Dean of the College of Engineering. (Sigelmann history)

Edgar Allen Loew reached the mandatory retirement age for Dean in 1948. Dean since 1935, he had presided over the College during the last half of the Great Depression and the run up to war, through the dislocations of wartime instruction, and then coped with the vast expansion of the G.I. Bill. Named Dean Emeritus, he returned to the Electrical Engineering department (and a brand new office) to teach.

In the summer of 1948 Bell Laboratories announced the invention of the point contact transistor, developed in late 1947 by John Bardeen and Walter Brattain. It would have far-reaching effects on the field of electrical engineering. Its most immediate effect was to drive Shockley to invent the bipolar junction transistor.

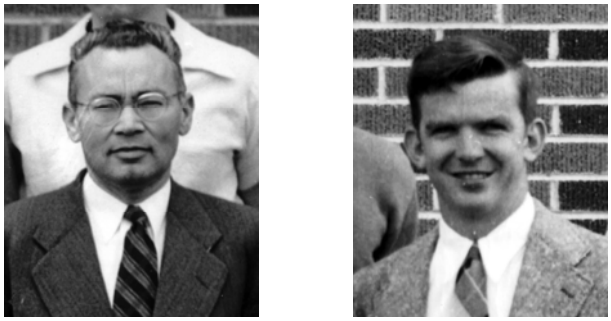
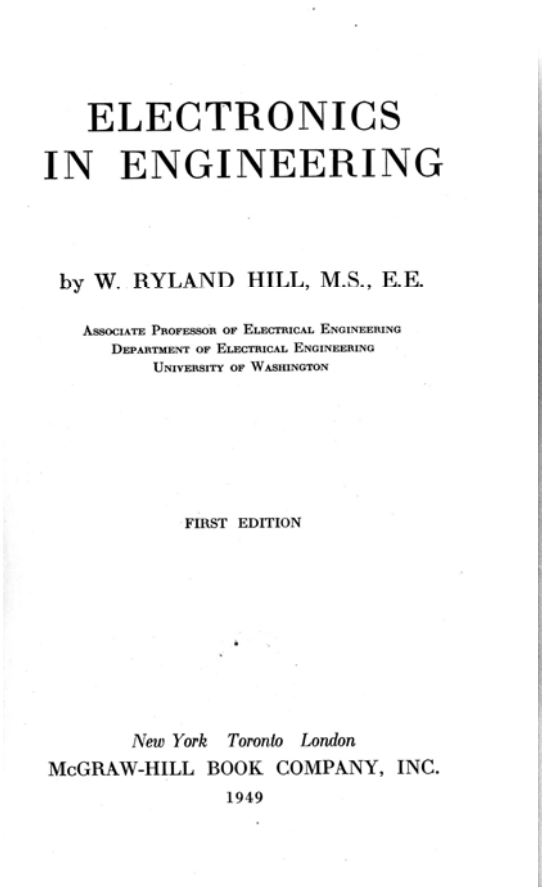


Figure 62. Left: Professor Arthur E. Harrison, Spring1954. Right: Instructor Thomas M. Stout, Spring 1949 (EE Department photos)

The immediate problems of the Electrical Engineering Department continued to revolve around an excess of students and shortage of faculty. In 1948 Arthur E. Harrison, B.S.E.E. 1936, California, M.S. 1937, Ph.D. 1940, California Institute of Technology, was hired as an Associate Professor of Electrical Engineering. Harrison had worked with Sperry on the klystron project and published a textbook, *Klystron Tubes*, in 1947. Harrison would develop a research sideline studying the movement of glaciers on mountains in Western Washington. Thomas M. Stout, B.S.E.E. 1946 Iowa State, M.S.E. 1947 Michigan, was hired as an Instructor. Elder Haldon Smith E.E. 1942 University of

Cincinnati and Robert Leigh Tanner A.B. 1944, M.A. 1947 Stanford, were hired as instructors, but left in 1949.



ELECTRONICS
IN ENGINEERING

by W. RYLAND HILL, M.S., E.E.

Associate Professor of Electrical Engineering
Department of Electrical Engineering
University of Washington

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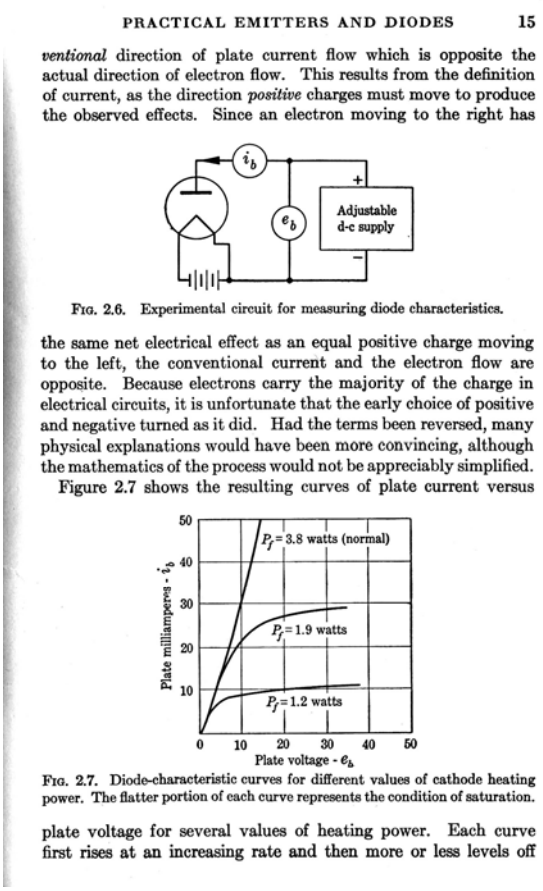


ventional direction of plate current flow which is opposite the actual direction of electron flow. This results from the definition of current, as the direction *positive* charges must move to produce the observed effects. Since an electron moving to the right has

Fig. 2.6. Experimental circuit for measuring diode characteristics.

the same net electrical effect as an equal positive charge moving to the left, the conventional current and the electron flow are opposite. Because electrons carry the majority of the charge in electrical circuits, it is unfortunate that the early choice of positive and negative turned as it did. Had the terms been reversed, many physical explanations would have been more convincing, although the mathematics of the process would not be appreciably simplified.

Figure 2.7 shows the resulting curves of plate current versus

Fig. 2.7. Diode-characteristic curves for different values of cathode heating power. The flatter portion of each curve represents the condition of saturation.

plate voltage for several values of heating power. Each curve first rises at an increasing rate and then more or less levels off

Figure 63. Title page and a page of text from Associate Professor Ryland Hill's 1949 textbook *Electronics in Engineering,* McGraw-Hill.

In 1949 Associate Professor Ryland Hill, already well liked by both faculty and students, and an excellent teacher, published his textbook *Electronics in Engineering* with McGraw-Hill. Intended to teach electronics to non-Electrical Engineers, it was a reassuringly slim volume, about half the size of Austin Eastman's electronics text. Hill's book would enjoy a few years of popularity before the transistor revolutionized electronics. Assistant Professor Laurel Lewis was promoted to Associate Professor. Instructor Floyd Robbins obtained his E.E. degree, and presumably a promotion from Instructor to Assistant Professor.

The Engineering Experiment Station had published its last Bulletin in 1945. Now the Station started publication of *The Trend in Engineering* magazine to provide short summaries of research more extensively reported in peer-reviewed journals. This event also marks the point at which this history leaves off discussion of specific faculty publications, other than textbooks. The number of research papers in the next 55 years is far too large to discuss or even list each one, and no convenient summary of research work such as the Engineering Experiment Station bulletins is available.

The spring of 1949 brought a peak in B.S.E.E. degrees awarded, three years after the enrollment peak of 1946. With the sudden release of many newly graduated engineers from many engineering programs onto the national job market, dire predictions appeared in the press claiming that there were too many engineers for the job market and all the new graduates would be out on the street. Pre-engineers deserted the College in droves, and enrollment in electrical engineering nosedived from 390 to 213. Enrollment would stay at about this level for four years. The predictions of doom for new graduates proved incorrect. Demand for engineers remained strong, especially for advanced degrees. In the Puget Sound region, Boeing and its suppliers were the main source of engineering hiring. However, the need for new faculty was eased by the drop in enrollment.

Curricular change in 1949 saw a Field Theory course added to the senior year, at the further expense of elective credits, which became three EE and five free. The faculty added graduate courses. Associate Professor Laurel Lewis added a three course sequence on circuit theory and networks. Professor Loew, returned from the Dean's office, offered and Advanced Power Systems course that covered transient stability. Professor Harrison installed a course in his specialty, Microwave Vacuum Tubes.

Figure 64. EE 161 class from the Spring of 1950. Front row from left: L.E. Sofie, Siro Cugini, K.E. Russell, F. Bjornstrom, Paul Jacobson, M.R. Benson, Professor Gordon Shuck. Back row from left: J.D. Knisely, R.R. Olson, J.A. McMillan, Don Stevenson, B.D. McAssey, J.L. Grove, H.A. Moore. (EE Department photo)

The following year saw a major change in numbering. The courses were given three numbers with the first designating the nominal year for the course. The system is still in place, although none of the course numbers from this era have survived unchanged. Two tracks with minor differences were offered. Power majors could take vacuum tube electronics specialized for their interests, such as rectifiers and thyratrons. Communications majors could take Communication Networks instead of Advanced AC machines. The first modern materials science course appears in the EE curriculum. The

faculty continued to add graduate courses. Professor Harrison added Microwave Measurements, and Assistant Professor Palmer added a course on Radiation and Propagation. The graduate curriculum was acquiring a decidedly electromagnetic flavor.

Figure 65. Victor Grgurinovitch in the junior course EE 161 as a naval cadet in 1944. (EE Department photo)

A notable alumnus of 1945 was Victor Grinich. Born in Aberdeen, Washington as Victor Grgurinovich, or Grgurinovitch, son of Croatian immigrants, he simplified his name to aid roll calls while serving in the United States Navy during WWII, before graduating in June 1945 with a B.S.E.E. cum laude. Grinich obtained an M.S.E.E. from Washington in December 1950, with a thesis "Square Law Device Using Non-Linear Feedback." He then obtained his Ph.D. from Stanford in 1953. His thesis there was "On the Approximation of Arbitrary Phase-Frequency Characteristics." Grinich worked for Stanford Research Institute for three years, then in 1956 answered a brain-teaser ad placed by William Shockley. Shockley had quit Bell Labs, moved to Palo Alto, and obtained funding to form the Shockley Semiconductor Laboratory of Beckman Instruments. Grinich found himself working with many superb engineers, including Robert Noyce and Gordon Moore, and one insufferable supervisor, Shockley.

Eight of the engineers working for Shockley appealed to Beckman to replace him, but were turned down. They then linked up with a Stanford MBA named Arthur Rock to find funding to form their own company. Rock made 35 unsuccessful pitches before landing $1.3 million from Fairchild Camera and Instrument. Grinich and the others each invested $500 for a 10% equity in Fairchild Semiconductor, with Rock's investment bank owning the remaining 20%. Fairchild Camera had an option to buy them out in two years. The arrangement set the model for an explosion of venture capital expansion in what had just become Silicon Valley. The Fairchild Eight, or the Traitorous Eight, as Shockley called them, left in 1957, which ruined his company. In 1959 Fairchild Camera exercised its option and each of the eight netted about $250,000 from their $500 investment.

Grinich was the only electronics engineer among the eight, and became head of applications engineering and device evaluation. He designed test instrumentation and test procedures for the transistors Fairchild developed and manufactured. In 1968 Grinich left Fairchild to take some computer science courses at Stanford. It was the same year Gordon Moore and Robert Noyce left to found Intel, but Grinich's interests were

elsewhere. He taught at Berkeley and Stanford, and co-wrote a widely used textbook, *Introduction to Integrated Circuits*, in 1975. In 1978 Grinich became CEO of Identronix, a company spun off from Los Alamos Laboratories in 1977 to commercialize RFID technology. Grinich stayed until Identronix was purchased by Allen Bradley in 1985, when he formed Escort Memory Systems to work on the industrial use of RFID. After bypass surgery in 1989 Grinich sold the company, but stayed on until 1993, when he formed Arkos Design, an emulator manufacturer. He sold Arkos to Synopsys in 1995 and retired in 1997, dieing in 2000, one of the first generation of modern technological entrepreneurs.

Back on campus, in 1950 Instructor H. Myron Swarm acquired his M.S.E.E. from Washington. In 1951 he was promoted to Assistant Professor. In the latter year Assistant Professor Vinson Palmer left for industry. Professor George Smith and Instructor Andrew Jacobsen obtained a grant from the Bonneville Power Authority to study corona formation on high voltage transmission lines in dusty winds in the same wind tunnel used to study the Tacoma Narrows bridge.

In 1952 Lyall Cochran and Arthur Harrison were promoted to full Professor, and F. Robert Bergseth to Associate Professor. Edgar A. Loew and Gordon Shuck retired, becoming the first Emeriti from the department. Loew had served since 1909 and for many years was the second senior professor in the department, before stepping up to the Dean's office. He had published two textbooks. His research in residential electric heating and transmission line design was supplemented by work on electrical production of sodium nitrite. His greatest contribution came through the exercise of his administrative skills as Dean. In 1969 Loew Hall, a classroom building and the site of the Dean's Office in 2005, was named for him.

Gordon Shuck had served quietly, as was his way, since 1918. An excellent teacher, his research contributions had been in symmetrical component computation and metering.

A major step in the intellectual development of the Electrical Engineering department came with permission from the Faculty Senate in 1953 for the department to offer the Ph.D. degree. Previously a few Ph.D. degrees had been earned from the Physics Department by electrical engineering students through an agreement between departments. The Electrical Engineering department granted its last E.E. degree in 1950. Now the top graduate degree would reflect academic research rather than practical experience. The move can be seen as part of the post-war trend in engineering to embrace science in preference to practice, emphasizing basic research more than applications. This trend in turn can be traced to the strong preference for employing physicists to the exclusion of engineers in the central components of the Manhattan project, even the non-nuclear ones, and to the subsequent growth in government funding of science research on university campuses. The trend towards more science and basic research in academic engineering would continue until the mid-1980s and remains a strong influence in 2005.

Figure 66. Electrical Engineering graduate students, 1952-53. From left, Akira Ishimaru, E.W. Early, C.R. Bigbie, R.S. Waggoner, M.G. Arya. (EE Department photo)

A further step was the inclusion of the first course in computers, EE 586, Electrical Computing Methods, in the graduate curriculum. It covered both analog and digital computers. The retirements of Professors Loew and Shuck had also retired their graduate courses in Advanced Power Systems and Symmetrical Components. The contents of these courses would return in different guise.

Figure 67. Assistant Professor James H. Fisher, Fall 1954. (EE Department photo)

By 1953 it was clear that the trough in enrollment had passed, future increases could be expected, and further faculty hiring was warranted. James H. Fisher, UW B.S.E.E. 1947, M.S.M.E. 1950, Ph.D. 1953 Purdue, was hired as an Assistant Professor.

In 1954 Professor Walter E. Rogers published his textbook *Introduction to Electric Fields*. It earned him an invitation to teach at M.I.T. in 1955. Associate Professor Laurel E. Lewis was promoted to full Professor. His research work involved the application of computers to analysis of power systems. Associate Professor Bergseth worked with Edgar A. Loew to publish the fourth edition of Loew's textbook *Direct and Alternating Currents*.

In 1954 University of Washington engineering enrollment was the largest on the west coast. Three more faculty joined the department in 1954: Paul C. Leach, B.S.E.E. 1949, University of Washington, was hired as an Instructor. Robert E. Wall, UW B.S.E.E. 1949, M.S.E.E. 1953, was also hired as an Instructor. Gedaliah Held, M.S. 1950, Hebrew University, Israel, Ph.D. 1953 California, was hired as an Assistant Professor. His particular area was microwave circuits and antennas, and Professor Eastman expected him to play an important role in the graduate program. Professor Homer M. Rustebakke, took a leave of absence at the end of the academic year and did not return.

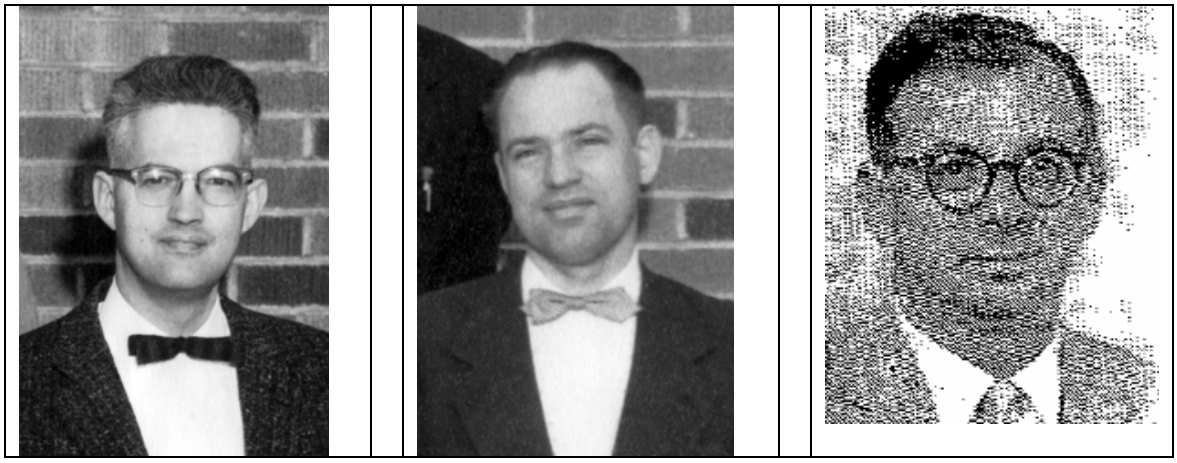


Figure 68. From Left: Instructor Paul C. Leach in 1958, Instructor Robert E. Wall in Spring 1955 (EE Department photos), and Professor Gedaliah Held in 1959. (IEEE)

In 1954 University of Washington engineering enrollment was the largest on the west coast. Three more faculty joined the department in 1954: Paul C. Leach, B.S.E.E. 1949, University of Washington, was hired as an Instructor. Robert E. Wall, B.S.E.E. 1949, M.S.E.E. 1953, University of Washington, was also hired as an Instructor. Gedaliah Held, M.S. 1950, Hebrew University, Israel, Ph.D. 1953 California, was hired as an Assistant Professor. His particular area was microwave circuits and antennas, and Professor Eastman expected him to play an important role in the graduate program. The academic year ended with the departure of Professor Homer M. Rustebakke, although realization of his departure would be delayed. He took a leave of absence and did not return.

By 1945, enrollment in Electrical Engineering doubled the pre-war maximum of 170 in 1940, and was eight times the 1944 enrollment of 46. One EE graduate student enrolled

in 1950. The first four Ph.D. students enrolled in 1954. One female student was enrolled in 1953. A sudden jump in degrees granted in 1947 is due to the G.I. Bill enrollment increase in 1945. The peak in 1949 corresponds to the peak post-war enrollment in 1946.

The Department story in the first post-war decade was one of growth in students, in faculty, in physical infrastructure, in academic achievement and in funded research. As the graphs show, enrollment took a major jump in the first post war year, and was even higher in the second. The enrollment crash in 1950 was followed by a steady recovery. The department would now be twice its pre-war size.

The faculty also doubled in this decade. Seventeen new hires joined nine existing faculty, with two retirements and, perhaps ominously, seven departures. The department ended the decade with 17 faculty members. Four of the 17 hires had doctoral degrees and five had master's degrees. Eight had had no association with Washington prior to being hired. Three had either earned advanced degrees after graduating from Washington, or had extensive experience prior to being hired. Of the six Washington graduates hired directly after graduation, three proved unsuccessful, or had not contemplated a teaching career. One (Swarm) was very successful, and two were still early in their career. Department chair Austin Eastman was successfully diversifying the origins and interests of the faculty, while raising the level of academic accomplishment.

All these students and faculty were happily ensconced in a new building with new laboratory space, albeit equipped with the same equipment and chairs. Construction of a building is a major achievement for any Dean or Chair, although the pressure of enrollment increases made the need obvious and the effort to convince the legislature to fund a building less daunting. The 1948 building, with additions, would serve the needs of the Electrical Engineering department until 1997.

The decade abounded with curricular growth. The advent of the Humanistic-Social Studies courses installed a definite humanities component in the engineering curriculum. Electrical engineering courses differentiated into circuits, machines, electronics (although still vacuum tube) and electromagnetics. The curriculum starts to offer two tracks, a depth of specialization beyond the few available elective credits. In the EE electives can be found the beginnings of controls and signal processing, and the first computer course appears at the end of the decade. Course numbers acquired the year-based encoding familiar in 2005.

Where before the graduate curriculum had involved taking undergraduate elective courses, now a well defined graduate curriculum appears, capped by a Ph.D. program. The move to establish a Ph.D. program placed Washington on an equal level of academic achievement with other electrical engineering programs nationwide. Although electrical engineering Ph.D.'s were offered by other schools as early as 1928, the move towards basic research in engineering did not really get started until the post-war era, and Washington's decision was only somewhat late. The first four Ph.D. students enrolled in 1954.

The final note for the decade belongs to funded research. The first funded research project in the department started some time in the late 1940s. The impression George Smith gives in his discussion of how the first funded research project came about is that the department and the faculty were somewhat reluctant to embrace this new mode of operation. Their caution is commendable or condemnable, depending on the reader's view of the long term effects of funding on academe. The first half century of the department is the story of its foundation by pioneers and devotion to quality in instruction, and to uncompensated research carried out above and beyond teaching responsibilities. In the second half-century, funded research will grow to dominate hiring, promotion, teaching, research and service.

1955-1965 The Technology Boom

Figure 69. Block W University of Washington Logo.

Seattle was living the good life. Technology, and the devastation that World War II had wreaked on the rest of the developed world, fueled a rising tide of prosperity and material well-being across America. You could climb into your new car (with or without tail fins), drive across the Evergreen Point floating bridge to the Northgate Mall, buy dinner with a credit card and then buy a television set to watch videotape on KING, KOMO or KIRO of Tex Johnston barrel rolling a Boeing jet airliner, the Dash-80, at 400 feet over Lake Washington. All this was new. Broadcast TV in Seattle and tail fins on cars started in 1948. Credit cards appeared in 1950, videotape in 1951. The bridge was built in 1953, the same year as the Northgate Mall, which claims to be the first shopping mall in America. The Dash-80 was brand new in 1955, and would become the 707.

Technology poured out of labs and universities. In 1946 at the University of Pennsylvania J. Presper Eckert and John W. Mauchly finally got a room full of vacuum tubes to work long enough to compute ballistic tables for Army artillery pieces. They called this first functional digital computer ENIAC. In 1947 Chuck Yeager broke the sound barrier and the FCC allocated cell phone frequencies, although the first public cell phone call would not be placed until 1973. It's likely that neither of these actions caused the sighting of the first UFO over the Cascades in the same year. In 1948 Claude Shannon took thesis topics away from generations of graduate students by describing communications theory – all of it – in a couple of papers in a Bell Labs journal. At Bell Labs William Shockley invented the bipolar junction transistor (BJT) in January 1948, only a month after he missed the invention of the point contact transistor. It took from 1948 to 1951 to build a bipolar junction transistor (BJT) with a base layer thin enough for high frequency amplification. Its announcement marked the true start of the transistor era. The BJT's consistency, reliability and manufacturability were far superior to the point contact transistor. The first commercial transistor product, a hearing aid, appeared in 1952, the same year as the first hydrogen bomb test. Technologies with less immediate impact included the first ultrasound imaging and first color TV broadcast in 1953, the solar cell in 1954, and the optical fiber in 1955.

The Electrical Engineering Department was in a period of extended growth. Enrollment had grown steadily since 1951 and was approaching G.I. Bill levels. The graduate program was also growing at both the Master's level and the recently established Ph.D. Department Executive Officer Austin V. Eastman continued the faculty hiring strategy of a mix of local graduates and Ph.D.s from other schools established after the war.

Figure 70. From left to right: Associate Professor David L. Johnson, circa 1960. Instructor David D. McNelis, 1960. John Bjorkstam as a junior, 1949. (EE Department photos)

In 1955 David L. Johnson, B.S.E.E. 1948 Idaho, Ph.D. 1955 Purdue, was hired as an Associate Professor. Professor Johnson worked with digital computers, including computer translation. He took over much of the instruction in computers from Professor Lewis. David D. McNelis, B.S.E.E. 1952, Gonzaga, was appointed Instructor in Electrical Engineering while he worked on his Master's degree. His topic was metering. Two Washington graduates were hired. John L. Bjorkstam, B.S.E.E. 1949, M.S. 1952, University of Washington, was appointed Instructor. He would work on electromagnetic properties of materials, a continuation of the research he was doing for his Physics Ph.D. at Washington. Bjorkstam was the first professor in the department with an interest in solid state physics, although department colloquia were already acquainting faculty and students with transistor theory. Harry Robert Fechter, B.S. 1944, Washington, M.S. 1950, Ph.D. 1954, Stanford, was hired as Assistant Professor. He was Electrical Engineering's contribution to nurturing the nascent Nuclear Engineering program. His Ph.D. was in Physic, and his thesis was "High Energy Electron Scattering From Atomic Nuclei." Although on the Electrical Engineering books, he would work with the Nuclear Engineering group. Jack W. Carlyle, B.A. 1954, University of Washington, was appointed Instructor while working on his M.S. on electrical transients.

In the curriculum, the first service course, a sophomore course for chemistry majors, appeared. The electrical engineering portion of the undergraduate curriculum was reorganized around the relationship between lumped components and electromagnetic fields. Three courses named Circuits and Fields occupied the sophomore year. Electronics courses were taught in the junior year, and both DC and AC machines courses were put off to the senior year. The change represented an innovative approach to teaching electrical engineering, and also reflected the increasing research focus on electromagnetics.

In 1956, in recognition of his textbook and on returning from teaching leave at M.I.T., Walter Rogers was promoted to full Professor. Instructor Thomas Stout left for industry. Stout had been an external hire with an M.S. His loss was unfortunate. At the same time it must have become clear that Homer Rustebakke was not returning from his 1955 leave.

The 1955 hirings were again leaning heavily on Washington graduates or graduate students, and had failed to attract Ph.D.s from more than one superior university. Department Chair Austin Eastman had been working hard since 1941 to gain the respect accorded to universities like Berkeley and CalTech, and the inability to hire as effectively as he wished was an obstacle to be overcome.

Eastman knew where the problem was, but also that he needed more than his own opinion to convince the upper administration he was correct. He embarked on an extensive tour of most of the western universities, inquiring about faculty salaries, support, facilities, and working arrangements. On his return he presented Dean Wessman with an extensive comparison between Washington and its peers, together with a list of departed faculty and faculty likely to leave. Eastman recommended four improvements:

1. Increase faculty salaries.
2. Provide more laboratory technicians and secretarial help for faculty.
3. Permit and encourage consulting.
4. Improve laboratory equipment and facilities.

His recommendations did not have immediate impact, but provided ammunition for seeking more resources from the upper administration. Improvement occurred over the long and is evident in the subsequent recruiting history of the department.

Also in 1956, Assistant Professor Myron Swarm took academic leave to work at the Littlefield Research Institute in Oregon on x-ray and microwave field emission tubes. Old Engineering Hall, home of Electrical Engineering from 1910-1948 and since given over mostly to Mechanical Engineering, was demolished to make way for a new Mechanical Engineering building. The sight was a moving one for the older professors in the department. Lisle Hoard, George Smith, Austin Eastman, Roy Lindblom and Lyall Cochran had spent many years in the old building.

In 1957 Floyd Robbins' yeoman service in teaching introductory courses, arranging field trips, sponsoring the AIEE, and advising students was rewarded with promotion to Associate Professor. Robert Bergseth was promoted to full Professor. Instructors Jack Carlyle and David McNelis completed their M.S.E.E. degrees. Carlyle left, but McNelis stayed on. Also leaving was Instructor Paul C. Leach, hired in 1954 with only a B.S.E.E. and five years' experience. A significant loss was Assistant Professor James H. Fisher, Ph.D., lured away by an outside offer after only four years, despite being a Washington alumnus. His departure served to emphasize Professor Eastman's concerns about faculty working conditions. Professor Ryland Hill went on sabbatical to teach in India.

Robert N. Clark, B.S.E.E. 1950, M.S.E.E. 1951, of Michigan, was hired as Assistant Professor of Electrical Engineering in 1957. Clark was working at Honeywell in Minneapolis when he was visited by a senior Washington professor. He was the first true control systems faculty member. His hiring had an immediate impact on the curriculum, and the first Feedback Controls course appeared the same year.

As to the curriculum itself, undergraduates had proved less able to see the connection between circuits and fields than the faculty who had combined them as the first course in electrical engineering in 1955. The experiment proved essentially a failure, and was replaced with a more differentiated approach. After the common first year, the sophomore year would now have two circuit theory courses, with labs, and a DC machines course. The junior year saw courses in fields, AC machines, transients and vacuum tube electronics. The senior year had 15 credits of EE electives. The humanities and mechanical components of the curriculum were unchanged.

Electrical Engineering played host to the nascent Nuclear Engineering program by listing three courses in reactor theory as electives. The M.S.E.E. program was given more structure, 36 credits, 2:1 electrical engineering, plus a thesis. A Master of Electrical Engineering degree was announced with a 72-credit requirement and a more extensive thesis, but was not a popular program. The Ph.D. program achieved better focus with the requirement that the Ph.D. must make a "definite contribution to knowledge," which still holds true. Evening courses were offered for Boeing employees.

Figure 71. EE 243 section B2, Winter 1958. Front, from left, J.W. Egan, D.P. Canwell, J.Y. Susuki, R.W. Brown, G.E. Reifers, R.N. Guyll, D. Schrader, Instructor. Back, from left: D.W. Baker, T.K. King, A.F. Hixenbaugh, E.R. Gustafson, C.O. Richards. (EE Department photo)

In October 1957, the Union of Soviet Socialist Republics won the first lap of the space race by putting the first artificial satellite into orbit. Sputnik I beeped through the skies, a triumphant contrast to the U.S. space program, which suffered a series of embarrassing launch failures. Sputnik created a perception of Soviet technological superiority that the Soviet propaganda machine trumpeted as evidence of the superiority of the communist ideology. The perception was largely incorrect, but spurred the United States to improve education and achievement in science and technology. Funding for science and technology research grew immensely in every area. It was a good time to start a research career.

Akira Ishimaru took a major step at the start of a long and very distinguished research career by completing the first Ph.D. in the University of Washington Electrical Engineering department in 1958. His thesis was “Radiation Pattern Synthesis With Sources Located On A Conical Surface.” His advisor was Professor Gedaliah Held. Ishimaru was immediately hired as an Instructor by the Electrical Engineering department.

Figure 72. Akira Ishimaru in 1954. In 1958 Ishimaru earned the first Ph.D. degree awarded by the Electrical Engineering Department. By 1954 he already looked like a professor! (EE Department photo)

Figure 73. Right: Professor H. Myron Swarm at the West Seattle Antenna Test Range about 1966. On the left, John Schultz, long-time EE Department technician. (EE Department photo)

Another acquisition by the burgeoning electromagnetics program was the transmitter site of the Alaska Communications System, located in West Seattle. It was donated to the Electrical Engineering department for studying the propagation of radio waves through the troposphere and ionosphere. It was renamed the West Seattle Antenna Test Range.

Assistant Professor Harry Fechter, who worked with the Nuclear Engineering Group, left the University after three years on the faculty.

Assistant Professor John Bjorkstam also completed his Ph.D. in 1958, although it was in the Physics department. His research interests in ferromagnetic materials started with his thesis, “Nuclear Magnetic Resonance in Potassium Dihydrogen Phosphate Type Crystals.” Bjorkstam turned down a higher financial offer from Arizona State University to stay at Washington, in part because he visited ASU in June and discovered that the nighttime temperatures were over 100ºF.

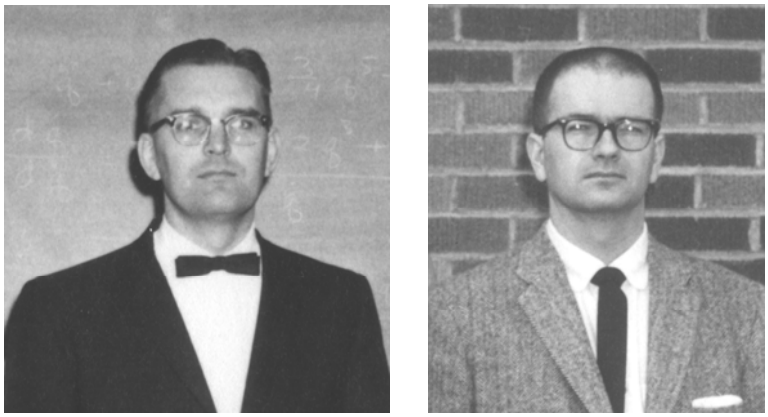


Figure 74. From Left: Endrik Noges as an Associate Professor in 1965, Dean Lytle as an Assistant Professor in 1959. (EE Department photos)

1958 was a red letter year for hiring, with six new faculty coming on board. Endrik Noges, B.S.E.E. 1954, M.S. 1956, Ph.D. 1959, Northwestern, was appointed Assistant Professor of Electrical Engineering. Noges was born in Estonia and as a teenager had been a displaced person at the end of World War II. His research and teaching interests were in control systems. Dean W. Lytle, B.S.E.E. 1950 Berkeley, M.S. 1954 and Ph.D. 1957 Stanford, was hired as Assistant Professor, and did teaching and research in control systems. Together with Bob Clark, these hires provided a critical mass for the control systems area in Electrical Engineering, and a textbook example of conducting a strategic thrust into a new technical area.

Figure 75. From Left: Chih-Chi Hsu in 1961, Katsunori Shimada in 1959, Alistair D. C. Holden in 1959. (EE Department photos)

Chi-Chi Hsu, B.S.E.E. 1945 Chio-Tung University, M.S. 1949 Michigan, Ph.D. 1951 Ohio State, was hired as an Assistant Professor. Hsu worked for Bendix Aviation on electronic circuits before coming to Washington. Katsunori Shimada, B.S. 1945 Tokyo University, M.S. 1959 Brown, was hired as Assistant Professor in 1958. His research area was electrical noise produced by gases. Alistair D. C. Holden, B.S. 1955 Glasgow, M.S. 1958 Yale, was appointed Acting Instructor while working on his Ph.D. on computer learning, an early form of artificial intelligence.

The hiring class represented an improvement in hiring quality. There were four Ph.D.s and two Ph.D. candidates (Shimada would pursue his Ph.D. at Stanford). The international diversity of the hires was also notable. One oddity is the hiring of Shimada as Assistant Professor, when Holden, with the same or slightly superior credentials, was only an Acting Instructor, and Ishimaru, with a Ph.D., an Instructor.

The EE Department was growing in every possible direction. Faculty, undergraduates, the M.S. program, the Ph.D. program, and research funding were all increasing, so much so that the newly completed Mechanical Engineering Building was promptly tapped for some Electrical Engineering office space, classrooms and computing space.

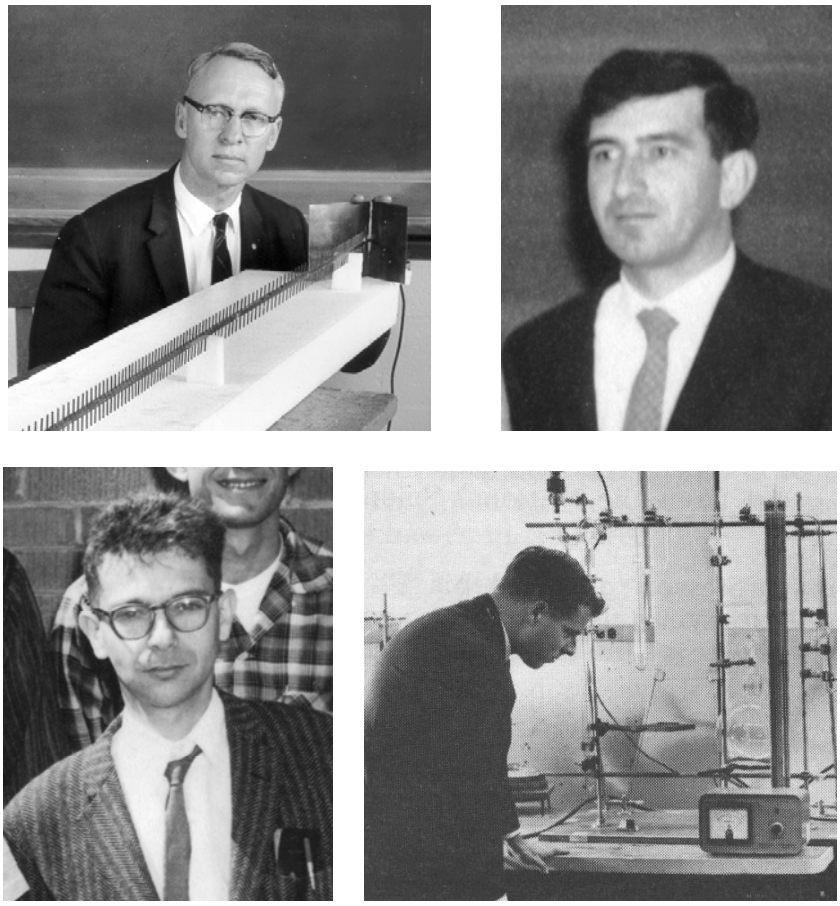


Figure 76. Top Left: Don Reynolds in the 1960s with a scale model of a narrow beam microwave antenna. Top Right: Hellmut Golde in 1964. Bottom Left: Rubens Sigelmann in 1959. Bottom Right: Lynn Watt in the lab, 1961. (EE Department photos)

In 1959 Associate Professor Myron Swarm was promoted to full Professor. Professor Ryland Hill became Associate Dean. Assistant Professor Katsunori Shimada finished up his M.S. from Brown. Assistant Professor Robert Clark was promoted to Associate Professor.

The expansion of the faculty continued apace in 1959 with five more hires. Donald K. Reynolds, B.A. 1941 M.A. 1942 Stanford, Ph.D. 1948 Harvard, was hired away from

Seattle University, where he was Professor and Chair of the Electrical Engineering Department. Reynolds came to Washington as an Associate Professor. His other experience had been at Stanford Research Institute and then from 1953-1956 as Associate Professor at the Institute do Aeronautics in Brazil. This connection brought a number of bright Brazilian graduate students to Washington. Reynolds worked on antenna systems, digital computers and communications. Lynn A.K. Watt, Ph.D. 1959 University of Minnesota, was hired as Assistant Professor. His work in solid state ferroelectric materials complemented Bjorkstam's, although Watt also worked with semiconductors.

Figure 77. Professor Ed Guilford, date unknown. (EE Department photo)

Hellmut Golde, Diplom 1953 Germany, M.S. 1955 Ph.D. 1959 Stanford, was hired as Assistant Professor. His Ph.D. was on microwave tubes (klystrons), but he would rapidly become interested in digital computers. Edward C. Guilford, B.A. 1942 M.S. 1950,Utah, Ph.D. 1959 Berkeley, was hired as Assistant Professor. His area was energy conversion. Rubens A. Sigelmann, M.E. 1952 University do Sao Paulo, was hired as an Acting Instructor while pursuing his Ph.D. in electromagnetics at Washington under the direction of Akira Ishimaru. The problem of where to put all these people started discussions about expanding the Electrical Engineering building that would continue for some time before reaching fruition.

The 1959 hires represented a significant reinforcement of the electromagnetics program at Washington. Three of the five hires, including a dynamic senior professor, were centered in electromagnetics. While the electromagnetics program would flourish as a result, and bringing control systems into the department was a solid step forward, the hiring strategy can be critiqued as essentially missing the boat on solid state electronics. Without slighting Bjorkstam and Watt's work in solid state materials, it is fair to say it was not in the mainstream of the electronics revolution now sweeping through electrical engineering.

The 1959 curriculum had only minor adjustments. The term "vacuum tube" disappeared from course titles. Differential equations, which had been urged on students in general and especially those interested in graduate school, finally became a program requirement. As nature abhors a vacuum so engineering faculty abhor elective credits. Senior elective credits were reduced to five, being replaced with required courses in transmission lines and electronics. Ironically, even as the number of available elective credits was reduced,

the number of elective courses exploded. Notable new electives appeared in controls, solid state and what would now be called computer engineering or digital systems:

- EE 471 Amplifier Theory
- EE 473 Pulse Circuits – Cochran
- EE 475 Digital Circuits – Cochran
- EE 477 Principles of Computer Application – Johnson (digital and analog)
- EE 479 Fundamentals of Automatic Control – Clark, Noges
- EE 483 Introductory Communication Theory – Swarm
- EE 485 Introduction to Solid State Electronics – Bjorkstam

New graduate courses appeared in the solid state, computer and electromagnetics area:

- EE 531, 532 Solid State Electronics – Bjorkstam, Watt
- EE 563, 564 Electrical Noise – Shimada
- EE 571 Radio Propagation – Swarm
- EE 572 Microwave Network Theory – Held
- EE 574 Microwave Antennas – Held
- EE 586 Electrical Computing Methods – Johnson
- EE 587 Application of Digital Computers to Engineering Problems – Johnson
- EE 588 Logical design of Digital Computers – Johnson

The digital computer work, teaching and research, was conducted on computers like the IBM 650 and the faster IBM 709. The latter was a vacuum tube digital computer that occupied most of the Mechanical Engineering basement. Control systems work, however, used analog computers with vacuum tube and later, transistor and operational amplifiers. The digital computers were not yet fast enough for real-time control.

Figure 78. Professor Roy Lindblom in 1958 (EE Department photo)

1960 was a year of departures as well as arrivals. Roy Lindblom died. Since coming to the department in 1924 he had quietly but effectively carried out his teaching responsibilities, including supervision, design and installation of the electrical laboratories since 1927. He had personally designed and in large part installed the power laboratory in the new electrical engineering building in 1948. Although he had made no

significant research contributions, Professor Lindblom's service and teaching had been part of the growth and success of the department. As a teacher, George Smith describes him as thorough, always well prepared, demanding and yet well liked by most students. To the younger faculty, he was formal, upright, but a private person, difficult to get to know.

Figure 79. George S. Smith in 1955 (EE Department photo)

George Sheridan Smith's involvement with Washington went back to the 1909 Alaska-Yukon-Pacific exposition, when, as a teenager, he had crept through sewers to enter the exhibition without paying the entrance fee. One of Carl Magnusson's bright students, Smith had gone to the General Electric electrical machinery test division and rapidly risen to division head before returning to Washington in 1921. Smith modestly claims a lesser teaching ability that most of the other faculty, but a fair record in research and publications. In fact Smith was involved in research from the start of his faculty career, working with Magnusson on the latter's transients textbook, with Kirsten on transmission line design, and on his own on the bismuth bridge to measure magnetic fields, before obtaining the first funded research project in the department. His work on heat pumps, now a widely used heating and air conditioning technology, garnered national attention and was instrumental in determining optimal installation strategies. Smith capped his service to the department with a detailed history written in 1969, invaluable for its record of the early years, his personal insights on the early faculty, and its precision combined with a slightly whimsical sense of humor. One of his sidelines was beekeeping, and he kept hives on the roof of the 1948 Electrical Engineering Building. He lived to 103.

Two faculty hired in 1954 left, with different impacts on the department. Instructor Robert E. Wall left for an outside position. With only an M.S. degree, his career prospects on the faculty may have looked dim. Associate Professor Gedaliah Held was promoted to full Professor, but left anyway for an outside salary offer. A demanding person, he was not especially well liked the faculty or the average student. To his credit, however, he graduated the first Ph.D. in the department and contributed to the rise of the

electromagnetics area. His student and subsequent long-time faculty member Akira Ishimaru took over Held's research project on conical slot antennas.

Another significant departure was that of Miss Bernez Northern, now Mrs. Kuhn, secretary to the chair. Over time she had come to believe that she knew exactly how the department should be run. Although her handling of a large and growing administrative burden justified her views to come extent, she was also willing to request that junior faculty change the grades they had awarded to certain students. Her move to Camano Island was a relief for at least some faculty. Her replacement was Mrs. Elfreda Pond.

Figure 80. From Left: Don Baker, B.S.E.E. 1960 (*Tyee* photo), and in the lab 1979. (*Trend* photo); Showing off the first ultrasound prototype in 2002. (*Columns* photo)

A notable alumnus of 1960 was Donald W. Baker. After high school in 1951 he spent four years in the Air Force, including two at the Air Force Cambridge Research Center, which was funding Professor Akira Ishimaru's research program. After leaving the Air Force, Baker attended the University of Washington, working as instrument technician in the wind tunnel to eke out his GI Bill benefits. In 1958, as a junior, his classmate Wayne Quinton introduced him to Dr. Robert Rushmer, a pediatrician and physiologist who had been researching cardiovascular systems at the University of Washington since 1947. Baker started work as a research assistant in Dr. Rushmer's laboratory, initially working on invasive blood flow measurement techniques with Jack Reid and other researchers.

After graduation in 1960 with a B.S.E.E., Baker continued to work in Rushmer's research team, holding a research position at the University. Working towards the goal of measuring blood flow without breaking the skin, the team used spectral analysis of continuous wave ultrasound to detect fetal heartbeats, resulting in a commercial instrument in 1964. Although this was a significant diagnostic tool, even better imaging was wanted. By 1964 Baker was the chief of Rushmer's technical team.

A breakthrough came when Don Baker read an article about pulse-doppler radar used to measure snow and rain in clouds. Doppler ultrasound had been used in Japan in 1955 to study heart valve movement, but with continuous wave signals. Earlier work with Rushmer's team gave Baker experience with pulse ultrasound in invasive instruments.

By combining the two concepts, the pulse let Baker control the depth in tissue from which the ultrasound image was created, while the doppler information in the pulse showed the speed of blood flow. The combination, called duplex pulse-doppler ultrasound, allowed simultaneous observation of anatomical details such as artery walls and the velocity profile of the arterial blood flow, and provided significant diagnostic benefits. The team developed prototype instruments by 1967, the same year Dr. Rushmer established the Center for Bioengineering (now the Bioengineering Department).

Don Baker now sought to commercialize the new technology, holding "show and tell" meetings with companies and banks around Puget Sound. This effort could be viewed as an attempt to profit from research results that should be public knowledge, but Dr. Rushmer's view was that research was not useful unless it was helping people, and commercialization was the path to this goal. In the event, both results ensued.

Baker eventually connected with a small startup called ATL. In 1973 and 1974 he was part of a pioneering effort in technology transfer. Much more than simply licensing patents, the effort involved transfer of hardware from the University to ATL, movement of engineers from University employment to ATL, and sometimes dual employment, participation by the technology developers in product creation and marketing. In exchange Don Baker got a significant block of stock in ATL, and the University received annual payments from the company. This was a new model for technology transfer, and proved extremely successful. The first commercial product appeared in 1975.

Based on feedback from sales and use, Don Baker and his technical team made further improvements in the hardware, adding new modes of operation and display features, which flowed from University laboratories to ATL. The National Institute of Health funded research at the University, and Don's lab grew to a staff of 40, occupying half the basement of the Electrical Engineering building. Don progressed to Research Associate Professor as the merit of his work overcame concerns about lack of an advanced degree. A funding reduction in 1979 caused Baker to close the lab and move to ATL full time.

To this point in his career, Don Baker had deployed an impressive set of talents, demonstrating competence as a research technician (a skill many researchers lacked), creating original and valuable research ideas, conceiving and implementing a new and successful approach to technology transfer, and competently administering a large research laboratory. Now he would demonstrate one more talent, conducting a marketing campaign in which he traveled around the world for five years demonstrating and popularizing ATL's pulse doppler ultrasound systems, putting ATL in the forefront of medical technology companies. Don left the ultrasound business in 1984. He received the Alumnus Summa Laude Dignatus award from The UW Alumni Association in 2002, and he has received numerous other honors.

Figure 81. Professor Simon M. Sze, M.S.E.E. 1960, co-inventor of non-volatile semiconductor memory. (EE Department Photo)

1960 was a great year in terms of Electrical Engineering alumni. Receiving the M.S.E.E. at the same time as Don Baker was Simon M. Sze. He had come from Taiwan, where he had a B.S.E.E. from National Taiwan University, and would go on to obtain his Ph.D. from Stanford in 1963. He then worked at Bell Labs from 1963 to 1989. In 1967, with Dr. Dawon Kahng, he proposed a floating gate process for charge storage, and supporting technologies that would become non-volatile semiconductor memory (NVSM), the basis for flash memory, EPROM and EEPROM chips found in thousands of electronics applications including PCs, digital cameras and cell phones.

Dr. Sze has made fundamental contributions to both device physics and technology that have shaped the understanding and advancement of the microelectronics industry. He provided the basic understanding of the temperature dependence of avalanche breakdown phenomena, of transport processes in metal-semiconductor contacts, of the operational principles of microwave and photonic devices (e.g., IMPATT, BARITT, and avalanche photodiodes), of the insulating properties of silicon nitride and silicon dioxide, and of the subthreshold characteristics of MOSFETs.

Dr. Sze literally wrote the book on semiconductor device physics. His book *Physics of Semiconductor Devices* (Wiley, 1969, 2nd Ed., 1981) has been translated into six languages, adopted by thousands of universities around the globe, and is used by industrial and research institutions. The book is the most cited work in contemporary engineering and applied science publications. Dr. Sze has written four other books, edited eight and published over 200 technical articles.

In 1990 Professor Sze joined the faculty of the Electronic Engineering Department of the National Chiao Tung University (NCTU), Taiwan, where he is UMC Chair Professor. He is a Fellow of the IEEE, a member of the National Academy of Engineering, a member of the Academia Sinica, and he received the IEEE J. J. Ebers Award in 1991.

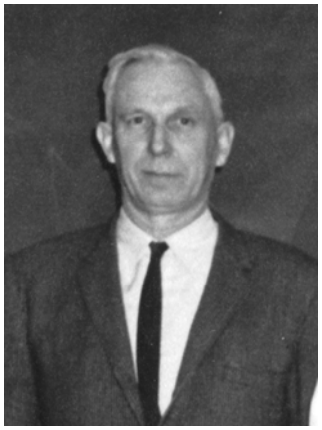
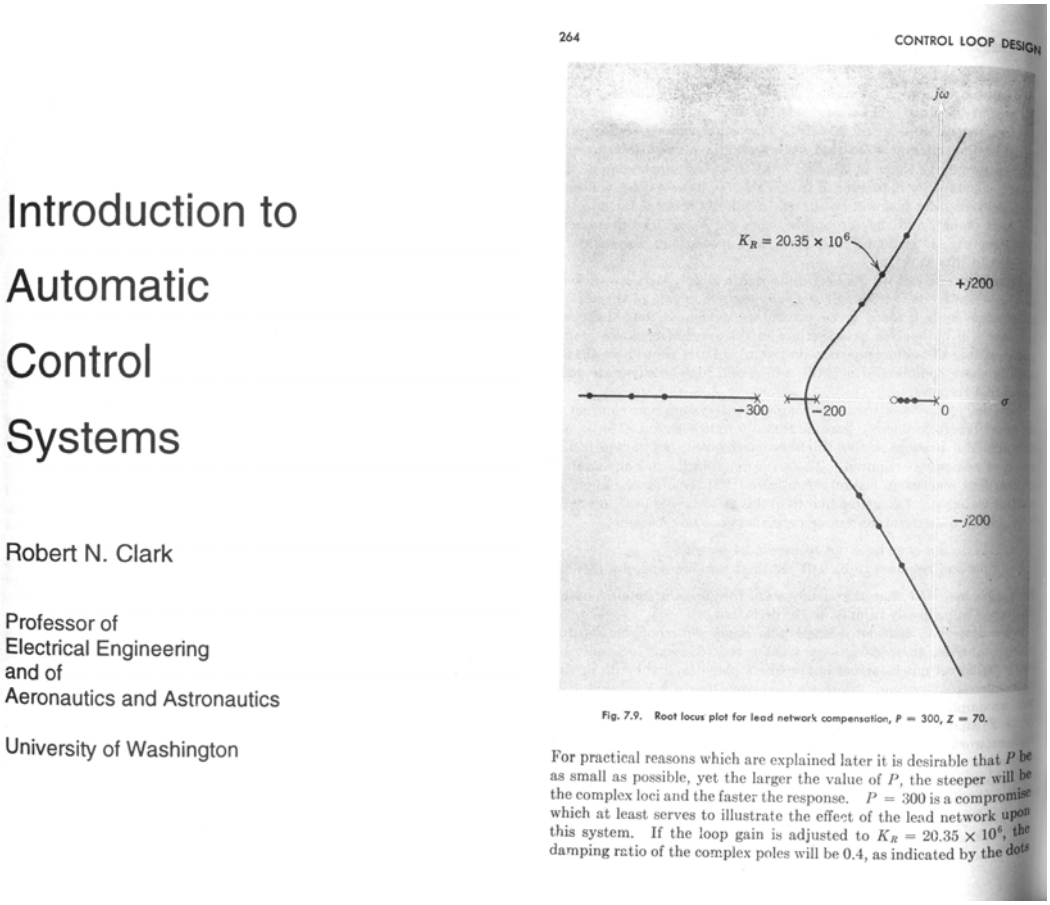


Figure 82. William Creedon in 1964. (EE Department photo)

Back in the Washington electrical engineering faculty, the departures of 1960 were balanced by a promotion and three new arrivals. Don Reynolds was promoted to full professor. Gordon H. Hanson, Ph.D. 1957 University of Minnesota, was hired from Bell Telephone Laboratories in Allentown, PA. His interests were in transistors and solid state electronics. Charles Wang, B.S. 1957 Taiwan College, M.S. 1959 Brown, Ph.D. 1960 Stanford, was hired as an Assistant Professor. His thesis dealt with the solid state electronic properties of silicon. William E. Creedon, B.S.E.E. 1929 M.I.T., M.E. 1938, Berkeley, was hired as a Lecturer. He concentrated on teaching introductory courses.

The hiring of 1960 addressed the lack of faculty working on transistor-related solid state electronics with two excellent hires, replaced a lost resource in the power area, and widened the distance between teaching and research slightly by hiring a full time lecturer specifically to teach the introductory courses.

In 1961, Associate Professor Robert Clark published his textbook *Introduction to Automatic Control Systems*. The book was still on Permanent Reserve in the University of Washington Engineering Library in 2006. Associate Professor David Johnson was promoted to full Professor, well deserved for his efforts in building the computer program. After about a year and a half in the department, Ed Guilford was promoted to Associate Professor, surprisingly fast work.. Akira Ishimaru was also promoted to Associate Professor. Assistant Professor Katsunori Shimada completed his Ph.D. from Stanford. Instructor David McNelis left. He had been hired in 1954 with an M.S.



Introduction to
Automatic
Control
Systems

Robert N. Clark

Professor of
Electrical Engineering
and of
Aeronautics and Astronautics

University of Washington

264 CONTROL LOOP DESIGN

$j\omega$

$K_R = 20.35 \times 10^6$

$+j200$

-300 -200 0 σ

$-j200$

Fig. 7.9. Root locus plot for lead network compensation, $P = 300$, $Z = 70$.

For practical reasons which are explained later it is desirable that P be as small as possible, yet the larger the value of P, the steeper will be the complex loci and the faster the response. $P = 300$ is a compromise which at least serves to illustrate the effect of the lead network upon this system. If the loop gain is adjusted to $K_R = 20.35 \times 10^6$, the damping ratio of the complex poles will be 0.4, as indicated by the dots

Figure 83. Title page and a page of text from Robert Clark's 1961 textbook *Introduction to Automatic Control Systems*, published by John Wiley. This particular copy was a later re-publication.

The 1961 curriculum saw very minor changes. One of the General Engineering problems courses in the common first year was replaced with a statics course. There are signs of some confusion about expectations on the part of Ph.D. students, and possibly faculty advisors, in the catalog's admonition about the E.E. Ph.D. degree:

> This is primarily a research degree. It is not conferred as a result of course work, no matter how faithfully nor how long it is pursued. The granting of the degree in this department is based essentially on general demonstrated ability to pursue independent research. Evidence of research investigation is the production of a doctoral thesis which makes a definite contribution to knowledge and is presented with a satisfactory degree of literary skill.

These words certainly capture the present understanding of the requirements for a Ph.D. degree.

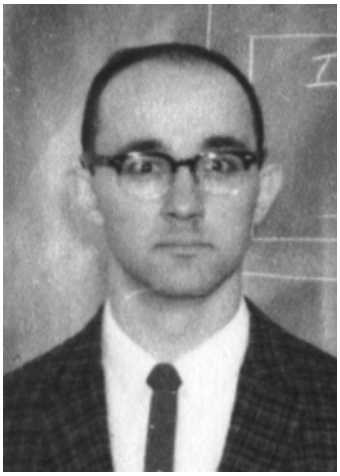
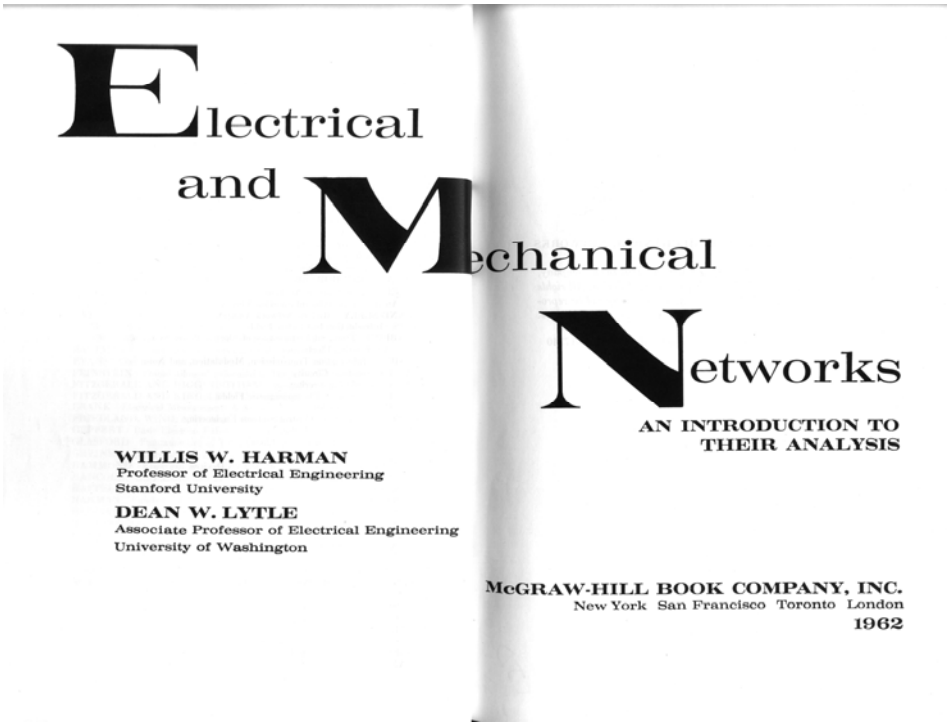


Figure 84. From Left: Irene Carswell Peden; Peter Metz in 1962. (EE Department photos)

Faculty growth continued with three hires in 1961. Most notable was the hiring of M. Irene Carswell, B.S.E.E. 1947, Colorado, who was finishing up her Ph.D. thesis on modeling microwave periodic circuits at Stanford. Professor Carswell, or Professor Peden, as she became after marrying, was the first female faculty member in the Electrical Engineering department. Her arrival was warmly welcomed by the majority of the faculty, including Department Chair Austin Eastman, not least because of her academic abilities. A few of the faculty were predictably but unfortunately less welcoming. Some of the news coverage of her arrival is now painfully embarrassing to read, extolling her appearance rather than her talent. She set to work on her research program, and on encouraging women to enter engineering.

Robert W. Albrecht, B.S.E.E. 1957, Purdue, M.S.E.E. 1958, Ph.D. 1961, Michigan, was hired as an Assistant Professor. Albrecht's graduate work applied control theory to reactor stability. His hiring nurtured the Nuclear Engineering program, which had yet to become a department. Peter R. Metz, B.S.E.E. 1956, Washington, S.M.E.E. 1958, M.I.T., returned as an Acting Instructor while pursuing his Ph.D. at Washington. His interests were in biomedical work and solid state electronics.
Enrollment in Electrical Engineering had been steadily increasing since hitting a post-GI Bill trough in 1951, at all levels, undergraduate, M.S. and Ph.D. In 1960 undergraduate enrollment peaked at 542, just under the maximum post-war level, and started a slow but sustained decline, bottoming at 402 in 1966. M.S. enrollment also declined, but the Ph.D. program continued to grow. The reasons for the enrollment decline are unclear.



Electrical and Mechanical Networks

AN INTRODUCTION TO THEIR ANALYSIS

WILLIS W. HARMAN
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DEAN W. LYTLE
Associate Professor of Electrical Engineering
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McGRAW-HILL BOOK COMPANY, INC.
New York San Francisco Toronto London
1962

Figure 85. Title page from Dean Lytle's textbook *Electrical and Mechanical Networks*, written with W. W. Harman and published by McGraw-Hill in 1962.

Figure 86. Robert E. Lindsay in 1965. (EE Department photo)

1962 saw three newly promoted Associate Professors: Chih-Chi Hsu, Endrik Noges and Dean Lytle. Lytle published a textbook, *Electrical and Mechanical Networks*, with W. W. Harman. The Seattle World's Fair opened, with the Space Needle signifying America's interest in high technology. However, perhaps with an eye on the declining enrollment, only one new faculty member was hired in Electrical Engineering. Robert E. Lindsay, B.S. 1957, M.S. 1958, Ph.D. 1962, Stanford, was hired as Assistant Professor. His thesis was on computational solutions of differential equations.

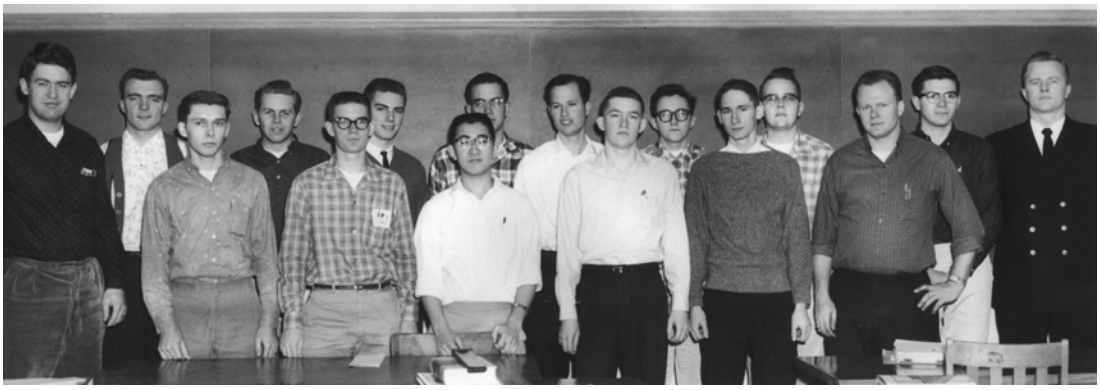


Figure 87. EE 233 section BA, Winter 1962. Front row from left: J.C. Mendenhall, R.F. Priebe, T.N. Thwing, F. Koyama, G.L. Hall, E. Hutcell, A.J. Pennington. Back row, from left: D.E. Haan, G.A. Bean, J.O. Renn, W.E. Ward, R.J. Ausere, J. Erskine, W.J. Green, T.E. Doyle, D.S. Rigg. (EE Department photo)

In 1963 Assistant Professor Charles Wang left, after only three years on the faculty. His departure must have emphasized Austin Eastman's concerns about retaining quality faculty. Although no outside hiring was done, Instructor Rubens Sigelmann completed his Ph.D. and became an Acting Assistant Professor. Lynn Watt was promoted to Associate Professor. Endrik Noges went on sabbatical as a Fulbright lecturer at Finnish Institute of Technology, Otaniemi, Finland.

1964 saw changes in faculty and curriculum. Instructor Alistair Holden completed his Ph.D. at Washington, and was duly promoted to Assistant Professor. Hellmut Golde, and Irene Peden were promoted to Associate Professor. George Hoard retired. He had joined the faculty in 1920 and served for 44 years, 23 as a full Professor. Like many of his contemporaries, his entire career, from freshman to Professor Emeritus, had been at Washington. He did not have much of a research record, although he had some involvement with Seattle transit systems and was the faculty advisor to the 1936 fish tag detection project. He taught electrical machinery, power systems and later electronics. George Smith describes him as a good teacher, but a little tough on the students.

Figure 88. From Left: George Lisle Hoard in 1956; Frank J. Alexandro in 1964 (EE Department photos)

Two hires were made in 1964. Frank J. Alexandro, B.S.E.E. 1956, M.E.E. 1959, D.Sc. 1964 New York University, was hired as Assistant Professor. Alexandro worked in the control systems area and had experience with Ford Instrument Company and Sperry Gyroscope Company before coming to Washington. Robert B. Pinter, B.S.E.E. 1959 M.S. 1960 Marquette, Ph.D. 1964, Northwestern, was hired as an Assistant Professor. His thesis studied photoreceptors, and his research interests were in biomedical engineering.

Betsy Ancker-Johnson, B.A. Wellesley, Ph.D. 1953 Tübingen, was appointed a Research Associate Professor of Electrical Engineering. The second woman faculty member, she was very active in the department, advising students and participating in several research projects. Her interests were solid state physics, microwaves, and plasmas.

The undergraduate curriculum received another major change in 1964. As in 1955, a radical innovative concept for electrical engineering education was implemented, reflecting the research strengths of the department. The curriculum was based on the observation that electrical circuits are one of many types of linear system. Mechanical circuits and acoustic circuits are models with similar relationships from other disciplines. Rather than teaching the specific instance of electrical circuits, the idea was to teach students the more general topic of linear systems first, and then introduce circuits as a special case. It was this thought that replaced the traditional circuit theory courses of the sophomore year with three courses called Introduction to Linear Systems I, II and III, and two EE Labs. The first course introduced students to integro-differential equations, transient and steady state behavior, and pole-zero concepts. Thévenin and Norton did not make an appearance until the third course, which was also the quarter in which students took their first differential equations class.

The junior year now became the province of the electromagnetics group, with 15 credits of courses and labs in the junior year. Electronics started only late in the junior year and had 10 credits in the curriculum. Electrical machinery was the big loser, being reduced to one five-credit course in the senior year. Electives grew back to 16 credits, and the General Engineering Department introduced a two-credit course in Digital Computing in the freshman year.

The list of available electives grew modestly, including courses in Transistor Circuit Engineering and Linear and Non-Linear Systems Analysis. The only course number that seems to have survived to the present day is EE 499, the undergraduate projects course. The graduate program was unchanged.

Comparing the 1964 curriculum to the modern canon, only the area of signal processing is missing. It is also missing from the specific research interests of the faculty, although signal processing was certainly used in different research projects. Time would tell whether the push to generality, so prized in research work, would prove an effective approach to instruction.

A hint of the future appeared in 1964 when Associate Professor John Bjorkstam lectured on lasers, a topic that made the *Daily*. It would be a few more years before lasers became a common topic in the Department.

The academic year 1964-65 ended on a ground-breaking note. In April a major earthquake struck Puget Sound. In May three graduate students, including Arthur Guy, traveled to Antarctica to lay a 21-mile antenna for propagation measurements in Antarctic regions, a project headed by Professors Don Reynolds, Myron Swarm, and Irene Peden. The graduate students got to remain in Antarctica over the Antarctic winter to take measurements. Associate Professors John Bjorkstam and Akira Ishimaru were elevated to the rank of full Professor. Instructor Peter Metz completed his Ph.D. and became an Assistant Professor. The Nuclear Engineering program was formalized sufficiently for Bob Albrecht to become a joint Assistant Professor of Electrical and Nuclear Engineering. Associate Professor Katsunori Shimada and Assistant Professor Gordon Hanson left the University.

A drop in undergraduate enrollment in 1961 was the start of a trend, though the reason is not known. The Ph.D. program showed steady growth, while the number of MS students grew rapidly until 1960 and declined a bit thereafter. Degrees granted followed a similar pattern with a bit of a time lag.

Department Chair Austin Eastman was approaching retirement. Looking over the past ten years, he could be very satisfied with his accomplishments, despite a few concerns. Undergraduate enrollment had risen from 296 to 514 from 1955 to 1960, somewhat less than doubling. However, there had then been a gradual five year drop off, with only 410 undergraduates to start 1965, despite the excitement of the space race and the rising national interest in technology in the 1960s. The cause of the drop is a mystery. The MS program had grown and shrunk in proportion to the undergraduates. The Ph.D. program had awarded its first doctorate, and continued to grow, along with research funding.

The decade had seen a major reshaping of the faculty. Numbers expanded from 17 in 1955 to 30 in 1965. This actually represented a slight decrease in the rate of expansion from the previous decade, when the faculty doubled, but was the largest absolute increase in faculty. Faculty hiring had finally caught up with the post-war GI Bill undergraduate boom, and was sustained by the new modality of funded research. 26 new faculty had been hired. There had been one death and two retirements. Ten faculty had left.

Eastman’s efforts to change the salary and working conditions of the faculty had led to continuing improvement in quality, as measured by academic credentials, that had started post-war. Seventeen of the 26 new hires held Ph.D degrees. Five were working on the Ph.D., most at Washington, when hired. Two were M.S. only. Two, at the start of the decade, were working M.S. degrees when hired. By the end of the decade the Ph.D. had become a prerequisite for a tenure-track faculty position. Diversity of hiring sources also improved, although the strong taboo against hiring from one’s own Ph.D. program was not yet in place.

Half of the departures were instructors with M.S. degrees. Some had instructed simply as a means to their M.S. Others presumably found their prospects without a Ph.D. better elsewhere. The five with Ph.D. degrees who left were a signal that concerns about low salaries had not been completely addressed. Particularly to be regretted were the departures of Gedaliah Held, advisor of the department's first Ph.D., and Gordon Hanson from the electronics program.

The decade had also seen changes in research areas. Electromagnetics, strong and growing at the start of the decade, continued to strengthen. It was the largest area, with seven tenure-track faculty and the first research faculty member at the end of the decade. Completely new was the controls area, which had grown from zero to five faculty during the decade, or seven if the two faculty with biomedical interests are included. Electronics grew from three to six, two of whom had interests in solid state electronics. The digital computer area grew from a half a faculty member to four. The power area continued the contraction that had started with the death of Carl Magnusson in 1941, having four faculty at the end of the decade.

The emphasis on electromagnetics reinforced success and would gain Washington a national reputation in this specialization. The choice of computers and controls as growth areas was perhaps obvious. If the department had a weakness it was in electronics. This comment is not meant to reflect on the individual faculty of the electronics area. It is only with the benefit of hindsight that the importance of electronics, and of specific types of electronics, has become clear.

Two new types of faculty had appeared during the decade, representing specialization in teaching or research. Prior to 1960, people with recent B.S. or M.S. degrees had been hired as Instructors. While some simply taught classes and left after a few years, others followed the tenure track career path through Assistant, Associate and full Professor, and some of these had impressive research achievements. In 1960 William Creedon was hired as Lecturer rather than Instructor, becoming teaching faculty not on the tenure track. Small numbers of lecturers would continue to be hired.

Betsy Ancker-Johnson's hiring as research faculty in 1964 confirmed the burgeoning importance of research in the department. In the early years research had been an avocation of many of the faculty, while teaching was the profession of all. With the advent of advanced degrees, research had also become a means of teaching students how to do research, and thus become part of the faculty's profession. The appearance of funded research in the late 1940s encouraged the faculty and the department to further emphasize the role of research. Now research, coupled with the instruction of graduate students associated with that research, was sufficient by itself to justify faculty hiring, just as teaching by itself was sufficient to justify the hiring of lecturers.

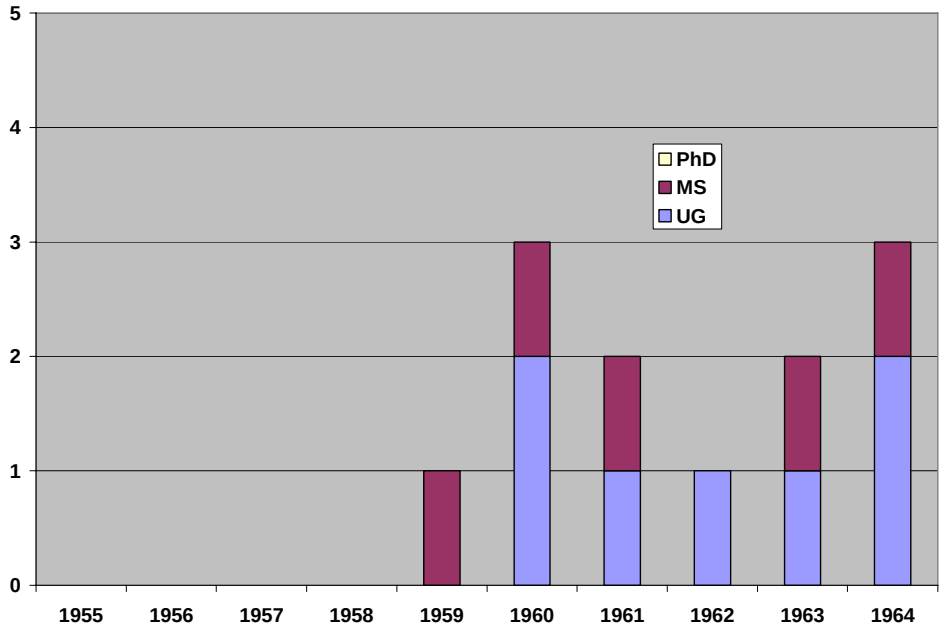


Figure 89. Female enrollment in Electrical Engineering, 1955-1964.

Women had been students and faculty at the University of Washington from its earliest days, and there had never been a formal bar keeping female students and faculty out of Electrical Engineering. Nevertheless bringing in two female professors during this decade was a significant achievement. The department, the department chair, and the faculty involved deserve credit for making this progressive effort a success. Just before Irene Peden's arrival, the first female students since the end of World War II started to appear in the department, the beginning of a sustained enrollment of women in the Electrical Engineering program.

Faculty hiring had tapered off during the last half of the decade, as undergraduate enrollment dropped and the building filled up. The era of frantic growth might finally be coming to an end. Outside the department, however, technology was taking an increasing role in society. Then next decade would see some public triumphs for technology, and an increase in demand for technology graduates, but also some serious social questioning of the value and values of technology.

1965-1975 Troubled Times

Figure 90. UW Husky, 1970s.

The underground upheaval of the 1965 earthquake reflected the state of society. The assassination of John F. Kennedy in 1963 marked the end of the comfortable 1950s and the start of the turbulent 1960s. In 1964 the Beatles came to America, changing popular music forever and making long hair fashionable for men. In the same year a naval encounter in the Gulf of Tonkin brought an increasing US presence in South Vietnam. The apparently inexorable growth in U.S. casualties would, by 1970, arouse the first significant anti-war protests since the Civil War. In 1965 a routine traffic stop in Watts, a black neighborhood in Los Angeles, erupted into six days of riots, arson, and looting. In 1966 Timothy Leary advised "turn on, tune in, and drop out." Casual use of recreational drugs like marijuana and LSD became commonplace on college campuses, although beer remained the primary drug of choice. Society seemed to be coming apart at the seams.

The United States was in the middle of the race to the moon ignited first by Sputnik of 1957 and then by President Kennedy's bold public vision of putting a man on the moon by the end of the 1960s. In 1965, when the first two-person Gemini space capsule orbited, the Russian cosmonauts held all the space records worth having.

The space program, however, was a boon to technology, and especially electrical engineering. The limited thrust of early U.S. boosters made miniaturization of electrical and electronic hardware mandatory at any cost, and spurred research and innovation in electronics. The integrated circuit was developed at Fairchild and also at Texas Instruments in 1959, and the first ICs (four transistors!) were commercially available in 1961. Lasers, including gas lasers, ruby lasers, and the laser diode appeared in the early 1960s, although ideas on how to use them were scarce. FORTRAN was invented, and assembly language programming passed into the realm of computer wizards. In 1965 a PDP-8 12-bit minicomputer cost $18,500 and fit in a room smaller than a basement. Communications satellites were launched, and satellite phones and intercontinental live TV became possible. In 1965 the Fast Fourier Transform (FFT) was published. Dolby noise reduction was commercialized, so now an 8-track audio tape would have less noise.

In the Electrical Engineering department, hiring continued to sustain the growth of the faculty. In Autumn, 1965 Peter O. Lauritzen, B.S.E.E. 1956 CalTech, M.S.E.E. 1958 Ph.D. 1961 Stanford, joined the faculty as an Assistant Professor. Lauritzen worked on solid state electronic materials and devices. His Ph.D. thesis was "Experimental Measurements of 1/f Noise in Germanium Filaments."

Faculty careers proceeded apace. In 1966 Bob Clark was promoted to full Professor, Endrik Noges became Assistant Dean of Engineering and Ryland Hill went on sabbatical to UNSECO in Paris.

Figure 91. Left: F. Paul Carlson as an instructor in 1965. (EE Department photo); Right: Professor Sinclair Yee, probably in the mid-1970s. (*Trend* photo)

The academic year 1966 saw three faculty hires. F. Paul Carlson, B.S.E.E. 1960, Washington, M.S.E.E. 1964, Maryland, was hired as an Instructor. Carlson was working on his Ph.D. thesis, "Propagation in Stationary and Locally Stationary Random Media," advised by Akira Ishimaru. He was the second of Ishimaru's students to obtain a UW faculty position. He would complete his Ph.D. in 1967. Sinclair S. Yee, B.S.E.E. 1959, M.S.E.E. 1961, Ph.D. 1965, University of California was appointed Assistant Professor. His Ph.D. thesis was "An Investigation of the Mechanisms of Radiative Recombination in Germanium." His hiring strengthened the growing electronics area. Jay H. Harris, B.E.E. 1958, Polytechnic Institute of Brooklyn, M.S. 1959, Caltech, Ph.D. 1965, U.C.L.A., was appointed Assistant Professor of Electrical Engineering. His interests were radiation, plasmas and some biomedical engineering.

Three professors were promoted. Alistair Holden became an Assistant Professor of Electrical Engineering and Computer Science. Robert Albrecht was promoted to Associate Professor of Nuclear Engineering, and departed to that department. Hellmut Golde became an Associate Professor of Electrical Engineering and Computer Science.

By 1967 it was clear that Department Chair Austin Eastman would shortly retire, and the succession became an issue. Only the second chair in the history of the department, Eastman had served for 26 years. Just one other active faculty member had been in the department when Eastman was appointed. The major issue was whether to seek internal or external candidates. Professor Lynn Watt wanted the position, and was considered capable, but many of the faculty felt that, despite Watt's abilities, an external chair should be hired to bring new ideas into the department. Eastman had been in the department since he was a sophomore, but had worked hard to diversify the origins of the faculty, and an external successor would be a continuation of this healthy trend. When the Dean made the decision to look outside, Watt departed for the University of Waterloo, where he spent the rest of his career, quickly becoming Dean of Graduate Studies. Assistant Professor Robert Lindsay also left the faculty in 1967, after five years of service.

By 1967 it was clear that the slow drop in undergraduate enrollment from 1960-1965 had turned around. Faculty expansion continued with three hires. Eugen Schibli, Dipl. Ing.

1961 E.T.H. Zurich, M.S. 1963 Technion Haifa, Ph.D. 1967 Carnegie Mellon University, was appointed Assistant Professor of Electrical Engineering. His thesis was “Deep Impurities in Silicon” and his interest was solid state electrophysics. Graham L. Duff, B.Eng. 1961 McGill, M.S. 1963 Ph.D. 1966 Illinois, was appointed Assistant Professor. His interests were largely in radiation patterns, small loop dipoles and antennas in general. Jonny Andersen, B.S.E.E. 1960 Colorado, S.M. in E.E. 1962 Ph.D. 1965 M.I.T., was appointed Assistant Professor. He focused on circuit theory and thesis title was “Realizability Conditions for New Classes of Three-element-kind Networks.”

Two professors pursued interesting sabbaticals. John Bjorkstam took leave in France and Yugoslavia. Robert Clark, a full professor and author, but one of the few faculty without a Ph.D., started a two-year leave of absence to work as a graduate student at Stanford. Rubens Sigelmann, Peter Lauritzen, and Frank Alexandro were promoted to Associate Professor. Hellmut Golde became Acting Assistant Dean for Research and Planning.

Don Baker published the first papers on pulse doppler ultrasound, which provided the first general purpose non-invasive diagnostic ultrasound capability. His colleague, Dr. Robert Rushmer, founded the Bioengineering Group, and the ultrasound work would occupy a significant place in its research, providing work for EE students, until 1979.

1968 was an eventful year for both the nation and the EE Department. Martin Luther King, civil rights hero, was assassinated. Robert F. Kennedy, presidential candidate, was assassinated at the height of a tumultuous presidential campaign. Anti-war demonstrations were commonplace. Long-haired marijuana-smoking, LSD-dropping, free-loving hippie freaks congregated on campus. The Naval Reserve Officer Training Corps (NROTC) offices in Clark Hall were firebombed. As usual, most of the engineers were too busy to pay much attention to the protesters.

Figure 92. The Electrical Engineering building in the 1960s, after construction of the fourth floor. The indoor antenna range occupied the windowless space in the base of the T. (EE Department photo)

Probably more distracting than the protests was the noise from the construction of the fourth floor of the Electrical Engineering building. Talked about since 1959, the addition finally commenced in 1968. Although the building had been designed for easy addition of a wing to make an H shape rather than a T, the decision to go up instead of out was made for two major reasons. First, the burgeoning electromagnetics research program had antenna measurements as a major components. Many M.S. and Ph.D. theses, and much funding, were based around antenna design and testing. This testing was conducted with antennas on the roof of the EE building, and at the West Seattle Antenna range. However, the weather in Seattle is not the best for outdoor antenna testing. Therefore, a number of the leading electromagnetics faculty, including Professors Ishimaru and Sigelmann, lobbied for an indoor antenna test range, or anechoic chamber, of 120' x 30' x 30'. This could only be accommodated by going up.

A second reason for going up instead of out was parking. The parking lot surrounding the base leg of the Electrical Engineering Building had become one of the most sought after parking permits on campus because of its proximity to the center of campus. Only the President and the Deans had better parking spots. It is difficult to imagine the faculty surrendering these prime spots if any other reasonable alternative was available.

Figure 93. Daniel G. Dow, third Chair of Electrical Engineering, 1968-1977. (EE Department photo)

While the fourth floor literally built up the department, growth in another dimension was provided by the arrival of Dr. Daniel G. Dow to replace Austin Eastman as Department Chair. The new chairman of Electrical Engineering brought outside ideas to the department from other schools and also from industry. Dan Dow, B.S. 1952 M.S. 1953 University of Michigan, Ph.D. 1958 Stanford, had taught at Stanford in 1957, and at the California Institute of Technology from 1958 to 1961. From 1961 to 1968 he was with Varian Associates, where he led the development of the Gunn-effect oscillator which can be used instead of klystrons. Dan had grown up in an academic environment, as his father was a famous and influential Dean at Michigan. Austin Eastman returned to teaching for the remainder of the academic year.

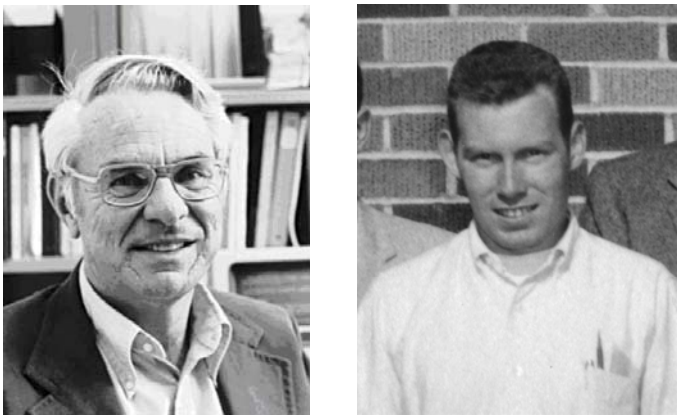


Figure 94. Left: Jerre Noe, hired in 1968 as Chair of the Computer Science Group, with a faculty appointment in Electrical Engineering for administrative purposes. He would later be the first chair of the Department of Computer Science. Picture probably from the 1980s. Right: Ward Helms as a graduate student in 1960. (EE Department photos)

Dow arrived with three other new faculty, two of them senior. Jerre Donald Noe, B.S. 1954 Berkeley, Ph.D. 1948 Stanford, was hired away from Stanford Research Institute and Hewlett-Packard to become Professor of Electrical Engineering and Computer Science and chair of the newly formed Computer Science Group. Noe's relationship with the Department of Electrical Engineering was purely administrative. For all intents and purposes except on paper, he reported to the Dean rather than the EE chair. Curtis C. Johnson, B.S.E.E. 1954 M.S.E.E. 1955 Caltech, Ph.D. 1958 Stanford, was appointed Associate Professor of Electrical Engineering and Associate Director of the Bioengineering Program. As with Noe, his relationship to EE was solely administrative. Ward Julian Helms, B.E.E.E. 1960 Washington State University, M.S.E.E. 1963 Ph.D. 1968 University of Washington, was appointed Assistant Professor. His PhD. advisor was Don Reynolds. Helms had wintered over in the Antarctic, although he had been funded from Stanford based on his undergraduate research work at Washington State. His thesis was "Experimental Study of the Lower Polar Ionosphere using Very Low Frequency Radio Waves." Ward would actually work in the EE department.

In the spring of 1969, the Administration Building was bombed by student peace protesters. Professor Bob Clark completed his Ph.D. at Stanford University, entitled "Analysis of Oscillations in Pulse-modulated Satellite Attitude Control Systems." Research Associate Professor Betsy Ancker-Johnson left her position at the University and went to Boeing, retaining a tie as an Affiliate Professor. Some of the faculty wanted Ancker-Johnson to move to a tenure-track position, but the transition from research faculty to tenure-track at the same institution is always difficult. Ancker-Johnson's husband was a mathematics professor, which raised concerns about nepotism. Ancker-Johnson's subsequent career, including a flag-rank appointment at the Treasury, head of the Argonne National Laboratory, and Vice President at General Motors, emphasize the opportunity lost to the department.

Professors Lyall Cochran and Austin V. Eastman retired. Cochran was a UW alumnus from 1923, who hired on in 1934 to teach electronics. His career was primarily teaching and service oriented. He had designed and installed the first electronics laboratory in Old Engineering Hall and the electronics laboratory in the 1948 Electrical Engineering Building. In 1943 he had started courses in radar electronics on campus, using what he had learned in short courses at M.I.T. in 1941 and 1942. Washington became a major source of radar technicians for the Navy in World War II. Cochran continued to teach radar electronics courses under the name Ultra High Frequency Techniques after the war, providing an educational foundation for the growth of the electromagnetics program. His career spanned 35 years.

Figure 95. Austin V. Eastman. (EE Department photo)

Austin V. Eastman had graduated from UW in 1922, worked for two years and returned as the first professor in the electronics area, working on vacuum tubes. He published a widely used textbook on vacuum tube electronics in 1937. He was the logical choice to replace Carl Magnusson as chair, or rather, as department executive officer, as was the title in 1941. In his 27 years as chair, second only to Magnusson's 36, Eastman had seen the department through three major eras with sustained growth and quality improvement. His first challenge was World War II. Major changes in curriculum and academic calendar, service courses for navy electronics and radar technicians, and an absence of students in the conventional program and instructors were overcome by hard work. No sooner had the war ended than the G.I. Bill explosion quadrupled enrollment overnight, to twice the pre-war levels. Eastman hired faculty as fast as he reasonably could and organized the construction of a new Electrical Engineering Building. The final era, lasting from about 1950 to his retirement, was the transition of the Department to the new funded research paradigm. Eastman supervised continued growth in faculty numbers, while working for improved quality in hiring, principally by seeking faculty from outside the University. His ambition was to be as highly ranked as any school in the nation, and he worked hard for the resources, especially faculty salaries, to progress towards his goal. He instituted a Ph.D. program, and saw continued growth in funded research.

Hiring faculty is probably the most important aspect of improving quality in an academic program. The number of faculty from the 1960s who remember Austin Eastman suggesting they consider coming to, or staying at, Washington is a remarkable testament

to his personal proactive involvement in recruiting. A detail-oriented manager, Eastman could be genial or formal in turns.

Bob Albrecht tells a story about Eastman. When Albrecht arrived in 1961, Bob Clark took him flying in his private airplane. Albrecht was hooked, and bought a plane of his own. One day Albrecht offered to take the department secretaries, Elizabeth Equals and Freda Pond, up for a ride. Austin Eastman heard them talking and emerged from his office to declare that Albrecht could "kill any faculty member you want, but you can't kill the secretaries."

The Electrical Engineering department had missed the golden ring during the Second World War and had to settle for brass, not through any fault of Eastman's. The prewar focus on power engineering made Washington a secondary player in radar during the war, compared to M.I.T.'s commitment to electronics. The sonar problems addressed at the Applied Physics Laboratory, while important to national defense and providing good collaborative opportunities through the years, did not have the growth potential of the CalTech Jet Propulsion Laboratory, with its major role in the space program, or of the digital computer developments at the University of Pennsylvania. Further, APL was run as a classified lab, limiting student access to its research projects. Because William Shockley's mother did not live in the Puget Sound region, Washington missed out on the transistor and solid state revolution that Shockley Transistor Company brought to Silicon Valley. Limitations on state support of higher education presented Eastman, and every other EE chair, with the continuing problem of non-competitive faculty salaries, despite his special efforts to persuade the administration to fix the problem.

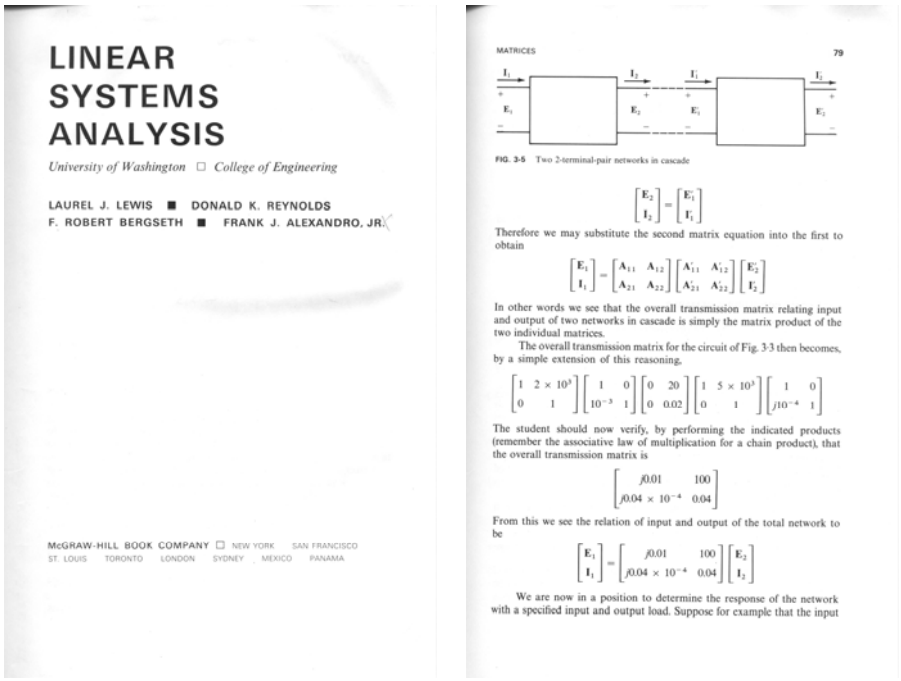
By 1969 Washington had a solid national reputation and well funded, synergistic research programs in electromagnetics, acoustics and ultrasound. Eastman had more recently added a strong control systems presence to the department, one that had solid connections to The Boeing Company. He hosted the start of what became a top ten Computer Science department, which became a Group as he departed. The power area had been allowed to decay. Eastman had made a gentleman's agreement with Washington State University to let them have the power area. The completion of the available major hydro projects in the Northwest reduced the growth potential in this infrastructure area, and funding was not as readily available as in many other areas. In the electronics area the department could be considered to lag, nationally. Unfortunately it was precisely the electronics area that was and would prove to be the long term driver for major growth in electrical engineering. Eastman had tried hard to recruit faculty in the electronics area, but had lost a number of young faculty in the area to industry. The departure of Lynn Watt over thwarted administrative ambitions was another blow to the area. The faculty who remained were good, but the sum of their efforts was bettered by many other EE departments. This must have been frustrating for Eastman, whose own area of interest was electronics.

Taking all things into consideration, and with knowledge of the achievements of his successors, Austin Eastman had done very, very well by his alma mater, and had reason to be proud of the accomplishments of his long career as professor and administrator.

1969 saw three promotions to full Professor. Endrik Noges, still Assistant Dean, and Dean Lytle were promoted in Electrical Engineering, and Hellmut Golde became Professor of Electrical Engineering and Computer Science, and also Assistant Director of the university computer center.

Figure 96. From Left: Kenneth O'Keefe as a graduate student in 1962; Professor Mark Damborg, probably from the 1980s (EE Department photos); Professor David Auth in 1975 (*Trend* photo)

The year saw four faculty hires. Kenneth O'Keefe, M.S. 1963 Ph.D. 1967 Washington, was hired as an Acting Assistant Professor to work in the computer hardware area, or what might now be called digital electronics. His thesis was "Application Of Shift Registers To Secondary State Assignment." Jean-Loup Baer, Diplome d'Ingénieur in Electrical Enginering and the Doctorat 3e cycle in Computer Science from the Université de Grenoble (France), Ph.D. 1968 UCLA, was hired into the Computer Science Group. As with Jerre Noe, his association with the EE department was purely administrative. David Christopher Auth, A.B. 1962 Catholic University of America, M.S. 1966 Ph.D. 1969 Georgetown University, was hired. His degrees were in physics. Georgetown had no engineering program, and Department Chair Dan Dow evaluated Auth's work as good engineering and pushed for his hiring. Auth's thesis title was "Orthogonal Photon-Photon Scattering." His hiring marked the start of the optics area in the department. Mark J. Damborg, B.S.E.E. 1962 Iowa State University, M.S.E.E. Ph.D. 1969 Michigan, with a Fulbright year in the Netherlands, joined the control systems area. His thesis was "Stability Of The Basic Nonlinear Operator Feedback System." He would work on dynamic and control problems in power systems.



LINEAR
SYSTEMS
ANALYSIS

University of Washington □ *College of Engineering*

LAUREL J. LEWIS ■ DONALD K. REYNOLDS
F. ROBERT BERGSETH ■ FRANK J. ALEXANDRO, JR.

McGRAW-HILL BOOK COMPANY □ NEW YORK SAN FRANCISCO
ST. LOUIS TORONTO LONDON SYDNEY MEXICO PANAMA

MATRICES 79

FIG. 3-5 Two 2-terminal-pair networks in cascade

$$\begin{bmatrix} E_2 \\ I_2 \end{bmatrix} = \begin{bmatrix} E_1' \\ I_1' \end{bmatrix}$$

Therefore we may substitute the second matrix equation into the first to obtain

$$\begin{bmatrix} E_1 \\ I_1 \end{bmatrix} = \begin{bmatrix} A_{11} & A_{12} \\ A_{21} & A_{22} \end{bmatrix} \begin{bmatrix} A'_{11} & A'_{12} \\ A'_{21} & A'_{22} \end{bmatrix} \begin{bmatrix} E'_2 \\ I'_2 \end{bmatrix}$$

In other words we see that the overall transmission matrix relating input and output of two networks in cascade is simply the matrix product of the two individual matrices.

The overall transmission matrix for the circuit of Fig. 3-3 then becomes, by a simple extension of this reasoning,

$$\begin{bmatrix} 1 & 2 \times 10^3 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 \\ 10^{-3} & 1 \end{bmatrix} \begin{bmatrix} 0 & 20 \\ 0 & 0.02 \end{bmatrix} \begin{bmatrix} 1 & 5 \times 10^3 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 \\ j10^{-4} & 1 \end{bmatrix}$$

The student should now verify, by performing the indicated products (remember the associative law of multiplication for a chain product), that the overall transmission matrix is

$$\begin{bmatrix} j0.01 & 100 \\ j0.04 \times 10^{-4} & 0.04 \end{bmatrix}$$

From this we see the relation of input and output of the total network to be

$$\begin{bmatrix} E_1 \\ I_1 \end{bmatrix} = \begin{bmatrix} j0.01 & 100 \\ j0.04 \times 10^{-4} & 0.04 \end{bmatrix} \begin{bmatrix} E_2 \\ I_2 \end{bmatrix}$$

We are now in a position to determine the response of the network with a specified input and output load. Suppose for example that the input

Figure 97. Title page and a page from the text *Linear Systems Analysis,* published in 1969 by Professors Laurel Lewis, Bob Bergseth, Frank Alexandro, and Don Reynolds.

In 1969 Laurel Lewis, Bob Bergseth, Frank Alexandro, and Don Reynolds published the textbook *Linear Systems Analysis* with McGraw-Hill. Ironically, this was also the year when the undergraduate curriculum moved away from the linear systems approach put in place in 1964 and reverted to the more conventional approach of teaching circuit theory in the sophomore year. Students had complained about learning non-electrical systems after choosing electrical engineering, and found the intellectual beauty of the systems synthesis difficult to appreciate without a broader knowledge background. The attempt was a good idea applied too early in the curriculum.

The junior year was now is more evenly split among electromagnetics and electronics, with a new course in Signals and Systems and a course in electrical machinery rounding out the EE topics. Signals and Systems may have been the first signal processing course, if the Linear Systems sequence of 1964 is viewed as having a broader focus. Elective credits roughly double, but with some constraints. The previous curriculum offered 16 free elective credits. The new curriculum offered 6 mathematics elective credits, 15 EE elective credits, and 15 free elective credits.

Campus activism became ever more active through the year. In May 1970 the anti-war movement was galvanized when four students were killed at Kent State University in Ohio when the Ohio National Guard tried to break up a demonstration. On campuses across the nation students went out on strike. The principle immediate effect on Electrical Engineering was debate over how to deal with student grades, when students were away attending demonstrations.

In the long term, the May, 1970 national student strike was one of many events that came together to seriously impact the field of engineering. The first event was the publication in 1962 of *Silent Spring* by Rachel Carson. Credited with starting the environmental movement, the book's theme of technology destroying nature slowly gained ground in society. Anti-war activists also embraced environmental causes and anti-war demonstrations publicized these issues, portraying technology, not completely without justification, as the villain. It would take time for society to realize that technology was both the cause of environmental problems and the only feasible solution.

The second event was the abandonment in October 1968 of the Boeing swing-wing Supersonic Transport (SST) design. The reported reason was the discovery that the titanium hinges crucial to the design would crack when exposed to rainwater. Boeing shifted to a fixed wing design and panic mode, and started leaking engineers. The full effect would appear in March 1971 when Congress cut off SST funding and Boeing came close to foundering. This was the era of the famous billboard, "Will the last person leaving Seattle turn out the lights?"

The third event was the remarkable success of the American space program in the moon race. Apollo 11 landed on the moon in July, 1969. Immediately upon the safe return of the astronauts, NASA began closing down development activities in the space program. As is all too common in the aerospace industry, NASA contractors terminated projects and dumped a flood of engineers on the job market. Horror stories about PhD Electrical Engineers driving cabs because no better job could be found appeared in the media. Laid-off engineers paid for advertisement in the local press to discourage students to pursue engineering careers.

The effect of the anti-war protests was to sharpen public disapproval of technology. One of the protest sports was chasing Dow recruiters off campus, because Dow made napalm. Iconic protest images of B-52s raining down bombs were contrasted with flower power, sending the side message that technology is evil. The extrinsic appeal of engineering had been based on a combination of reliable job opportunities and social progress through technology. Now there appeared to be no jobs, and society was questioning the value of technology. Electrical Engineering enrollment would fall by a quarter over the next six years.

Amid the stagnant and eroding economy, in a mood of futility, the state legislators cut university funds. University President Odegaard had to make drastic cuts. Salaries were cut, hiring and purchasing were severely restricted. At least one department of the College of Engineering had to lay off faculty members. The difficulties in the Department of Electrical Engineering were only somewhat less bad. The department faced a 30% budget cut. In 1970 hiring was only possible to replace departing faculty. In 1971 hiring was not possible at all.

Ironically, the drop in interest and investment in engineering came as research funding in the department hit new highs. Research grants in 1970 were $1.5 million per year, corresponding to $7.6 million per year in 2005 dollars.

In 1970 Alistair Holden and Sinclair Yee were promoted to Associate Professor. Ryland Hill accepted the administrative task of Director of the Applied Physics Laboratory. This marked a major change in operation of the Laboratory, towards a more open model that better facilitated interaction with the rest of the University. No new faculty were hired. The undergraduate curriculum received a minor revision that increased elective credits by another 50%. The academic year saw two retirements: William Creedon and Floyd Robbins.

William Creedon had been hired in 1960 as a Lecturer. He and taught introductory courses and was the undergraduate advisor, a time consuming but important task. Floyd Robbins had been hired in 1946. Completing his E.E. degree in 1949, he had progressed to Associate Professor. His special interest was in the generation and distribution of electrical energy. He had excellent rapport with students, and arranged and supervised many student field trips to view local projects. He was a long time advisor to student branches of the AIEE and IRE, IEEE predecessors, and received a special award for his fifteen years as faculty advisor of students in these branches. He was a consultant to General Electric at Hanford in studies leading toward the generation of power from nuclear sources, and to the State Fisheries Department on the effects of dams on the spawning of fish. He retired as Associate Professor Emeritus.

Three faculty were promoted to full Professor in 1971: Irene Peden, Ed Guilford, and Chih-Chi Hsu. William W. Potter was hired as a Lecturer. Long lines of students waited patiently outside his office door for both course and career advice at registration time.

The moderate decline in engineering enrollment from 1960-66, accelerated by the events of 1969, led the College to form a committee to reconsider the undergraduate engineering curriculum. The committee named itself the CH^2A^2OS committee, appropriate given the times, after its members, Russ Chrisman, Bill Chalk, Bob Albrecht, Professor Ahlstrom, and Blair Osborn. The identity of the committee chair was long a tightly held secret, as the committee realized that the committee chair would take all the blame for its recommendations. However, in 2006 Bob Albrecht revealed his long-suspected but never before confirmed role as chair.

The CH^2A^2OS committee carefully studied the question of who the engineering students were and why they came to engineering. A notable finding was that engineering had the highest percentage of students whose parents had not attended college. They viewed engineering as the path to upward social mobility. The committee concluded that affluence was reducing the supply of such students, and that engineering was isolated from the rest of the campus, so that students in other areas who might want to pursue an engineering career faced high administrative barriers to entry.

The remedy proposed by the committee was to devise a curriculum that could be more easily entered from the rest of the campus, to promote interaction between engineering students and the rest of the campus, and to ease the transfer of students from community

colleges into the engineering program, as desired by the Higher Education Coordinating Board (HEC Board).

Recall that the old curriculum consisted of a common first year for engineering students featuring problem solving, drawing and surveying courses taught by the General Engineering Department, and a set of required humanities courses specifically for engineering students taught by the Department of Humanistic and Social Studies, with the rest of the curriculum left to the departments.

The revised curriculum had a common first two years, containing mathematics, science, programming and humanities requirements that could be acquired in community colleges, and engineering fundamentals courses. The fundamentals courses included writing, computation, linear systems and subjects such as mechanics and thermodynamics, which were of common interest to mechanical, civil, aeronautical and chemical engineers. The General Engineering courses were done away with, as was the department. Its faculty were dispersed to relevant departments. Charles C. Redeker, who had joined General Engineering in 1960, moved to Electrical Engineering.

The humanities courses could now be satisfied by taking courses from the College of Arts and Sciences, permitting engineering students to rub shoulders with the rest of the campus population. The Department of Humanistic and Social Studies now threw its courses open to the rest of the campus, but would not long survive the change. It eventually evolved into the Technical Communications department.

The college curriculum change was sweeping, but after a year of preparation was fairly smoothly implemented. Most of the committee's reasoning was justified by the results. The broad structure of the curriculum remains in place today. Enrollment in engineering recovered in the short term, and has been sustained in the long term. Engineering has continued to provide upward social mobility, notably to generations of immigrants. One disappointment has been that the expected increase in enrollment of underrepresented minorities did not occur.

The broad benefits of the CH^2A^2OS changes were less beneficial to Electrical Engineering. The committee had no Electrical Engineering representation. Bob Albrecht was fully in Nuclear Engineering at the time, and his controls expertise was not at the core of Electrical Engineering. The lack of representation shows in the engineering fundamentals topics, which had very limited electrical content. Students would now wait until the junior year to take their first circuits course.

The new College curriculum required major changes in the departments. Electrical Engineering adopted a less tightly scheduled curricular description. Henceforth there would be a core and then electives, and the core courses could be taken in any order constrained by prerequisites, rather than in specific quarters. This core and elective structure has persisted to the present day.

The core consisted of two circuit theory courses, an electronics course, a computer organization course, and two electromagnetics courses. Added to this were two three-credit laboratory courses, one on electronics and one on electrophysics. Notably the labs were not coupled with relevant courses, but stood on their own. Notably missing from the core were electrical machinery, signal processing and control systems. Signal processing as such was missing from both undergraduate and graduate elective courses. The elective credits were now 18 credits of EE, 4 technical non-EE and 21 free.

In 1972 Peter R. Metz left for the Boeing company. He had joined the department as an Instructor while working on his Ph.D., which he completed in 1965. He had worked in the biomedical area. Eugen Schibli left after five years on the faculty, and Kenneth O'Keefe after only three. All three were junior faculty, without tenure, whose careers were doing well, but not well enough. Budget pressure forced all three out of the Department. No hires were made in 1972.

In 1972 Professor Endrik Noges met Professor Paul M. Frank of the Technical University of Karlsruhe, Germany, through a mutual colleague. Professor Frank invited Professor Noges to spend his sabbatical at Karlsruhe. During the year they co-authored a book in German on pulse frequency modulated control systems. The visit would be the start of an extended collaboration.

At the end of the 1972-73 academic year Curtis Johnson left the department to advance his career, becoming Chair of the Department of Bioengineering at the University of Utah. Hired in 1968 as an Associate Professor he had immediately become Associate Director of the recently created Bioengineering Program and his career move was predictable. As Johnson worked in Bioengineering rather than EE, the effect of his departure on EE was not large.

In the same year Professor Arthur Harrison became Professor Emeritus. Harrison, a senior hire in 1948, had, with Walter Rogers, been the foundation for the remarkable success of the electromagnetics program at the University of Washington. He was not as active in research as later faculty in the program, but his stature provided some credibility to the department and his graduate instruction helped develop the program. His side line of research on Cascade range glaciers was exactly the sort of eccentricity expected of college professors.

Promotions in 1973 included Pete Lauritzen to full Professor and David Auth to Associate Professor. Ryland Hill became Dean. Associate Dean under the previous administration, Hill viewed his appointment as short term, as he was soon to retire. He tapped other EE faculty to help him. Myron Swarm was Hill's Associate Dean for Research, and Irene Peden became Associate Dean for College Relations, administering among other duties the College's affirmative action programs.

Faculty hiring started to recover from the state budget crisis, but not immediately in the tenure track. William E. Moritz, B.S.A.E. 1965, Rensselaer Polytechnic Institute, M.S. 1966, Ph.D. 1969, Stanford University was appointed Research Assistant Professor of

Electrical and Bioengineering in 1973. His thesis was “Transmission Characteristics Of Distension, Torsion And Axial Waves In Arteries.” Although his Ph.D. was nominally in Aeronautics and Astronautics, he was clearly a bioengineer. Raymond Heald, who was interested in a strange new concept called integrated circuits, was hired as an Assistant Professor.

The year 1973-74 saw Don Baker implement the previously described technology transfer of pulse-doppler ultrasound technology to ATL. This was the first major technology transfer of electrical engineering technology from the University of Washington.

In 1974 Robert Pinter was promoted to Associate Professor. Walter Rogers retired. Hired in 1946 with an M.S. degree, he had published a textbook on electric fields, and had supervised the graduate program during its formative period, aiding the build up of the research infrastructure of the department and the electromagnetic program. He became Professor Emeritus.

Graham Duff, who worked in the electromagnetics area, left after seven years on the faculty. Duff had developed some differences with the Department that motivated his departure. Raymond Heald left after only one year. He felt that a fabrication laboratory was essential to his research, but there was not one on campus, and he saw no immediate prospect of building one. Sinclair Yee was promoted to full Professor.

In 1974 the Computer Science Program cast loose its nominal ties to its host departments and grew into a full-fledged Department of its own. Jerry Noe became the first Chair. The Department occupied the General Engineering Building, renamed Sieg Hall in 1972. The faculty of Electrical Engineering and Computer Science who now became Computer Science faculty were Noe, Hellmut Golde and Jean-Loup Baer. Other computer-oriented faculty such as David Johnson, Alistair Holden and Laurel Lewis, remained in the EE department.

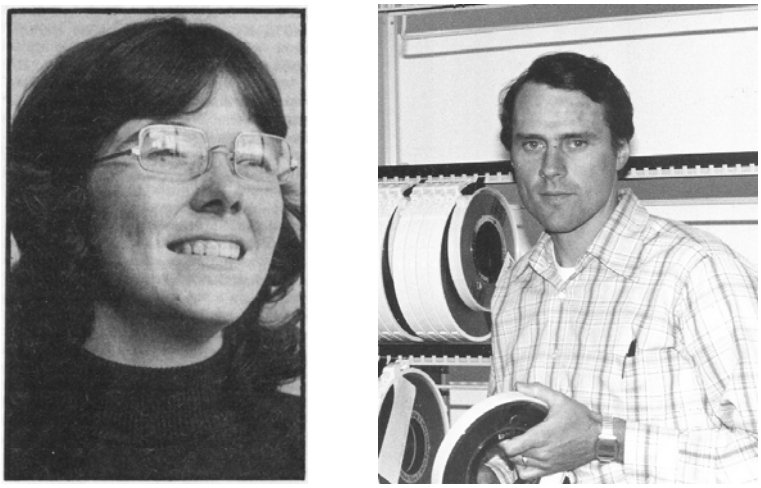


Figure 98. Right: Assistant Professor Patricia Daniels, 1974. Left: Assistant Professor Greg Zick, ca. 1974. (*Trend* photos)

Two new faculty started in the fall of 1974. Patricia Daniels, B.S. and Ph.D. in Electrical Engineering and Computer Science, Berkeley, was the second female tenure track faculty hire in the department. Her thesis was “Vestibular Unit Activity In The Alert Monkey During Visually And Rotationally Induced Eye Movements.” She was expected to generate closer interaction with Bioengineering, but in the event her interests did not fit as well as was hoped. She worked in control systems. Gregory Leonard Zick, B.S.E.E. 1970, Illinois, M.S. 1972, Ph.D. in Biomedical Engineering 1974, Michigan, was appointed Assistant Professor. His thesis was “Direct Determination Of The Oxygen Tension Of Intracardiac Blood By Pulsed Electrode.” He would, however, develop an interest in computers, which stemmed from the need to manage the data he collected in the lab.

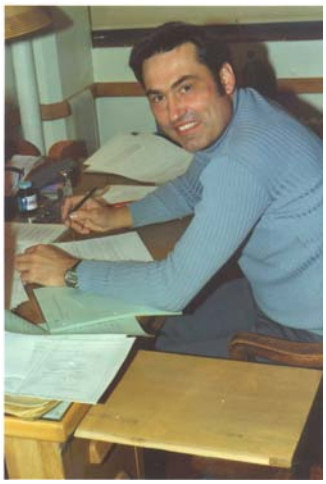


Figure 99. Professor Paul M. Frank, Visiting Professor at Washington in 1975. (EE Department photo)

In 1974-5 Professor Endrik Noges repaid his 1972 sabbatical in Karlsruhe by hosting Professor Paul M. Frank at Washington. During his visit, Professor Frank became interested in Professor Clark’s work on fault detection.

At the end of the 1974-75 academic year, and thus the end of this chapter’s decade, Professor Jay Harris left for the National Science Foundation. He would go on to become Dean at San Diego State.

The decade of 1965-75 had opened with the Electrical Engineering department in a state of constant growth The slow decline in undergraduate enrollment reversed early in the decade, rising to a peak in 1970. Faculty numbers also continued to increase, peaking at 41 in 1969. The department had fully embraced a very successful transition to new paradigm of funded research. Growth in enrollment and faculty was matched by an expansion of the physical plant, with a fourth floor added to the new building. In keeping with the new faculty hiring mode, an outside chair was sought when Austin Eastman retired, and a chair with a successful record of research management in industry was obtained. Research reached a near-apogee in 1970. The department had also adjusted adroitly to the new college curriculum of 1971, adopting the core and elective model that

has lasted to the present day. Things looked good. Continued growth and continued improvement seemed inevitable.

Then the wheels came off. The economic slump of the early 1970s, made more intense in the Puget Sound region by Boeing's misadventure with the SST, caused the state to make significant cuts in the University's budget, leading to the essential halt of faculty hiring for several years and the need to bid farewell to several untenured junior faculty. Funding for antenna research dried up just as the department completed a major facility for exactly that purpose, a first check to the dominant area of electromagnetics. The controls area reached maturity and the electronics area showed growth over the decade. In computers, the department acted as one of the administrative sponsors of the Computer Science program, watching it achieve independence as the Computer Science Department. The separation would not be especially beneficial to the faculty with interests in computing who remained in the Electrical Engineering department.

The bioengineering area was a source of beneficial interaction for the department, although many of the projects, while electrical in nature, were not as closely integrated with the department as one might think. Don Baker's laboratory space in the EE building, for example, was not accessible to the department chair, unlike laboratories belonging to EE professors.

After five years of impressive growth, state policy decisions had checked the rush to excellence. It would take time for the EE department to regain its lost momentum.

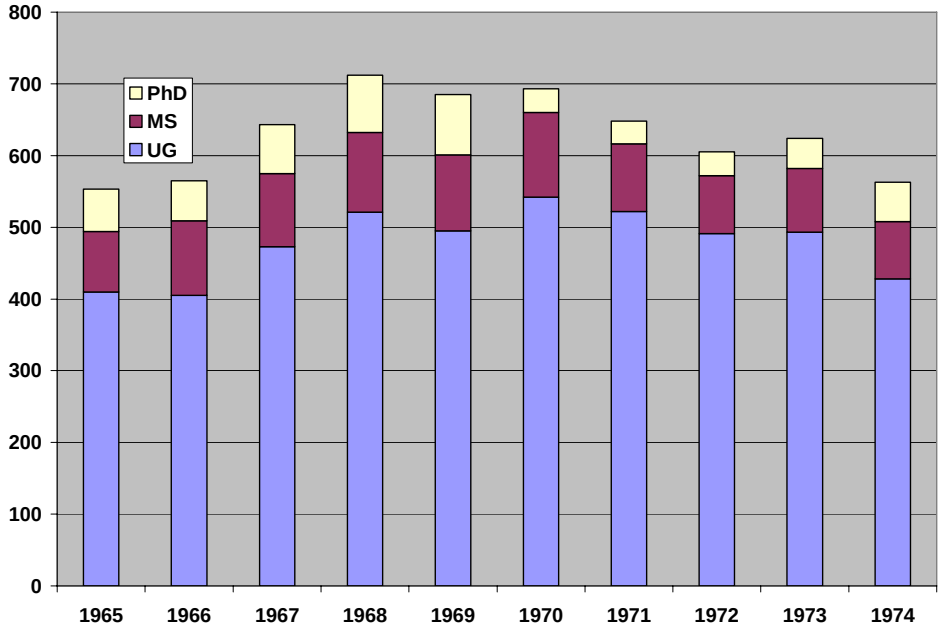


Figure 100. Total Enrollment in Electrical Engineering, 1965-1974. The fall in enrollment after 1970 is due to layoffs caused by the end of the Apollo program, and the rise of environmental concerns. The first created the impression that engineering jobs would be hard to obtain. The second held engineers responsible for pollution, making the field socially unpopular.

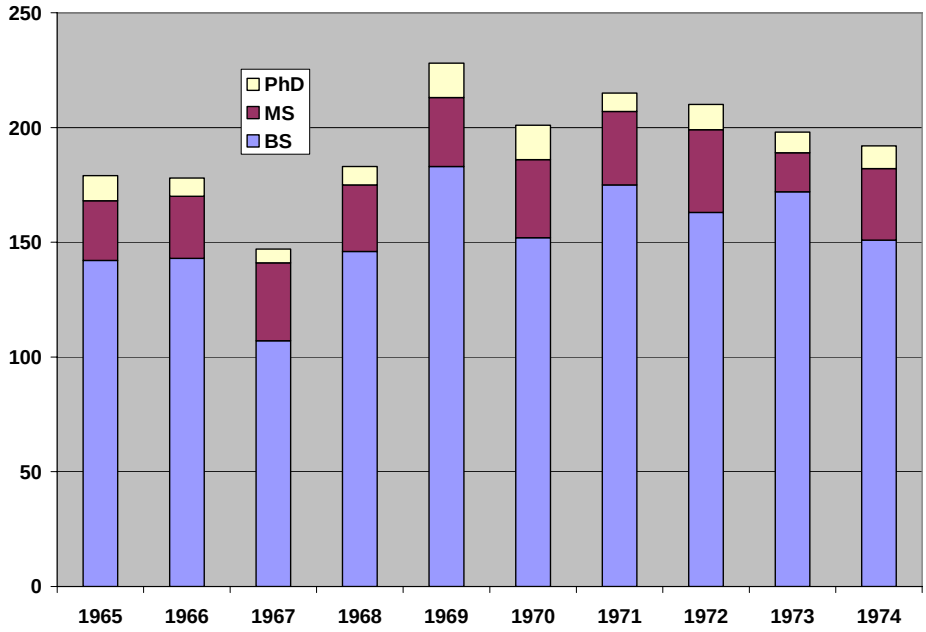


Figure 101. Electrical Engineering degrees granted, 1965-1974.

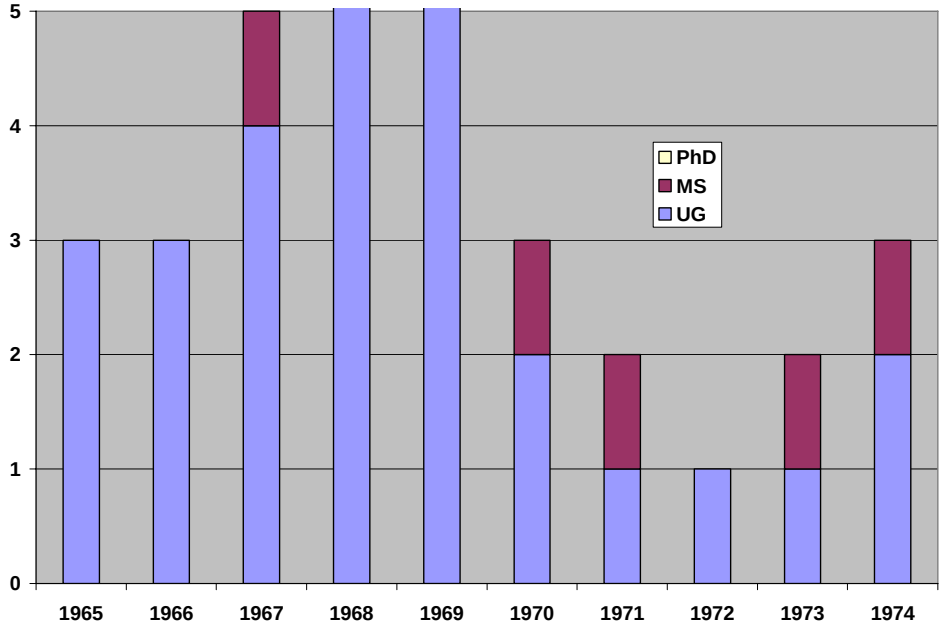


Figure 102. Electrical Engineering female enrollment, 1965-1974.

1975-1985 Steady State

Figure 103. UW Husky, 1980s.

The 1970s can loosely be said to start after the US withdrawal from Vietnam in 1973. It was an era of bad hair, bad music and stagflationary economics. Almost everything seemed to go wrong. The Vietnam War destroyed the sense of optimism that had characterized American society since the end of World War II. OPEC slapped an embargo on oil exports in 1973 to punish the United States for supporting Israel in the Yom Kippur war. Though the embargo and its gas lines were short lived, OPEC continued to fix oil prices, doubling gas prices overnight and creating fears about energy shortages. NASA's glory days ended in 1972 when the agency turned from putting a man on the moon to building an orbital pickup truck. In 1974 President Nixon was caught on tape covering up a second rate burglary and had to resign to avoid impeachment.

Despite the national malaise, technical innovation continued apace. The first hints of what are now major technologies appeared. In 1967 Transit navigation satellites were made available to the public. Transit was a precursor to GPS with limited functionality. ARPANET went on line in 1969. It was used by a few computer geeks on opposite coasts to send messages to each other. The messages quickly acquired the name "e-mail." Spice appeared at Berkeley in 1971, the same year Intel invented the first microprocessor, the 4004. Its instruction set, much expanded, can still be found in current Intel processors. In 1972 Atari released the first video game, *Pong*. Computer assisted tomography and magnetic resonance imaging, both competitors to Don Baker's ultrasound work, were developed in 1972 and 1973 respectively. In 1975 a couple of young entrepreneurs in the Seattle area founded a company to write programs for the new microprocessors. It was called Microsoft.

No new Electrical Engineering faculty were hired for the 1975-76 academic year. Undergraduate enrollment was flat, which was an improvement compared to the decreases of the preceding three years. The major news of the academic year was the retirement of Dean Ryland Hill.

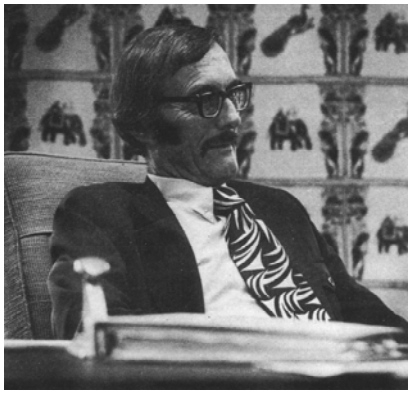



Figure 104. Left: Dean W. Ryland Hill discusses his retirement in 1976. Right: Ryland Hill (at left), probably on Mount Rainier. (*Trend* photos)

William Ryland Hill was an undergraduate at the University of Washington, graduating with a BSEE in 1934. After working for a small electronics company, he obtained an MS and the Electrical Engineer (E.E.) professional degree from Berkeley in 1939 and 1940, respectively. He was hired as faculty at Washington in 1941. He is remembered as the most well-liked professor in the department during his tenure by students and fellow faculty. He was funny and supportive. He always had a kind word and guided junior faculty through the sometimes-hostile world of faculty politics. Considered an excellent teacher, he wrote a well-received textbook on electronics intended for non-electrical engineers. He published research papers, but did not have an extensive funded research career. He did far more than his share of service to the department, the University and the world. He served on the University School Executive Committee, the Freshman Year Committee, and the Commission on the University Senate. From 1957-58 he took leave to be head of electronics at Madras Institute of Technology in India. In 1959 he became Associate Dean. In 1967 he traveled the world for UNESCO, visiting Europe, Cairo, Buenos Aires and Santiago de Chile. In 1968 he operated a short course in technology for Boeing Mangers. From 1970-73 he did an important but difficult job as Director of the Applied Physics Laboratory as it transitioned from a closed shop doing classified work to a more open interaction with campus. He maintained the respect of most of the lab personnel even though they were unhappy with the mandated changes. Hill capped his career by serving as a transitional Dean for three years, stepping down at the mandatory retirement age of 65. In his spare time, Hill was a mountain climber, summiting Rainier five times. He brought his technical abilities into the mountains, making sound movies of his climbs, carrying a camera and a tape recorder. Ryland Hill passed away in 1988.

The 1976 catalog marked the advent of political correctness on campus. Dan Dow, referred to as Chairman of Electrical Engineering in the 1974 catalog, was now Chairperson. More positive aspects of this change in institutional attitude were rising concerns about the level of enrollment of women and minorities, and the advent of programs to encourage and assist them. Promoting the enrollment of women in engineering had been a long time interest of Professor Irene Peden, who had devoted time and attention to this issue throughout her career, most recently in her capacity as Associate Dean. Minority enrollment had been a professed objective of the 1972 CHAOS engineering curriculum revision, although the expected increase had not come to pass. Other ways would now be found to encourage it.

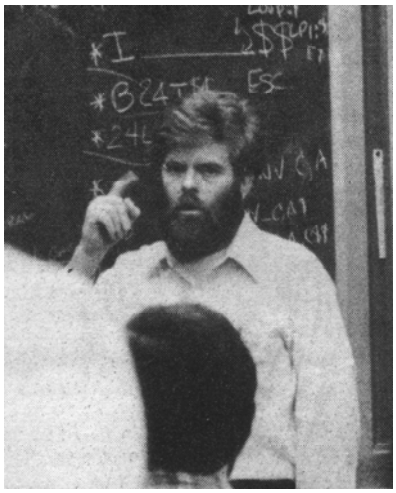


Figure 105. Assistant Professor Bill Moritz in the late 1970s. The full effect is lost in this black and white photograph. He had bright red hair. (*Trend* photo)

Two new faculty arrived in 1976. Bill Moritz, research faculty jointly in Electrical Engineering and Bioengineering, successfully transitioned into the tenure track, becoming an Assistant Professor of Electrical Engineering. His first course offering was a Medical Instrumentation senior elective. Van E. Mablekos, B.S.E.E. and M.S.E.E. from Wisconsin, Ph.D. 1969 Virginia Tech, was hired as an Associate Professor of Electrical Engineering.

Mablekos' hiring represented a new strategic initiative for the Electrical Engineering Department. Despite the department's pre-war eminence in power engineering, Austin Eastman had at some point made a gentleman's agreement with Washington State University to leave the power engineering to Pullman. The existing faculty in power engineering were not replaced as they retired. However, utilities in the Puget Sound region, especially Puget Power, now lobbied for a power program in the Seattle area. Department Chairperson Dan Dow eventually made the decision to reinvigorate the area, and Mablekos was hired. His wife Carole obtained a position in the Humanistic-Social Studies department.

The Trend In Engineering published a list of research projects in Electrical Engineering in January 1977. The list was dominated by biomedical applications, notably but not exclusively David Auth's work on medical application of laser endoscopic surgery. The National Institutes of Health was the primary funding agency. Control and electromagnetics work also appear. The list reflects the strategic focus on biomedical work revealing in recent faculty hiring and also the ability of Dr. Robert Rushmer to attract talented researchers to medical problems.

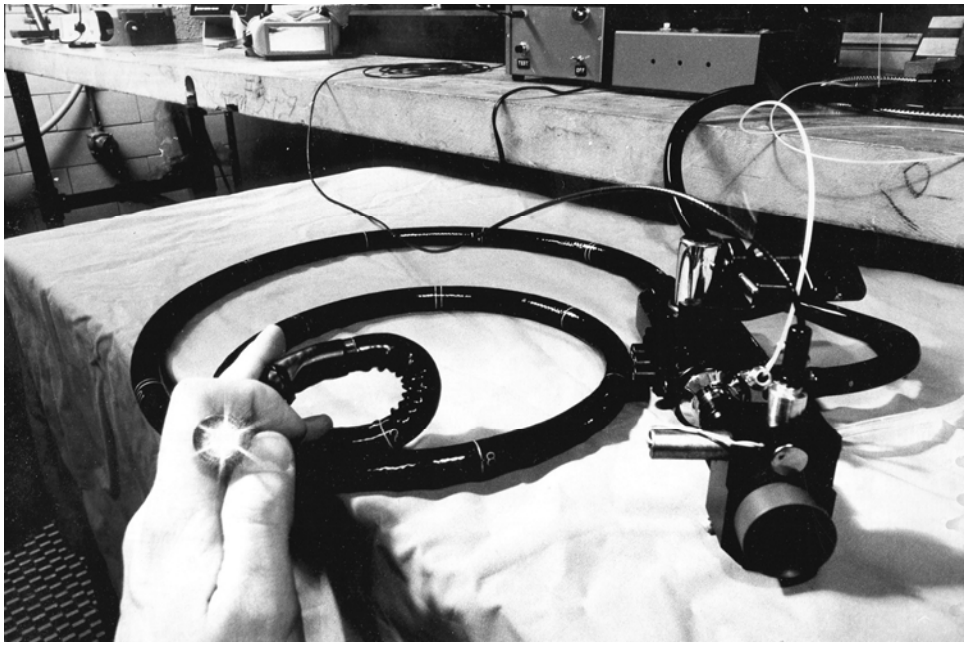


Figure 106. Laser endoscope from Professor David Auth's research project, 1977. (*Trend* photo)

In 1976-1977 Professor Robert N. Clark spent the year on sabbatical as a Visiting Scientist at the Fraunhofer Institute in Karlsruhe, at the invitation of Professor Paul M. Frank. He was the second controls faculty to visit with Frank. During the year, Professor Frank became Professor of Automatic Control in Electrical Engineering at the University of Duisburg, which later became Gerhard Mercator University. He invited Professor Clark to Duisburg to inaugurate a joint colloquium in Automatic Control between the Electrical and Mechanical Engineering Departments.

In 1977 Professor F. Paul Carlson became President of the Oregon Graduate Center, now the Oregon Graduate Institute. Carlson had been Akira Ishimaru's graduate student and was hired as an instructor two years before he completed his Ph.D. in 1967. In ten years of work Carlson had successfully pursued optical research topics, and in particular optical processors. He had competed in this area with Jay Harris. With a broader executive vision than Harris, Carlson commanded the backing of the department chair, a factor in Harris' departure to the NSF. Carlson now followed his administrative ambitions out of the Department. After the Oregon Graduate Center he went on to Vice President of Strategy and Business Development at Honeywell, then was a board member for many technology companies and a consultant. Carlson's formal separation from the Department would be in 1980. The necessary three years of leave were negotiated between Department Chair Dan Dow and the Provost, because Carlson's brother was Dean.

In 1977 Betsy Ancker-Johnson departed from the University. Now an Affiliate Professor, highly placed at Boeing Research Laboratory, Ancker-Johnson was often on campus and was active on a number of research projects and student committees. However, when Boeing's financial straits caused a drawdown in their research staff, Ancker-Johnson looked elsewhere for work. Also in 1977, Alistair Holden and David Auth were promoted

to Professors of Electrical Engineering, and Akira Ishimaru became a Professor of Electrical Engineering and Applied Mathematics.

The big news in 1977 was the chair succession. Dan Dow's hiring in 1968 had set a new paradigm for department chairmen. Henceforth they would serve at the pleasure of the Dean and be subject to a review in the sixth year. The "pleasure of the Dean" had not sat well with existing chairs of the time. At his review in 1974 Dow had agreed to serve only another three years, and by the end of that time he was done being a chair. He had not been fortunate in the timing of his tenure, being hit with a budget crisis that required him to essentially fire three junior professors and suspended hiring for several years, derailing his strategic plans. The difficult times made for difficult relations with some of the faculty. All acknowledged his integrity as chair.

Upon stepping down, Dow became Associate Director of the Applied Physics Laboratory. APL was still struggling with the transition to a more open laboratory. One of the requirements placed on the lab was that the director be a tenure-track faculty member. This had caused some difficulties, as the Director after Ryland Hill did not have a strong academic record and the faculty had been reluctant to approve his tenure. The lab was regarded with suspicion in the post-Vietnam anti-military climate on campus. The new director came from inside the lab, but was committed to openness. Having Dow as Associate Director was viewed as sufficient to meet the tenured faculty requirement.

Dow's tenure as chair saw the department move in two strategic directions. The first was biomedical research. Building on the success of Rushmer's ultrasound work, the department hired faculty in the area, and other faculty were persuaded to work on biomedical projects. It is fair to say that biomedical research was the major research effort in the department at this time. The second strategic thrust was the new reinvigoration of power engineering.

Figure 107. Professor and Department Chair Jim Meditch in 1980. (*Trend* photo)

Dan Dow's successor as chairperson was James Stephen Meditch, B.S.E.E. 1956 Purdue, S.M. 1957 M.I.T., Ph.D. 1961 Purdue. Meditch had moved back and forth between industry and academia, and was Professor and Chair of Electrical Engineering at the

University of California at Irvine prior to becoming department chair at Washington. Author of a textbook on estimation and control, by the time he came to Washington he was working on computer communication networks. Meditch arrived on campus in 1976 as a visiting professor on sabbatical. He was, in a sense, an inside-outside candidate, since he nominally came from another University but was on campus interacting with the faculty during the search. Meditch would aggressively continue to transition the department to a research model.

Figure 108. Robert J. Marks II in the late 1980s. The top of the photograph has faded from exposure to sunlight. (EE Department photo.)

Arriving on campus in 1977 was Robert Jackson Marks II, B.S.E.E. 1972, M.S. 1973 Rose-Hulman Institute of Technology, Ph.D. 1977 Texas Tech University. Appointed Assistant Professor, Bob Marks was the first pure signal processor to appear in the Department. Prior to his arrival, faculty in various areas had dealt with signal processing as a part of the larger problems they studied, rather than considering it as an area in its own right. As bandwidth and computational capacity increased, the signal processing area became broad and deep enough to stand on its own. Bob Marks dealt with optical information processing, image processing, and signal analysis.

In 1977 the core of the undergraduate curriculum was restructured to reflect the change in department strategic direction. The first circuit theory course was renumbered with a sophomore year number, although it probably did not meet the CHAOS intent of having course content with a college-wide interest in the sophomore year. A second course in electronics was added, and a course in linear systems. From its syllabus, the latter looks a lot like a continuous time signal processing course. Finally, a course in energy systems and devices was added, reflecting the department initiative in this area. The electro-physics laboratory lost one credit, but the rest of the added credits came from electives.

A second major change was the announcement of a Computer Engineering program in Electrical Engineering. The program was primarily the work of Bill Moritz, with help from Greg Zick, both Assistant Professors. Alistair Holden and David Johnson were also involved. The program introduced four new senior electives on computer architecture and microprocessor systems, with a fundamentals course in digital logic for freshmen. The

decision to go ahead with Computer Engineering was based on the rising importance of microprocessors and the absence of a hardware component in the Department of Computer Science. However, Computer Science regarded anything to do with computers as their turf, and did not especially welcome the initiative from Electrical Engineering. Students, however, flocked to the program. The area was something of a departure for both Moritz, whose early work was in biomedical instrumentation, and for Zick.

In other news, Mark Damborg spent the year on leave in Washington D.C. with the Department of Energy. Myron Swarm became Associate Dean for Research in the Graduate School, while Irene Peden returned to Electrical Engineering from the Dean's Office. Affirmative action programs for minorities appeared with the MITE (Minority Introduction To Engineering) program, which aimed to bring minority high school students on campus and expose them to the existential pleasures of engineering. *The Trend* reported that Randy Jones, EE senior, won 2nd place in the Conference on Systems and Devices for the Disabled undergraduate competition for a bite-switch controlled human interface to a Selectric typewriter. The academic year concluded with the promotion of Bill Moritz and Greg Zick to Associate Professors.

The January 1978 *Trend In Engineering* contained another list of Electrical Engineering research projects. The list continued to be heavily biomedical in orientation, with NIH as the funding agency for most of the funded projects. Principal Investigators on funded projects (not all NIH) included Afromowitz, Alexandro, Auth, Baker, Daniels, Ishimaru, Moritz, Pinter and Yee. Funded research is given as $800K/year, corresponding to $2.4 million per year in 2005 dollars. This is about one third of the 1970 constant dollar research volume. The drop off was due in part to the inability to hire aggressively during the early 1970s. Although both Dan Dow and Jim Meditch are credited, correctly, with continuing the departmental transition to a research culture, the effects did not show in the funding area.

In 1978 Professor Van Mablekos died of a heart attack at age 48. The loss was sudden, only a few weeks from the first symptoms until he died one evening at home. It was a major setback for the power engineering initiative. Since arriving at Washington Mablekos had reformed the power curriculum, introduced several new senior and graduate courses and gotten a power course into the core. He was also working on a textbook, *Electrical Machine Theory for Power Engineers*, which was published posthumously. Mablekos had been under a lot of self-imposed stress since arriving, amplified by the department's inability to provide additional support in the form of junior faculty and staff. In the words of one professor "he was expected to be Superman, and he tried to be Superman."

Curricular change in 1978 was limited. Communications theory expanded to two courses in the senior electives, and new microprocessor courses were added. A second course in power systems analysis also appeared. Jim Meditch introduced a graduate course in computer networks.

Meditch's arrival did not bring an immediate influx of new faculty. Martin Afromowitz, B.S. 1965 M.S. 1966 School of Engineering and Applied Science of New York, Ph.D. 1969 Columbia, was hired as a Research Assistant Professor in 1978. His thesis was

"An Investigation Of The Effects Of Charged Impurities On The Shape Of The Fundamental Optical Absorption Edge Of Gallium Arsenide." He worked on optical systems. Darrell Jackson, B.S.E.E. 1960 M.S.E.E. 1963 Ph.D. 1966 Washington, Ph.D. in Physics 1977 Cal Tech, was appointed Research Assistant Professor of Electrical Engineering. Jackson's E.E. Ph.D. advisor was John Bjorkstam, and he worked on magnetic resonance. His physics Ph.D. dealt with gluons. In 1978 Jackson was and would continue to be a full time researcher at the Applied Physics Laboratory working with ocean acoustics and signal processing. His research faculty appointment allowed him to supervise EE graduate students funded by the APL. Jackson would have research collaborations with Professors Leung Tsang and later Jim Ritcey. His appointment illustrates the current mode of interaction between APL and the Electrical Engineering department.

National attention was riveted on advanced technology in March 1979 as the accident at the Three Mile Island nuclear reactor dominated press coverage. The upshot was a further erosion in the public image of technology. No wonder the College of Engineering visiting committee, headed by Electrical Engineering alumnus John Fluke Sr., expressed concern about the lack of University support for the College. Despite the negative publicity, excellent students continued to seek engineering educations. Electrical engineering students took three of the four faculty medals in Spring 1979. The medals were awarded for the best academic performance in each class. Sheri Kaye Kingma and Bror V. Saxberg tied for the junior faculty medal. Keith F. Anderson received the sophomore faculty medal. Electrical engineering students took second prize in an Intel design contest, winning a development system for the department. Bruce Honda and John Kotwitz were the student team, based on a project from EE 479 Microcomputer System Design, instructed by Bill Moritz. Mark Damborg became the Graduate Program Advisor.

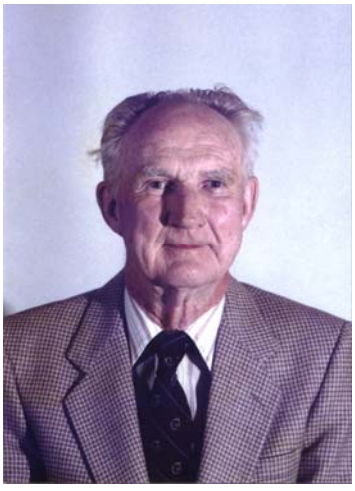


Figure 109. Left: Professor Emeritus Laurel Lewis in the late 1980s. Right: Professor Emeritus Robert Bergseth in the late 1980s. (EE Department photos)

Laurel Lewis and Bob Bergseth became Professors Emeriti in 1979. Hired in 1946, as the third Ph.D. on the faculty, Laurel Lewis worked on power system analysis and relaying problems in an extended study with the Bonneville Power Administration, becoming an

early user of digital computers for power system analysis. In his later years he became increasingly interested in the computer topic. For the last five years of his career he was Secretary of the Faculty, a very sensitive and time-consuming job acting as an advocate for the faculty in dealing with the administration.

A 1937 Washington graduate, Robert Bergseth, was hired in 1947. He taught power systems courses and worked on an electronic relaying project with the Bonneville Power Administration. He was a strong advocate for licensing engineers, working to establish the State Board of Engineering Examiners, which administers licensing, and serving as its chairman. He assisted Edgar A. Loew on the fourth edition of *Direct and Alternating Currents* in 1954, and in 1969 co-authored with F.J. Alexandro, L.J. Lewis and D.E. Reynolds the textbook *Linear System Analysis*. Bergseth also served in department administrative roles.

Another departure in 1979 was Don Baker's ultrasound research effort. A review panel from NIH decided that new results were unlikely from the existing project and funding was terminated. While Baker's research funding went through the Bioengineering department, he employed a number of electrical engineering students in his lab, and various faculty had had projects related to his work. His departure was a blow to the department. *The Trend* reported that ATL payments to the University in 1979 as part of the technology transfer program were in the $100–200K/year range.

Figure 110. Professor Mani Venkata at a faculty retreat circa 1980. (*Trend* photo)

The Department persisted in its strategic initiative to revitalize the power area. Subrahmanyam Saraswati (Mani) Venkata, B.S.E.E. 1963 Andhra University, India, M.S. 1966 Indian Institute of Technology, Ph.D. 1971 University of South Carolina, was hired away from West Virginia University as a full Professor of Electrical Engineering. Both sides of the hiring negotiation were cognizant of recent events. Significant additional support for the power initiative was forthcoming in promises to hire junior faculty in the power area and provide significant laboratory and administrative support. Venkata's energy, enthusiasm, research acumen and interpersonal skills would repay the department's investment.

Among faculty advancements and honors in the 1979-1980 time frame, Bob Clark became Associate Chair. Ward Helms was advanced to Associate Professor, and Bob

Albrecht to full Professor of Nuclear Engineering and Electrical Engineering. Sinclair Yee became a Fellow of the IEEE. Jim Meditch served as president of the IEEE Control Systems Society, and Irene Peden chaired the accreditation committee of the Accreditation Board for Engineering and Technology. In the same year the Department received $310K in equipment gifts from HP, Tektronix, TI, Intel, Motorola, Signetics, and Fluke.

In May 1980 Mount St. Helens erupted, a landmark event in the Pacific Northwest. It was also in 1980 when IBM obtained a non-exclusive license for a disk based operating system from a small and relatively unknown software company in the Pacific Northwest.

In 1980 the department lost an outstanding researcher. Professor David Auth left the Electrical Engineering department to become founder and Chief Executive Officer of Heart Technologies, Inc. Auth arrived in 1969 with a Ph.D. in physics dealing with lasers. He was quickly influenced by Robert Rushmer to work on medical applications of lasers, and achieved rapid success. He focused on using high-power lasers for surgery inside the body, using endoscopic instruments to deliver laser energy to the right location, initially in the intestinal tract. He extended the concept to use lasers to burn out the plaque that blocks coronary arteries and causes heart attacks. The commercial potential of such a technology was sufficient to attract funding for a startup company. In the event, problems with a laser based approach led to the development of the Rotablator, a mechanical plaque remover for arteries, which was a commercial success. Heart Technologies was sold to Boston Scientific in 1995. Auth's teaching and research areas included lasers and electro-optical system design, electrophysics, and medical instrumentation. He was chairman of the Technical Program Committee of the 1980 IEEE/OSA conference on laser and electro-optical systems and a member of the editorial board of Lasers in Surgery and Medicine. In 1985 he became an affiliate Professor of Electrical Engineering and Bioengineering.

In 1980 Pat Daniels took a leave of absence to serve at the National Science Foundation. The curriculum added a Computer Engineering Laboratory, EE 372, to the core. Pete Lauritzen introduced a graduate course in power electronics.

Figure 111. Professor Mohamed El-Sharkawi in 1999. (EE Department photo)

In 1980 Mohamed El-Sharkawi, B.Sc. 1971 Cairo High Institute of Technology, M.S.Sc. 1977 Ph.D. 1980 University of British Columbia, was hired as an Assistant Professor of

Electrical Engineering. His Ph.D. was “Modelling and Parameter Estimation of Unknown Large Power System Dynamics.” He was the first junior faculty hired as part of the power systems strategic initiative.

Figure 112. Professor Myron Swarm, date unknown. (EE Department photo)

In 1981 Myron Swarm retired and was appointed Professor Emeritus. A UW graduate with a BS from 1940 and an MS from 1950, Swarm was a successful electromagnetics researcher working in antennas and propagation. With Don Reynolds he was a key investigator in the Antarctic propagation research project. In his later career he had performed important administrative service as Associate Dean in the College of Engineering and later as Associate Dean for Research in the Graduate School.

The Puget Sound Engineering Council in 1981 named Professor Emeritus F. Robert Bergseth its Engineer of the Year, recognizing his leadership and service on the State Board of Engineering Examiners.

In 1981 the Electrical Engineering department had one of the three Industrial Affiliates programs in the College of Engineering. Its members included Fluke, Physio-Control, Honeywell, Boeing, ATL, Tektronix, Intel and IBM. The affiliates were faced with the problem of a 5.5% budget reduction, the University being in an extended budget crisis. The Dean’s discussion in *The Trend* implies that budget problems were the cause of an enrollment drop from 2000 to 1350 in the College of Engineering since 1978. Electrical Engineering undergraduate enrollment had dropped from 521 to 425 in the same interval, a lower proportion but still of concern. Ph.D. enrollment also hit a low in 1981. The Dean’s plaint must have been effective, since Electrical Engineering enrollment would now climb through 1985.

In conjunction with the budget crisis, there was no new faculty hiring in 1981. Professor Dan Dow returned full time to teaching. After his time at APL Dow had been Director of Washington Energy Research Center, an organization formed to promote alternative energy in the energy crisis of the mid-1970s. As the crisis eased, so did opportunities in the alternative energy field. Dow would devote himself to basic undergraduate instruction and laboratories. Research Assistant Professor Marty Afromowitz was promoted to Research Associate Professor of Electrical Engineering.

In 1982 Robert J. Marks II was promoted to Associate Professor. Linda Lou McGee, B.S.E.E, received the President's Medal, awarded to the student graduating with the highest academic accomplishment. McGee had won faculty medals as a sophomore and junior. The undergraduate curriculum again saw minor changes. It now required ENGR 190, Introduction to Logical System Design, as an engineering fundamental. The core grew by two credits, in the electronics and power areas. Professor Venkata replaced a senior level transmission lines course with a course in distribution systems, of especial interest to local utilities. Optimal Control and Estimation expanded from one to three courses in the graduate curriculum, while graduate courses specific to retiring faculty were also retired.

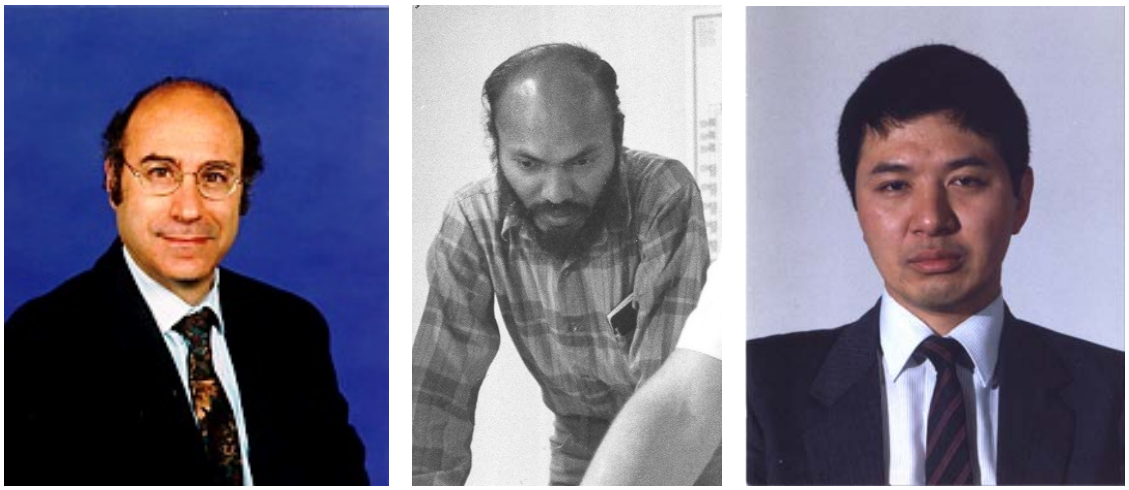


Figure 113. From Left: Professor Marty Afromowitz in 1999 (EE Department Photo); Mani Soma as an Assistant Professor in the 1980s (*Trend* photo); Yongmin Kim as an Associate Professor in the late 1980s. (EE Department photo)

The budget crisis of 1981 had passed, and Electrical Engineering could finally hire. Four new faculty were brought in. One was perhaps not completely new. Martin Afromowitz was promoted to Associate Professor of Electrical Engineering and Bioengineering. His strong research performance enabled him to make the difficult transition from research faculty to the tenure track. Mani Soma, B.S.E.E. 1975 B.A. 1975 California State University, M.S. 1977 Ph.D. 1980 Stanford University, was appointed Assistant Professor of Electrical Engineering. His thesis was "Design and Fabrication of an Implantable Multichannel Neural Stimulator." His bioelectronic interests would eventually lead to work on digital test problems. He also worked with computer-aided design and device modeling. Yongmin Kim, B.S. 1975 Seoul National University, Korea, M.S. 1975 Ph.D. 1982 University of Wisconsin, was appointed Assistant Professor of Electrical Engineering. His thesis was "Three-Dimensional Modifiable Computer Body Model and Its Applications." Kim would focus strongly on medical imaging in his research. Peter F. Swaszek, BSEE New Jersey Institute of Technology, Ph.D. Princeton 1982, was hired as an Assistant Professor of Electrical Engineering. His thesis was "Robust Quantization, Vector Quantization and Detection." His area was communication systems.

Since 1972 there had been visiting back and forth between controls faculty and Professor Paul M. Frank, now at the Gerhardt Mercator University (GMU) of Duisburg. In 1982 the relationship was formalized by the signing of an exchange agreement between the universities. Students and faculty would move back and forth between the universities under the terms of the agreement. Professor Robert Clark, who provided most of the information on this topic, spent the 1983-84 year in Duisburg as the first faculty member to participate in the agreement. He was followed in subsequent years by Professors Rubens Sigelmann, Dean W. Lytle, Jonny Anderson, and S.S. Venkata. Several other faculty have spent shorter sabbatical leaves there, and many have visited GMU to give invited lectures or to confer on research problems with colleagues in the Electrotechnik faculty there. At one time more than 40 percent of the faculty had been on such visits in Duisburg. A like fraction of the GMU Electrotechnik faculty made similar visits to Washington.

The congenial relationships which began in Electrical Engineering led to similar interaction between colleagues in the Mechanical Engineering, Aeronautics & Astronautics, and Civil Engineering departments and their counterparts in Duisburg. Faculty members of the Washington Physics, Chemistry, and Mathematics departments have also made fruitful Duisburg connections through this program. There have also been numerous exchanges between UW and GMU faculty in the History, Education, Asian Languages, International Studies, Sociology Psychology, Business Administration, and other units of the University including Germanics.

On the student side, many graduate students from GMU came to Seattle and completed MS and Ph.D. degrees at the UW. Some UW graduate students in Engineering went to Duisburg to pursue research coupled to their UW degree programs. Interestingly, contrary to the University of Washington where students are required to pay tuition, in Germany universities are free. This required special arrangements for tuition waivers, or other financial aid to be made at Washington for the visiting German students. Language is normally not an impediment for the visiting Germans, whereas it frequently is a problem for the visiting US student expecting to attend lectures in Germany.

Although money had finally been found to support hiring in Electrical Engineering, the University was still looking for ways to trim its budget. It decided it could dispense with a number of professors in the liberal arts, on the upper campus, and offered a relatively lucrative early retirement program. Three electrical engineering professors took advantage of the opportunity and were appointed Professors Emeriti.

Don Reynolds was close to retirement age and thus did not retire especially early. He had come to the department in 1959 as an experienced senior faculty member with terms in Brazil and at Seattle University. His research had been at the Seattle Antenna Range and on the Antarctic VLF Propagation project, where he played a major role. He consulted for Boeing and for Minneapolis-Honeywell. Professor Reynolds died in January 1992.

Figure 114. Left: Professor Don Reynolds, probably in the late 1970s. He is demonstrating an antenna (out of the picture to the right) (*Trend* photo). Right: Professor Emeritus John Bjorkstam in the late 1980s (EE Department photo).

John Bjorkstam was barely within the limits of the early retirement program and was quick to seize the opportunity. He had spent his entire career at Washington from undergraduate to Emeritus. His research stayed focused on the magnetic resonance properties of solid state materials. He would continue to work and teach in the department long after his formal retirement.

Ed Guilford also took the early retirement opportunity. He had taught and worked in the area of energy conversion applied to power systems, broadening the conceptual understanding of his students.

In 1983 Bill Moritz and Greg Zick were promoted to full Professors. Zick also was appointed an Adjunct Professor of Computer Science. Zick was invited on a lecture tour of China by the Chinese Society of Astronautics. He lectured in various cities on computer engineering, on the efficient sorting of data files, on software engineering, and on design of microprocessor-based instrumentation.

Since 1973 the College of Engineering had been considering extending the M.S. program to engineers working in industries around Seattle. Three successive committees were appointed to address the problem. Finally in 1981, the Department of Electrical Engineering was given the task to formulate and implement a Master's-level TV-program for Electrical Engineering. The EE Graduate TV Committee was chaired by Professor Peter Lauritzen with Professors Mark Damborg and Rubens Sigelmann as members. The committee had to address the following concerns from the administration: 1) the appropriateness of TV for graduate instruction; 2) the effect on academic standards and instructional quality in both the televised and campus classroom environment; 3) the appropriateness of a thesis requirement in the MSEE program; 4) the effect of non-degree seeking students participating in the same program with normal graduate students; 5) separation of TV students from on-campus students for accounting purposes; and 6) the need for a market survey. The committee's efforts met with success. In January 1983 Professor Endrik Noges was appointed the first Director of Televised

Instruction in Engineering (TIE). In the fall of 1983, the first televised graduate courses, known as TIE courses, were offered.

In 1983 the State Legislature approved funding for the Washington Technology Center (WTC). Its purpose is to enable technology transfer, helping companies develop and commercialize technology products and services in Washington State. It leverages state funding and university research results to attract additional outside funding, and provides a startup environment for new technology companies. Spiritually the WTC is the successor to the Engineering Experiment Station, which used state funds to maintain a research staff and work on problems of economic importance to the state. Dr. Edwin B. Stear, former U.S. Air Force chief scientist, and former chair of the UC Santa Barbara Department of Electrical Engineering and Computer Science, was appointed by the WTC board as Executive Director and received a tenure track appointment as Professor of Electrical Engineering, an arrangement similar to the Applied Physics Laboratory.

Also in 1983 the Department established the Electric Energy Industrial Consortium (EEIC). Part of the strategic reinvigoration of the power area, the Consortium of industrial members supports education in electric energy technologies, including power systems and power electronics, at the University of Washington, offering undergraduate scholarships, graduate fellowships, and more recently, undergraduate research assistantships to attract and retain students interested in the electric energy area. Professor Mani Venkata was the first director of the EEIC, and was instrumental in its formation.



Figure 115. From Left: Professor Leung Tsang in 1999; Professor Chen-Ching Liu in 1999; Professor Les Atlas in 1998. (EE Department photos)

Four new faculty were hired in 1983 in addition to WTC Director Ed Stear. Leung Tsang, S.B. 1971 S.M. 1973 Ph.D. 1976 M.I.T, was recruited away from Texas A&M and appointed Associate Professor. His field includes electrophysics, wave propagation and scattering, remote sensing, and optics. His hiring was a strong addition to the highly successful program in scattering and remote sensing built by Professor Ishimaru.

Chen-Ching Liu, B.S.E.E. 1976 M.S. 1978 National Taiwan University, Ph.D. 1983 Berkeley, was appointed Assistant Professor. His thesis was “New Methods for the Analysis of Reliability, Stability and Security Control of Power Systems.” He was the second junior faculty hire in the power system area. He would continue to work in his thesis area and develop an interest in expert systems.

Les Eugene Atlas, B.S.E.E. 1977 Wisconsin, M.S. 1978 Ph.D. 1983 Stanford, was appointed Assistant Professor. His thesis was "Speech Processor Design Considerations for an Auditory Prosthesis." His interests include speech processing, digital signal processing, auditory sciences, and neural networks. Les claims a family relationship with Leon Trotsky. His thesis title indicates that a link to bioengineering topics remained attractive in faculty hiring.

Yasuo Kuga completed a Ph.D. and was appointed Research Assistant Professor, continuing his research work with his advisor, Professor Akira Ishimaru.

1984 was the centennial year of the Institute of Electrical and Electronic Engineers (IEEE). To celebrate the occasion the IEEE awarded 1,984 Centennial Medals. Four faculty in the department were awarded Centennial Medals: Professor Irene Peden, Professor Akira Ishimaru, Professor and Chairperson Jim Meditch and Professor Robert Marks II. Assistant Professor Chen-Ching Liu received the EE Outstanding Teacher Award in his first year at Washington.

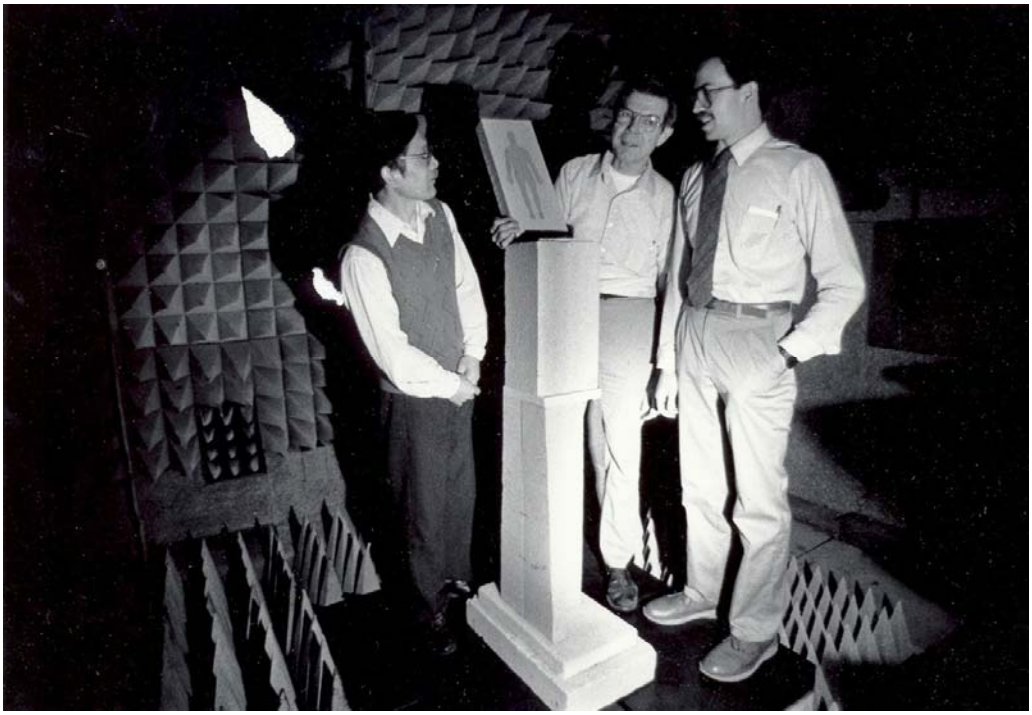


Figure 116. Anechoic chamber in the 1948 Electrical Engineering Building being used for electromagnetic exposure measurements on a scale human, ca. 1977. At center is probably Arthur Guy. The photograph has some damage. (*Trend* photo)

The Trend In Engineering reported on the research career of Professor Arthur Guy. Guy was an undergraduate and graduate student in Electrical Engineering at the University of Washington. In the late 1950s he was working on his M.S. under Professor Gedaliah Held. Held was asked to evaluate heating in humans due to electromagnetic radiation by the Chair of the Department of Rehabilitation Medicine. He assigned Arthur Guy to the project. At the time Rehabilitation Medicine wanted to use microwaves to provide localized heating as therapy.

Arthur Guy went on to work on the Antarctic VLF propagation project, finishing his Ph.D. on that topic in 1966. However, he was offered and accepted a faculty position in the Department of Rehabilitation Medicine based on his work on therapeutic electromagnetic heating. Two more factors fell into place to make his career. The first was the indoor antenna range on the fourth floor of the Electrical Engineering building, completed about 1970. A drop in antenna related funding made the range an unused white elephant in the department, eager to find users. Guy obtained some high power transmitters and installed a more modest anechoic chamber in part of the space to study therapeutic heating.

The second factor was a sudden Congressional interest in the effects of electromagnetic radiation exposure on humans, rising from the revelation that some color television sets created relatively high X-ray exposure. Very little was known about electromagnetic radiation effects on humans, and the need for basic measurements was urgent. Only two laboratories in the United States were prepared to make these measurements, and one was Arthur Guy's. From 1968, he said, "Almost every proposal we wrote was funded." Guy became a Professor of Bioengineering and an important national figure in the area, making the basic measurements that helped set exposure limits in the United States. In an intensely political area characterized by battles between concerned activists and reluctant manufacturers and operators, Guy steered a carefully neutral course, focusing on providing unbiased technical information to all sides. One of the more interesting sidelines of his work was an investigation of the ability of some people to detect electromagnetic radiation by hearing clicking sounds during exposure. Guy's work showed that this was in fact true and explained the mechanism.

Two senior faculty were added to Electrical Engineering in 1984. Interest among domestic students in nuclear engineering had dropped significantly in recent years. The faculty of the Department of Nuclear Engineering chose to slowly dissolve the department and return to their former homes in other departments, and so Robert Albrecht, Professor of Nuclear and Electrical Engineering returned primarily to the Electrical Engineering Department. His agreed role would be to increase the availability of hands-on laboratory experience in the department.

Figure 117. Professor Peter W. Cheung in 1985 (EE Department photo).

Peter Wing-Poon Cheung was a full Professor at Case Western Reserve and director of the Electronics Design Center, working on biomedical sensors. His hiring was a major strategic move, but it caused some disruption due to his requirements for specific laboratory and office space. Fortunately, a compromise was worked out.

In the 1984 Catalog, the electrical engineering core was changed to promote the Computer Engineering laboratory into a full course, EE 372, Introduction to Microprocessors, taught by Professor Bill Moritz and others. The core had grown from 40 credits to 44 over the course of the decade. No other significant changes were made.

Figure 118. EE 372, Introduction to Microprocessors, had its own laboratory space for the development systems. Here Professor Bill Moritz, left, consults with a student. (*Trend* photo)

In the spring of 1985 Mohamed El-Sharkawi was promoted to Associate Professor. Assistant Professor Les Atlas received the Presidential Young Investigator Award, a major early career NSF grant. The first Televised Instruction in Engineering (TIE) M.S.E.E. was awarded. Hewlett-Packard donated a network analyzer, an extremely expensive and highly useful piece of electromagnetics laboratory equipment. Associate Professor Leung Tsang was co-author of a new graduate text, *Theory of Microwave Remote Sensing*. It dealt with active and passive microwave remote sensing of terrain. Two departures finished the decade. Assistant Professor Peter Swaszek departed after only three years at Washington. Mani Soma reports that Swaszek was unhappy with the West Coast. He is now a professor at the University of Rhode Island.

Figure 119. Professor Jim Meditch, date unknown. (Sigelmann history)

After eight years, Jim Meditch departed the chairperson's office and returned to teaching and research. Meditch's term continued the struggle to regain the momentum lost in the budget cuts of 1970. Research funding had declined compared to the boom times of the 1960s. Continuing state funding shortages inhibited hiring in the early years – only two of nine new faculty were hired in the first four years, while six of ten departed. The later hires would take time to become productive researchers.

Judging from the thesis topics and interest areas of the faculty, the department had pursued two strategic initiatives since 1975. The first was the revitalization of the power area. After the unfortunate death of Professor Mablekos, the department had hired a superb program builder in Professor Mani Venkata and two strong junior faculty in Professors El-Sharkawi and Liu. The second strategic direction continued to be biomedical. Professors Kim, Soma, Atlas, and Cheung all had some form of biomedical connection in their areas of interest, although from three different directions: digital electronics (Kim, Soma), signal processing (Atlas) and sensors (Cheung). In this way the department was able to reinforce these areas while retaining a central focus. However, Don Baker's departure in 1979, the move by Professors Moritz and Zick into computer engineering and the growth of the Bioengineering Program were indicators that the bioengineering strategy might have run its course.

The department sought immediate improvement in selected areas by hiring senior faculty in remote sensing (Tsang) and sensors (Cheung). Five new faculty, plus a new chair, were hired for the fall of 1985, for a net growth of five over the decade.

Critical faculty departures were those of David Auth to industry and Paul Carlson to academic administration. While each made tremendous contributions in their future careers, they were not made in the Electrical Engineering Department. The problem of fostering entrepreneurial and administrative talent among faculty and then watching that talent leave the department in the course of its natural growth was a natural side effect of the reorientation of the department to a funded research culture.

The utility of the core and elective structure of the Electrical Engineering curriculum introduced in 1971 was clearly shown in the ease with which the Computer Engineering program was introduced into the curriculum in 1977. Minor changes in the core and new

elective offering were sufficient to implement the new area. Beyond this there was little curricular change during the Meditch administration.

The decade of 1975-1985 can be summarized as steady state for the Electrical Engineering department. The decade ended with roughly the same numbers of faculty and students as it started with, and by implication with about the same level of research funding. The only major change in department expertise was in power.

EE enrollment declined somewhat from 1978-1981, apparently an intentional limitation due to budget constraints. A dip in degrees granted in 1982 and 1983 follows the enrollment decline. However, Electrical Engineering suffered proportionally lower losses than did other departments, because student interest in EE grew over this time frame. Thanks to publicity and promotion in college publications and other programs, female undergraduate enrollment rose from 2.2% in 1979 to 15.7% by 1984 (close 90 undergraduates and 20 graduate students). Collection of statistics on minority enrollment started in 1977. Black enrollment was 2.4% in 1984, while the state population was about 3.1% black. Hispanic and Native American enrollment ran much further behind the state population, which had about 4.4 and 1.7%, respectively, in 1990.

1985-1995 High Tech

Figure 120. UW Husky, 1990s.

By 1985 the country was feeling fairly good about itself. Ronald Reagan's grandfatherly mien had seemingly cured the excessive inflation of the late 1970s, and the economy was booming. Ivan Boesky and Michael Milken were raking in the cash and not feeling a bit of guilt about it. NASA was successfully flying the remarkable vehicle known as the Space Shuttle. The President was out to win the Cold War with a ballistic missile defense system called the Strategic Defense Initiative, SDI. Opponents called it Star Wars. AIDS was a topic of discussion in medical conferences instead of the evening news. Wham! Madonna and Foreigner ruled the singles charts. In Husky stadium people were doing the Wave.

The world was being reshaped yet again by technology. In 1976 the Ethernet standard, or TCP/IP, provided a network architecture that was cheap and easy to implement locally but could conceptually scale up to world wide. In 1978 the first Global Positioning System satellite was launched. It was intended for military applications. In 1981 the Compact Disc (CD) standard was announced. Vinyl's days were numbered. In 1983 Apple released the Macintosh. Its revolutionary desktop paradigm changed the way we interact with computers. Microsoft announced Windows, its competing operating system, in the same year. The first commercial cell phones – about the size of a brick, and nearly as heavy – were available in 1983. The Internet appeared in 1983, with domain names for email and file transfer services. In 1985 Windows was finally released. Despite the delay, the hardware cost advantage of PC clones meant that Windows would triumph. Symbolics, Inc. registered the first .com domain name.

Figure 121. Left: Professor R. Bruce Darling in 2004. Right: Professor Jim Ritcey in the 1990s. (EE Department photos)

1984-85 was a busy year for faculty hiring. Six faculty positions were filled in the fall of 1985. Robert Bruce Darling, B.S.E.E. 1980 M.S.E.E. 1982 Ph.D. 1985 Georgia Tech was appointed Assistant Professor. His Ph.D. thesis was "A Theory for Optically-gated Gallium-Arsenide MESFETS." His areas of technical interest are semiconductor device

physics and modeling, optoelectronics, microelectronics, electronic circuit design, semiconductor fabrication processes, and instrumentation and sensors.

Arun K. Somani, B.S. Electronics 1973 B.I.T.S. Pilani, India, M.S.E.E. 1983 Ph.D. 1985 McGill University, was appointed Assistant Professor in 1985. His thesis was "A Unified Theory of System-level Diagnosis and its Application to Regular Interconnected Structures." His interests were reliability in communication networks. His hiring gave rise to a joke about "Too Many Manis" in Electrical Engineering, as he joined Mani Venkata and Mani Soma on the faculty.

James A. Ritcey, B.S.E. Duke University, M.S.E.E. Syracuse, Ph.D. 1985 UC San Diego was appointed Assistant Professor. His Ph.D. thesis was "Calculating Radar Detection Probabilities by Contour Integration." He would work in the general area of statistical signal processing with applications to radar, sonar, communications, and biomedical ultrasound.

Thomas Sloane, Ph.D. 1985 Duke, was hired as an Assistant Professor. His thesis was "A Computer-aided Measurement System for Characterization of Linear and Nonlinear Elements for Analysis of Switch-mode Systems." His area was power electronics. Paul Lin was hired as an Assistant Professor.

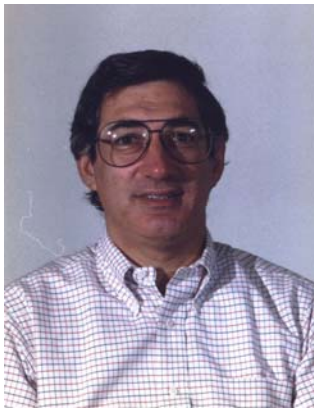


Figure 122. Robert Porter, Professor and Chair, 1986-1988. (EE Department photo)

The sixth hire and new department chair was Robert Philip Porter, B.S.E.E. 1965 M.S.E.E. 1966 M.I.T., Ph.D. 1970 Northeastern University. He was duly appointed a full Professor. He came to the University of Washington from Nippon Schlumberger K.K., Tokyo, where he had served as vice president. Prior to joining Schlumberger he had worked as a scientist with the Woods Hole Oceanographic Institution. Among his research interests were remote sensing by electromagnetic and acoustic techniques, marine acoustics, and magneto-hydrodynamic energy conversion. He was a Fellow of the Acoustical Society of America. Porter's hiring was unusual in that he had no experience in academia. Boeing thought highly of him and lobbied the Dean in his favor. It is likely that the Dean, and others, thought that it would be healthy to infuse some industrial management practices into an academic department.

Professor Rubens Sigelmann continued the exchange program by spending the 1985-86 academic year at the University of Duisburg.

The world of technology was forcibly reminded of its potential for making errors with serious consequences by two disasters in the first half of 1986. In January the Space Shuttle *Challenger* was destroyed during takeoff, killing seven. With painful irony, one of the casualties was the first Teacher in Space. The failure would be traced to O-rings stiffened by the low takeoff temperatures. In March the nuclear reactor at Chernobyl suffered a major meltdown, releasing large quantities of long-lived radioactivity into the surrounding environment; 28 people died within four months from radiation exposure or thermal burns, and total fatalities by 2004 were about 56. The accident was due to vulnerabilities in the reactor design combined with unsafe operating practices.

When questions arise about technology, as they do most acutely in the case of dramatic and unfamiliar failures, the press and public look to academia as a trusted repository of knowledge and expert opinion. The deluge of inquiries after the Chernobyl accident led Professor Bob Albrecht to call a press conference and explain to more than 50 reporters and cameramen the probable causes, sequence of events, and consequences of the accident.

In 1986 Leung Tsang was promoted to full Professor. Chen-Ching Liu and Yongmin Kim were promoted to Associate Professors. Kim's Image Computing Systems Laboratory (ICSL) announced the first UW Graphics System Processor (UWGSP). The processor would today be called a graphics card, and provided graphics speed and image resolution to support medical imaging applications far beyond what was currently available from industry. UWGSP 1 was the first of a line of processors that continuously advanced the state of the art through UWGSP 9 in 1995. Professor Pat Daniels, who had been with the department since 1974, departed for Seattle University, where she became chair of the Department of Electrical and Computer Engineering and later Associate Dean.

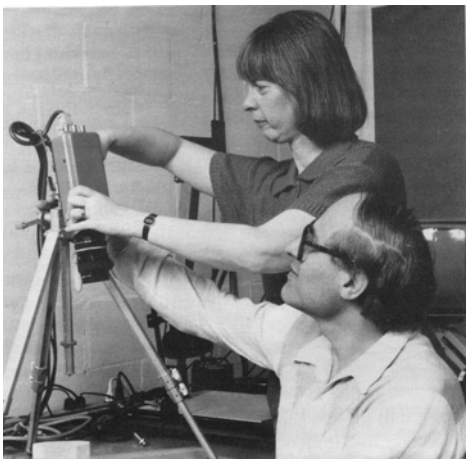


Figure 123. Professors Robert M. Haralick and Linda Shapiro in 1989. (*Trend* photo)

In 1986 the Boeing Company endowed a number of chaired professorships in engineering at the University of Washington. While endowed chairs were by now commonplace at private universities, a sense that it was proper for state universities to be wholly supported by state money had inhibited pursuit of endowments until relatively recently. The professorships were under control of the Dean. The Boeing Clairmont Egtvedt Professorship, named for a Boeing president who graduated from the Engineering School in 1917, was allotted to Electrical Engineering and used to recruit an outstanding senior professor. Robert M. Haralick, B.A. in Mathematics 1964 B.S.E.E. 1966 M.S.E.E. 1967 Ph.D. 1969, all from Kansas, was hired away from Virginia Tech and from his position as Vice President of Research at Machine Vision International to occupy the new Boeing Egtvedt endowed chair. Haralick had been a professor at Kansas through 1978, and then at Virginia Tech, where he was Director of the Spatial Data Analysis Laboratory. Haralick had been named a Fellow of the IEEE in 1984 for his contributions to computer vision and image processing.

With Haralick came his wife, Linda Shapiro, B.S. in Mathematics and Computer Science 1970 from Illinois, M.S. in Computer Science 1972 Ph.D. 1974 from Iowa. Shapiro had been an Assistant Professor at Kansas State University when she and Haralick met at a technical conference. The couple moved to Virginia Tech in 1978, where she was an Associate Professor of Electrical and Computer Engineering. She was Director of Intelligent Systems for Machine Vision International when she was hired as an Associate Professor of Electrical Engineering at the University of Washington. Her hiring defines the acceptance of what might be termed the "information" side of electrical engineering as coequal with the "physical" side. Shapiro would pursue research in computer vision independently and also in cooperation with Haralick.

In 1986 Dale Winebrenner from the Applied Physics Laboratory received a research appointment in the department. Mark Damborg became the graduate program advisor. Greg Zick became Associate Dean for Computing at the College of Engineering. He worked with departments to define their computing needs, manage support staff and allocate resources for computing. Pete Lauritzen traveled to the Soviet Union with Ploughshares[1] to set up slow scan television systems in Moscow and in Tashkent, Seattle's sister city. Slow scan television allowed the exchange of images over a telephone line at a low frame rate. The objective was to improve communications between peoples and ease the tensions of the Cold War.

Early in 1987 the University of Washington suffered its very own engineering embarrassment. After guy wires were mistakenly released, the structural steel for the roof of the new addition to the north stands at Husky stadium collapsed, a contractor error.

Bob Pinter and Bob Marks were both promoted to full professors in 1987. Bob Clark received a joint appointment recognizing his cross-department activity. He was now Professor of Electrical Engineering and Aeronautics and Astronautics. Assistant

[1] The Ploughshares project was a different organization from the more radical Berrigan peace activist movement Plowshares, although the two shared some common objectives.

Professor Chen-Ching Liu received the Presidential Young Investigator Award and was promoted to Associate Professor.

Figure 124. Professor and APL Director Robert Spindel ca. 2005. (APL photo)

The Applied Physics Laboratory (APL) hired a new Director. Robert Spindel had been the chair of the Ocean Engineering Department at Woods Hole Oceanographic Institution. In accordance with the policy hammered out in the 1970s, Spindel received a courtesy appointment as full Professor in the Department of Electrical Engineering. Jim Luby from APL received a research faculty appointment.

In 1987 a curriculum revision created by Bob Marks and his committee was put in place. There are indications that this revision was driven to some extent by the Accreditation Board for Engineering and Technology (ABET). In the core, the Fundamentals of Computer Operation and Organization course, EE 371, became an engineering fundamentals course, ENGR 275, nominally taught in the sophomore year. This freed up some credits for Electrical Engineering electives. The choice between EE 372, Introduction to Microprocessors, and EE 374, Data Structures, now became one course, EE 370, Introduction to Digital Systems and Computers. The core remained 44 credits, although four of those were now engineering fundamentals instead of EE.

More structure was introduced into the elective credits. To ensure depth, students had to take at least 11 credits and a capstone design course in one specialty area. To ensure breadth, students had to take at least eight credits in a second specialty area. Finally, students had to acquire 48 hours of Engineering Science and 48 hours of Engineering Design to graduate. The credits in each course were divided between science and design. Both the capstone course concept and the science and engineering credit requirement were based on new ABET accreditation criteria, which reflected a growing movement to define engineering as design, a movement that came primarily from the civil and mechanical engineers. While several of the specialization areas of electrical engineering already emphasized design, others had been more typically concerned with analysis, and had to scramble to develop a capstone course and find sufficient design credits.

The computer engineering program development effort by Professors Moritz, Kim, and others achieved a significant milestone when the state Higher Education Coordinating Board (HECB) approved establishment of a degree program in Computer Engineering.

In 1987, Professor Emeritus Bob Bergseth and Professor Mani Venkata published a textbook entitled *Introduction to Electric Energy Devices*. The text took an innovative energy oriented approach to electric machinery and was used for many years at Washington and elsewhere.

At the end of the 1987-88 academic year, Les Atlas and Mani Soma were promoted to Associate Professors. Frank Alexandro was promoted to full Professor. Professor Irene Peden was named a Fellow of the American Association for the Advancement of Science (AAAS). Department Chair Robert Porter was appointed to the Naval Research Advisory Council. The Computer Engineering program achieved another major milestone when it was accredited by the Accreditation Board for Engineering and Technology (ABET). It was one of 40 in the nation and the first in Washington State. Research Assistant Professor Yasuo Kuga left for a tenure-track position at Michigan. Assistant Professors Thomas Sloane and Paul Lin resigned. Sloane sought an environment more focused on teaching and went to Bucknell. Lin sought an environment more focused on research and went to Bell Communications Research in New Jersey.

Figure 125. Professor Endrik Noges, Acting Chair 1988-1990. (EE Department photo)

The big news was the resignation in July of Department Chair Robert Porter, after serving only two years. Porter took leave for a year to work with Fairchild-Westin in New York, then returned to teaching and research. Professor Dean Lytle served as Acting Chair over the summer, and Professor Endrik Noges became Acting Chair in fall 1988.

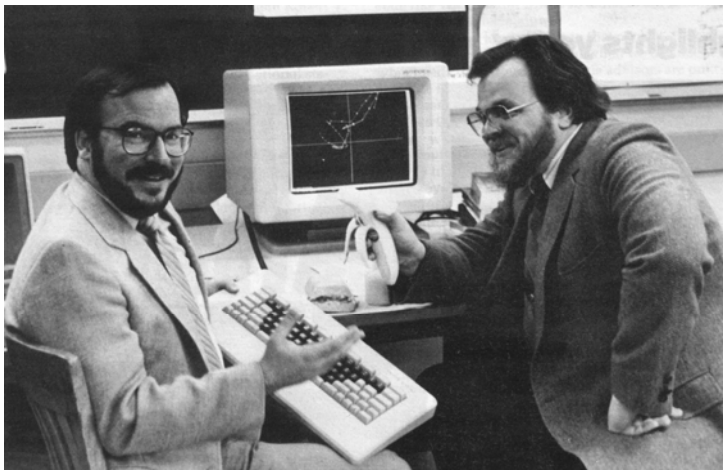


Figure 126. Associate Professor Bob Marks, right, uses a banana to make a point to Associate Professor Les Atlas. (*Trend* photo)

The Trend in Engineering reported on several faculty research programs in 1988. Professor Yongmin Kim was working with Professor Alan Nelson of Bioengineering on 3D display of the human spine. Associate Professors Les Atlas and Bob Marks were working in their Interactive Systems Design Laboratory on alternate projection neural networks (APNN) for image recognition, with funding from several sources. The Washington Technology Center broke ground on the Fluke building, named for electrical engineering alumnus John Fluke Senior and funded in part by a generous gift from the Fluke family. Space and clean rooms in the new building would become important resources for the Electrical Engineering department.

The Trend also reported that the Dean was concerned about engineering enrollment. He blamed demographics and a decline of interest in technology; 12% of freshmen in 1982, but only 8.5% in 1987, expressed interest in engineering careers. The twin disasters of the Space Shuttle and Chernobyl cannot have helped. Electrical Engineering enrollment did in fact start to decline in 1987, losing about 17% before bottoming out in 1989. The College of Engineering sought to make up for the shortfall by aggressively pursuing female and minority students, who were proportionally underrepresented in Engineering. The College started a Center for Women in Engineering a Minority Engineering Program (MEP), and the Mathematics, Engineering and Science Achievement (MESA) program to attract, recruit, and retain female and minority candidates.

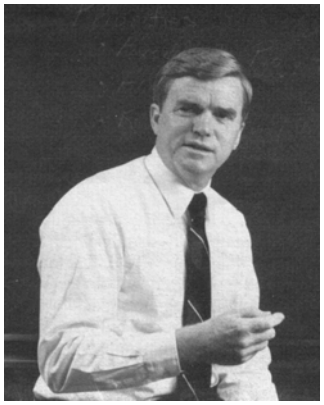


Figure 127. Edsel D. Dunford, BSEE '60, Executive Vice President of TRW Space and Defense Sector, and College of Engineering Visiting Committee member, 1988. (*Trend* photo)

The Trend also reported on the career of Edsel D. Dunford, BSEE 1960. After graduation Ed Dunford went to TRW, where he worked on the Pioneer 10 communications system. Pioneer 10, launched in 1972, was the first spacecraft to pass outside the asteroid belt. It visited Jupiter and sent back pictures and scientific data, then left the solar system. Dunford's communications system sent its last signal in 2003, from a distance of about 8 billion miles. In 1988 Dunford was the executive vice president of the TRW Space and Defense Sector, and a member of the College of Engineering Visiting Committee.

Figure 128. Research Associate Professor Daniel J. Dailey in the mid 1990s. (EE Department photo)

Uncertainty about department leadership inhibited recruiting in 1988. Daniel J. Dailey, B.S.E.E. 1979 Penn State, M.S.E.E. 1982 Ph.D. in Nuclear Engineering 1988 Washington, was hired as a Research Assistant Professor. His thesis was "A Study of the Neutron Noise in an Operating Pressurized Water Reactor." His advisor was Bob Albrecht. While writing his thesis, Dan had supported himself by working for Associate Dean for Computing Greg Zick supervising the installation of networks and PC labs throughout the College. He had also been teaching the graduate course in Stochastic Processes in Electrical Engineering. Now he used his interest in stochastic processes and his knowledge of computer systems and networks to move into the research area of

intelligent traffic control. He would be among the first to use correlation to measure traffic speeds, and Kalman filters to predict backups and detect traffic incidents.

The 1988-89 academic year was a very active one full of significant events for the Electrical Engineering department, including one major program reorganization.

When it was formally created and administratively separated from Electrical Engineering in 1974, the Computer Science Department placed itself in the College of Arts and Sciences, next to other science departments like Physics and Chemistry. With astute leadership and a selective choice of faculty and students, the department had broken through into the top 10 of computer science departments in the country, and worked assiduously to maintain its ranking. Now in 1988 Computer Science noticed that other top departments were moving to Engineering, and sought to follow suit.

J. Ray Bowen, Dean of the College of Engineering, was eager to have a top 10 department in the College. The prestige could be used to attract resources from the upper administration, from the state and from industry. The Computer Science Department occupied Sieg Hall, the old home of the long-defunct General Engineering department, and it would be good to have that space back in the College. Though the unification of Computer Science and EE's program in Computer Engineering into a new department was not without controversy, the Electrical Engineering faculty voted to approve the plan.

Four faculty retired in spring 1989. Dave Johnson was appointed Professor Emeritus. Since his hiring in 1955 he had worked with and taught digital computer technology in Electrical Engineering. He was the principal faculty member in computers prior to the creation of the Computer Science program in 1968, and then was part of the Computer Engineering program from 1977 through its transfer to Computer Science in 1989.

William Potter retired, being appointed Lecturer Emeritus. Potter had served as the undergraduate advisor from 1971 and taught fundamental courses. He was very popular with students, who often waited in long lines for his advice. Following his departure, advising would become a staff function. Charles Redeker also became a Professor Emeritus. He had come to the General Engineering department in 1960, and then to Electrical Engineering when the General Engineering Department was disbanded in 1971. Redeker had concentrated on teaching undergraduate courses. Edward Stear retired to a career in consulting. He had been Washington Technology Center Director since 1983, holding a courtesy faculty appointment in Electrical Engineering.

Three faculty were promoted to full Professor. Marty Afromowitz became Professor of Electrical Engineering and Bioengineering. Mohamed El-Sharkawi became Professor of Electrical Engineering. Linda Shapiro became Professor of Electrical Engineering and of Computer Science and Electrical Engineering, as her appointment was two-thirds in Computer Science and Engineering and one-third in Electrical Engineering.

Figure 129. A computing laboratory in the Electrical Engineering building about 1992. These are personal computers. Note the open windows. The Electrical Engineering building was not designed for rooms full of computers, and overheated labs would be common until a new building was finished in 1998. (*Trend* photo)

The Trend in Engineering reported significant gifts to Electrical Engineering in 1989. Mentor Graphics Corporation and Apollo Computer contributed gifts valued at $967,000 for computer design hardware and software for graduate level teaching and research. Associate Professor Mani Soma coordinated the gift. Hewlett-Packard gave the Department 85 workstations valued at $4.4 million for general computing laboratories, a gift coordinated by Professors Bill Moritz and Soma.

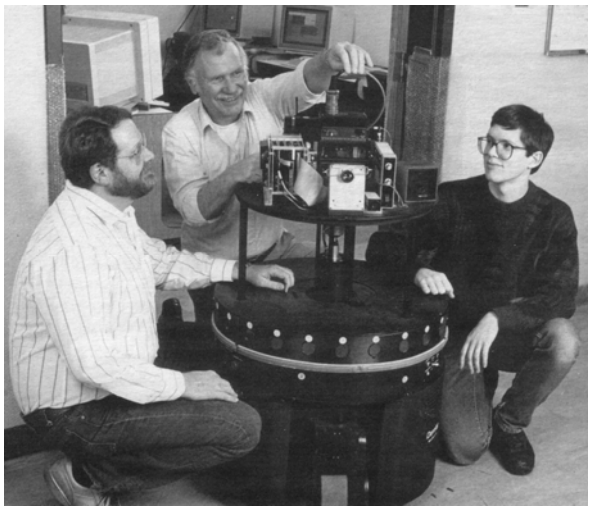


Figure 130. Professor Bob Albrecht, center, with two students and Miss Marple, a mobile robot, about 1992. (*Trend* photo)

The Trend also reported on two research projects in Electrical Engineering. Professor Bob Albrecht established an Autonomous Mobile Robots Laboratory with $180K from the National Science Foundation. Professor Bob Pinter and Assistant Professor Robert

Darling received $290K for their project “Sensory Neural Networks for Advanced Photodetectors.”

Among service, awards, and honors, Professor Bob Albrecht became Associate Chair of Research and Development. Professor Yongmin Kim received the IEEE Engineering in Medicine and Biology Society Early Career Achievement award. Professor S.S. Mani Venkata became a Fellow of the IEEE. Professor Irene Peden served as the President of the IEEE Antenna and Propagation Society, and was named a Fellow of the Accreditation Board for Engineering and Technology (ABET). Professor Pete Lauritzen followed up on his visit to Tashkent by coordinating an exchange with Tashkent Polytechnic Institute.

Towards the end of the 1988-89 academic year, the College of Engineering released a revised undergraduate curriculum, the work of the McCormick committee. Professor Bill Moritz had been the Electrical Engineering representative on the committee. The most significant change was the increase in credits to graduate from 180 to 192, or from 15 to 16 per quarter. The new curriculum also mandated that students take a writing course somewhere in the University, and technical writing courses from the Department of Technical Communications. The humanities and social sciences requirement was given more structure by requiring linked sets of HSS courses. A design course was required of all students. The committee also recommended limiting enrollment as a means of improving teaching quality.

In 1989 Professor Peter Cheung went to Hong Kong on an extended leave and ultimately found an academic position in Hong Kong. Professor Rubens Sigelmann obtained Fulbright support for a sabbatical in Brazil.

Also in 1989, the Electrical Engineering Department hired seven tenure-track faculty, and the Applied Physics Laboratory hired Eric Thorsos, who received a research appointment in the department.

Figure 131. From Left: Assistant Professor Chi Hou Chan; Assistant Professor Richard D. Christie; Assistant Professor Blake Hannaford. (EE Department photos, 1989)

Figure 132. Left: Assistant Professor Jenq-Neng Hwang; Right: Assistant Professor Kelin Kuhn (EE Department photos, 1989)

Chi Hou Chan, B.S.E.E. 1981 M.S.E.E. 1982 Ohio State, Ph.D. 1987 Illinois, was appointed Assistant Professor of Electrical Engineering. His thesis was "Investigation of Iterative and Special Galerkin Techniques for Solving Electromagnetic Boundary Value Problems." His teaching and research interests included computational electromagnetics, microwave integrated circuits, scattering and antennas, and bioengineering. Richard Dunstan Christie, Jr., B.S. 1973 M.E. 1974 Rensselaer Polytechnic Institute, Ph.D. 1989 Carnegie Mellon University, was appointed Assistant Professor of Electrical Engineering. His thesis title was "Expert Systems for On-line Power System Security Assessment." Prior to pursuing his Ph.D., Christie had been an officer in the United States naval nuclear power program, and then worked at Leeds and Northrup Company.

Blake Hannaford, B.S. 1977 Yale, M.S. 1982 Ph.D. 1985 Berkeley, was appointed Assistant Professor of Electrical Engineering. His thesis was "Control of Fast Movement: Human Head Rotation." Prior to pursuing his Ph.D. he worked in digital hardware and software design. After his Ph.D. he worked at NASA on remote control of robot manipulators, rising to manage his research group. His research interests continued his NASA work, focusing on telerobotics, anthropological robots and haptics. Jenq-Neng Hwang, B.S.E.E. 1981 M.S.E.E. 1983 National Taiwan University, Ph.D. 1988 University of Southern California, was appointed Assistant Professor of Electrical Engineering. His thesis was "Algorithms/Applications/Architectures of Artificial Neural Nets." His research interests would be image/video signal processing, computational neural networks, multimedia system integration and networking.

Kelin J. Kuhn, B.S.E.E. 1980 Washington, M.S.E.E. 1985 Ph.D. 1985 Stanford, was appointed Assistant Professor of Electrical Engineering. Her thesis was "Research and Development of a High Average Power Photoprocessing Laser System." Kuhn had been one of the pioneer female engineering undergraduates at Washington, and was featured in articles in *The Trend in Engineering* that helped bring other women into the field. After her Ph.D. she returned to Washington as a Research Assistant Professor of Materials Science and Engineering. She successfully made the transition to tenure track in 1989. Her research area of interest would be photonics, with an emphasis on optical sensing,

and she would teach lasers and electronics. Andrew Tien Yang, B.S. 1983 Berkeley, M.S. 1986 Ph.D. 1989 Illinois, was appointed Assistant Professor of Electrical Engineering. His thesis title was “iSMILE: An Integrated System for Device Model Design, Parameter Extraction, and Circuit Simulation.” He continued work in circuit simulators, including optoelectronics, microwave CAD, and modeling and simulation of GaAs/Si devices.

Figure 133. Boeing Johnson Professor Tom Pearsall in the early 1990s. (EE Department photo)

The Electrical Engineering Department obtained a second Boeing Professorship, the Boeing Johnson Professorship, in 1989. Philip G. Johnson was a 1917 graduate of the University of Washington who had become President of Boeing Airplane Company in 1926, at age 31. He went on to head United Air Lines and then the Boeing conglomerate, United Aircraft and Transport Company. He was President of Boeing during World War II, until his sudden death in 1944.

The Boeing Johnson professorship was used it to recruit a senior faculty member working in semiconductor electronics. Thomas P. Pearsall, B.A. 1957 B.E.E. 1968 Dartmouth, M.Sc. 1970 University of London, Ph.D. in Applied Physics 1973 Cornell University, was appointed Professor of Electrical Engineering and named to the Boeing Johnson Chair. Pearsall had worked for Bell Laboratories, except for five years in France with CSF Thompson, and had successfully developed gallium arsenide semiconductor devices for fiber optic communications systems. His research interests at Washington were the synthesis of high-temperature semiconductors and real-time, in-situ process control for semiconductor manufacture.

A review of the areas of the new professors indicates that the department was pursuing a hiring strategy that combined “hire the best” with “something for everyone.” The electronics area received the biggest boost, with one hire in photonics, one in circuit simulation, and a senior hire in semiconductor materials.

In Spring 1990, Assistant Professors Bruce Darling and Jim Ritcey were promoted to the rank of Associate Professor. Associate Professor Yongmin Kim was promoted to full Professor. Assistant Professors Christie and Hannaford received Presidential Young Investigator Awards from the National Science Foundation. Professor Leung Tsang

became a Fellow of the IEEE for contributions to wave propagation in discrete random media and the theory of microwave remote sensing. Professor Mark Damborg went on sabbatical to the Australian National University, Canberra, where he collaborated on research on neural networks in control systems.

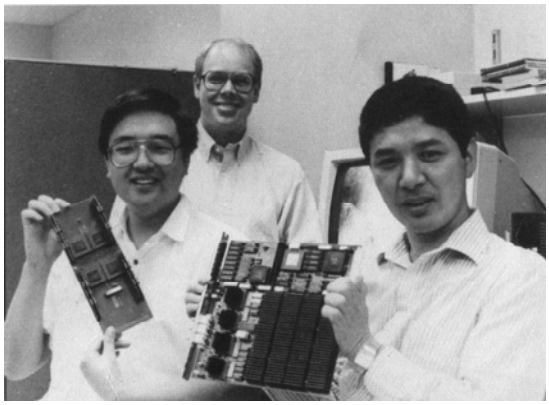


Figure 134. From left: Masters students Wong and Mills, and Professor Yongmin Kim, show off the UWGSP 3 processor. (*Trend* photo)

The Trend in Engineering reported that Washington ranked 24th among 192 engineering programs. *The Trend* also reported on two Electrical Engineering research programs. Professor Yongmin Kim's laboratory announced the UW Graphics System Processor 3, another quantum improvement in image display capability. Two master's students started the project when a new generation of processor chips became available. The students worked from 8:00 AM to midnight, seven days a week, for two years to get the processor done on time and to earn their degrees. Professor Kim put in just as many hours.

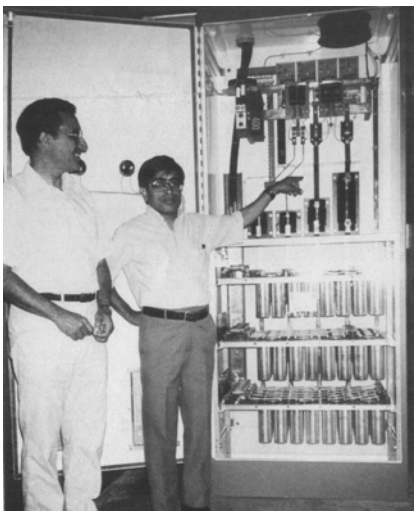


Figure 135. Professor S.S. Mani Venkata points to a component in a cabinet-mounted Adaptive VAR Controller (AVC) while Professor Mohamed El-Sharkawi looks on, about 1990. (*Trend* photo)

The Trend also reported on the Adaptive VAR Controller project supervised by Professors S.S. Mani Venkata and Mohamed El-Sharkawi. Starting in 1980, the project

had developed high-voltage electronically switched capacitor systems for cycle-to-cycle reactive power correction. The technology enabled delivery of identical amounts of real power at reduced current magnitudes, cutting line loading, losses, and hence reactive power fees. It was estimated that the University Hospital could save up to $12K/month with an AVC system. It also was an enabling technology for wind generation. The Bonneville Power Administration and Southern California Edison supported the project.

Figure 136. Left: Assistant Professor Eve Riskin in 1990 (EE Department photo); Right: Professor and Boeing Martin Chair Cornelius Leondes in 1990. (*Trend* photo)

Three faculty were hired in 1990. Eve Riskin, B.S.E.E. 1984 M.I.T., M.S.E.E 1985 M.S. in Operations Research 1986 Ph.D.1990 Stanford, was appointed Assistant Professor. Her thesis was "Variable Rate Vector Quantization of Images." She would continue working in her thesis area, in data compression, image processing, and linear systems analysis.

Electrical Engineering acquired a third Boeing Professorship in 1990 and used it to hire Cornelius Leondes. He had been a famously productive professor in space flight control at UCLA who had produced over 400 Ph.D.s in his career, and was expected to provide the controls group with an instant boost in visibility.

Figure 137. Professor and Chair Thomas Seliga in 1991. (EE Department photo)

The third hire in 1990 was the new department chair. Thomas Anthony Seliga, B.S.E.E. 1959 Case Institute of Technology, M.S. 1961 Ph.D. 1965 Pennsylvania State University, was appointed Professor and Chair of the Department of Electrical Engineering. He was hired away from Penn State, where he was Professor of Electrical Engineering and

Associate Dean for Graduate Studies and Research. Seliga's research area was radar aeronomy, the radar study of the atmosphere. He had been a Director of the Atmospheric Sciences Program at Ohio State, a conference administrator, and in 1987 the National Science Foundation program director of aeronomy. Former Acting Chair Endrik Noges agreed to continue as Associate Chair to aid the transition.

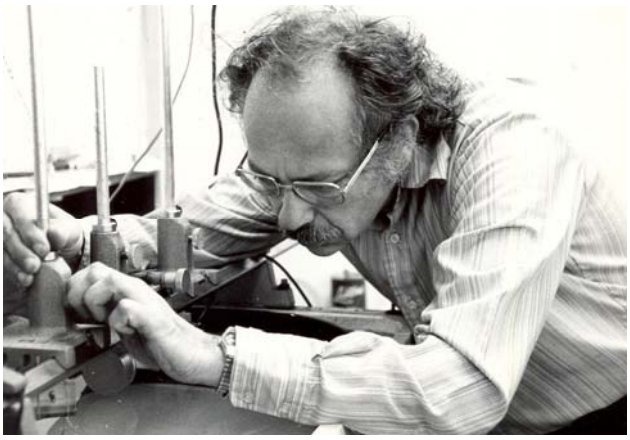


Figure 138. Professor Rubens Sigelmann in the laboratory, probably from the 1970s. (*Trend* photo)

In the spring of 1991 Professor Rubens Sigelmann retired, becoming Professor Emeritus. He had come to Washington from Brazil via Seattle University as an associate of Don Reynolds, taken his Ph.D. under Akira Ishimaru and then stayed on. He had worked on antennas, surface waves, and travel of sound in tissues, including work with Don Baker on ultrasound problems. He was a consultant on electromagnetic interference for Boeing. Sigelmann had spent sabbaticals at Duisburg, Germany twice, and also twice in Brazil. Rubens was notable for his humor, good spirits and his hobby of repairing clocks and watches. Remarkably, he had retired before his advisor!

In the same year, Associate Professor Chen-Ching Liu was promoted to full Professor. Assistant Professor Chi Hou Chan won a Presidential Young Investigator Award to work on computational electromagnetics. Assistant Professor Kelin Kuhn won a Presidential Young Investigator Award to work on quantum regime optical and electronic devices.

The Trend in Engineering noted that Electrical Engineering was first nationwide in percentage of female faculty, having four out of forty, or 10%. Alistair Holden was active in the Minority in Science and Engineering Program, MSEP, which brought minority students onto campus during the summer and provided them with a taste of engineering laboratory and course work.

Figure 139. Left: Professor Yasuo Kuga; Right: Associate Professor John Sahr (EE Department photos, 1989)

Two new tenure track faculty were hired in 1991, and one research faculty. Yasuo Kuga, B.S.E.E. 1977, M.S.E.E. 1979 Ph.D. 1983 Washington, had been a Research Assistant Professor at Washington until moving to Michigan from 1988 to 1991, where he received the Presidential Young Investigator Award. He was hired back from Michigan and appointed an Associate Professor of Electrical Engineering. His research interests are in the areas of microwave and millimeter-wave remote sensing and optics. Kuga's excellent experimental capability was a strong complement to the theoretical depth already in the electromagnetics area.

John D. Sahr, B.S.E.E. 1984 CalTech, Ph.D. 1990 Cornell University, CEDAR Postdoc 1990-1991 Cornell, was appointed Assistant Professor of Electrical Engineering. His thesis was "Observation and Theory of the Radar Aurora." His future wife came to Seattle as a resident in the Medical School, and John followed her. Inquiring about a faculty position at the University, he was met with open arms by Department Chair Tom Seliga. On an airplane trip, Seliga had struck up a conversation with his seatmate, who turned out to be a student at Cornell. The student had raved about the teaching ability of Dr. Sahr. He proved to be an excellent instructor, but interested in observing the upper ionosphere, rather than the atmosphere.

Patrick Carey, B.S. in Chemistry 1983 Western Washington University, Ph.D. in Chemistry 1987 Washington, was appointed Research Assistant Professor of Electrical Engineering. Carey had been a postdoctoral fellow at Los Alamos National Laboratory from 1987 to 1990, and a Postdoctoral Research Associate in the Electrical Engineering Department at the University of Washington in 1990. He was appointed Research Assistant Professor of Electrical Engineering in 1991. Carey worked with Sinclair Yee on chemical microsensors based on silicon devices, sensor arrays and systems, and statistical data analysis, departing in 1993.

The new professors would teach in a new curriculum. In 1989, in response to the McCormick report, Acting Chair Endrik Noges had convened a committee consisting of Chi Hou Chan, Rich Christie, Bruce Darling, and Blake Hannaford, all Assistant Professors. The idea was to bring new ideas from other schools into the curriculum. The committee met through 1989-1990 to review the existing curriculum and identify and resolve problems. A framework proposal was approved in Spring 1990 and the various

groups in the department worked on specific course creation during 1990-1991. The curriculum was put in place in fall 1991.

The revision focused on the core and found two goals: (1) to obtain more electrical engineering credits from the sophomore year, and (2) to modernize the laboratory experience for undergraduates. ENGR 215, Fundamentals of Electrical Engineering, was developed to meet the first goal. Intended as a general introduction to electrical engineering, over time the course reverted to a first course in circuit theory. The second goal was met by distributing the credits in EE 310, the Electronics Laboratory course, and EE 312, the Electrophysics Laboratory Course, into separate area-related courses. A side benefit was that the core courses became a standard size, four credits of classwork and one credit of laboratory work. Another side effect was a renumbering of courses so the second digit indicated the area; 331, for example, was a junior level course in electronics. 351 was a junior level course in energy. The net result was a reduction of two credits in the core, from 47 to 45.

In the larger world, the dissolution of the Soviet Union in late 1991 marked the end of the Cold War. Something like two-thirds of all electrical engineers were employed in the defense industry, and it was estimated that two-thirds of those would lose their jobs in a massive defense draw down. There was in fact a drop in enrollment in electrical engineering, but to the target levels set by the College. There was also a momentary rush to non-defense areas like energy. The effect lasted only a year or so, before the dot-com bubble soaked up all available electrical engineers and eagerly demanded more.

Figure 140. Professor Endrik Noges in the 1990s. (EE Department photo)

In 1992 Professor Endrik Noges retired to the position of Professor Emeritus. Since 1958 he had carried out research and teaching in control systems. He had been the first point of contact for the active exchange program with the University of Duisburg. He had been Assistant Dean, the first Director of Televised Instruction in Engineering and Associate Chair. Noges served as acting chair for two tumultuous years after Porter resigned, and stayed on as Associate Chair for the new Chairman. In addition to his other accomplishments, Noges is an avid downhill skier.

Also in 1992, Professor Peter Cheung finally released the faculty position he had been holding on leave since moving to Hong Kong in 1989. Boeing Martin Professor

Cornelius Leondes also departed. He returned to California for his retirement years and became adjunct at UC–San Diego.

Assistant Professor Kelin Kuhn was promoted to Associate Professor. Assistant Professor Eve Riskin won a Presidential Young Investigator Award. The faculty started to assert, only half-jokingly, that the PYI was now a prerequisite for junior faculty to get tenure. The quality of recent junior faculty hiring was evident in their near 100% success in PYI competition. Professor Emeritus Rubens Sigelmann spent another year at Duisburg. APL Director and EE Professor Bob Spindel became a Fellow of the IEEE. The College of Engineering Visiting Committee included Ed Dunford, B.S.E.E. '60, and John M. Fluke Jr., B.S.E.E. '64. Gary Rosenwald, B.S.E.E. '92, received the President's Medal for the highest academic performance in the senior class. Gary would go on to obtain his Ph.D. from Washington, and is now employed at AREVA T&D in Bellevue.

In 1992 the University requested funding for a new building to house both the Electrical Engineering Department and the Department of Computer Science and Engineering on the site of the current Electrical Engineering Building. When concerns about phasing the new building in around the old one were raised, EE Chair Tom Seliga offered to move the entire department off campus if that would help. Electrical Engineering had only 42% of the space per professor available to its peer universities. Lack of space was inhibiting research growth. The lack of space was so acute that the faculty did not even object strongly to the loss of the parking area around the 1948 building necessary for the new construction, although "Where will we park?" was one of the first questions asked when the new building was presented at a faculty meeting.

Sieg Hall, occupied by the Computer Science and Engineering Department, was even more overcrowded, with graduate students in temporary buildings and in cubicles in the hallways. Sieg's lack of air conditioning meant that it was not well suited to the needs of computer science. It was hoped that joint occupation of the new building, with frequent informal encounters in the hallways, would lead to increasing cooperation between the departments. The original building designs even contemplated the occupation of alternate floors by Electrical Engineering and Computer Science and Engineering.

Two research faculty, and two tenure-track faculty were hired in 1992. The research faculty appointments were made in support of other programs on campus. Brian A. Nelson, B.S.E.C.E. 1981 Iowa, M.S.N.E. 1983 Ph.D. in Nuclear Engineering and Engineering Physics 1987 Wisconsin-Madison, was appointed Research Assistant Professor in Electrical Engineering in 1992. Nelson had been a Research Assistant Professor of Nuclear Engineering since 1988. When the Nuclear Engineering Department formally ceased operation he found a new administrative home in Electrical Engineering. His area of research is plasma physics, including fusion energy research, plasma processing, and diagnostic development. His particular interest is helicity injection in tokamaks. Larry Crum was hired by the Applied Physics Laboratory and appointed to a Research Assistant Professor position in Electrical Engineering.

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Figure 141. Associate Professor Deirdre Meldrum in 1999. (EE Department photo)

Deirdre R. Meldrum, B.S. in Civil Engineering 1983 Washington, M.S.E.E. 1985 Rensselaer Polytechnic Institute, Ph.D. 1993 Stanford, was appointed an Assistant Professor of Electrical Engineering. Her thesis was "Indirect Adaptive Control of Multi-link Serial Manipulators Using Kalman Filtering and Bryson-Frazier Smoothing." It concerned control of large space structures. Meldrum quickly moved toward the hot area of automating the extraction of genetic information. She would provide tools for the Human Genome Project.

Figure 142. Professor Carl Sechen ca. 1999. (EE Department photo)

Carl Sechen, B.S.E.E. 1978 Minnesota, M.S.E.E. 1980 M.I.T., Ph.D. 1986 Berkeley, was appointed Associate Professor of Electrical Engineering. Sechen had been an Associate Professor at Yale. His teaching and research was in the area of design and computer-aided design of analog and digital integrated circuits. One of Sechen's hiring conditions was a parking space in the prized lot adjacent to the Electrical Engineering Building. He explained that he wanted to be sure his graduate students would see his car — a distinctive red Corvette — and know he was working when they came in or went home.

Figure 143. Professor Mark Damborg, Acting Chair, January-July 1993. (EE Department photo)

Department Chair Tom Seliga stepped down in January 1993 and returned to teaching and research. Professor Mark Damborg stepped in as Acting Chair.

Figure 144. Professor Greg Zick, Department Chair 1993-1998 (EE Department photo)

After an internal search, Professor Greg Zick was appointed Chair. In his role as Associate Dean for Computing Zick had successfully led the College into the era of networked computing. His mandate was to keep the department moving forward.

In 1993 Professor Chih-Chi Hsu retired. He had served the department since 1958, teaching and doing research in electronics and related areas. He was quiet and unassuming, and always pleasant.

Professor Emeritus George S. Smith, retired since 1960, turned 100 in 1993, and the department took him to lunch at the Faculty Club, where he recited a patriotic poem from World War I about the Kaiser. He lived to 103.

Figure 145. Professor Emeritus George S. Smith, 100 years old, 1993. (EE Department photo)

Assistant Professors Chi Hou Chan and Blake Hannaford were promoted to Associate Professor. Assistant Professor Deirdre Meldrum received a Ralph R. Teetor Educational Award from the SAE and a Special Emphasis Research Career Award (SERCA) from the NIH National Center for Human Genome Research. The SERCA award provided time and resources for Meldrum to learn about genomics and to bring her expertise in robotics and automation to bear on the problem of providing tools for the Human Genome Project. Meldrum started the Genomation Laboratory to pursue genomics research in Electrical Engineering. Professor Akira Ishimaru was awarded the Boeing Martin Chaired Professorship to acknowledge his international prominence and his long, productive and still active research career. Professor Irene Peden received the high honor of election to the National Academy of Engineering, the first faculty member in the department to do so. Professor Emeritus Rubens Sigelmann was now visiting in Brazil.

One research faculty member was hired in 1993. William Randall Babbitt, B.S. in Physics 1982 Stanford, Ph.D. in Physics 1987 Harvard, was appointed Research Assistant Professor of Electrical Engineering. Babbitt had been a research scientist at the Boeing High Technology Center from 1987-1993. His research interests were in applications of nonlinear optics, with funding from the Air Force Office of Scientific Research (AFOSR).

Figure 146. Professor Emeritus Robert N. Clark in 1999. (EE Department photo)

In 1994 Professor Robert Clark was appointed Professor Emeritus. He had come to Washington in 1957 and was the founder of the controls area at the University. He had

published a textbook in 1962 and, as a tenured full professor, gone to Stanford and completed a Ph.D. in two years to meet the new expectations in academic credentials. His interest in flying private aircraft infected Bob Albrecht and created the EE Air Force. He was the second link, and perhaps the crucial one, in establishing the long-lived cooperative arrangement with Professor Paul Frank at the University of Duisburg. He served the Department as Associate Chair and was for many years a voice in faculty meetings insisting on maintaining high academic standards. He passed away in 2006.

In 1994, Arun Somani and Les Atlas were promoted to full Professors. Professor Chen-Ching Liu was named an IEEE Fellow for contributions to development of knowledge-based systems for power systems applications. Professor Liu also started a one-year term as a Program Director at the National Science Foundation. Assistant Professor John Sahr received the National Young Investigator award, which replaced the Presidential Young Investigator award. Assistant Professor Eve Riskin received the Sloan Research Fellowship. Professor Robert Marks II published a book on fuzzy logic entitled *Computational Intelligence: Imitating Life*. Professor Mark Damborg became Associate Dean for Research and Facilities, and started his major role in the design and construction of a new Electrical Engineering building. His replacement as Associate Chair was Professor Mani Soma.

Figure 147. Assistant Professor Murat Azizoglu in 1994. (EE Department photo)

In 1994 Murat Azizoglu, B.S. 1985 (with Highest Honors) Middle East Technical University, Ankara, Turkey, M.S. 1987 Ohio State, Ph.D. 1991 M.I.T., was appointed Assistant Professor of Electrical Engineering. A member of the Technical Staff at Bell Communications Research in 1989 and an Assistant Professor at George Washington University from 1991-1994, Azizoglu's research and teaching interests were in high-speed communication networks, optical communications, communication theory and information theory.

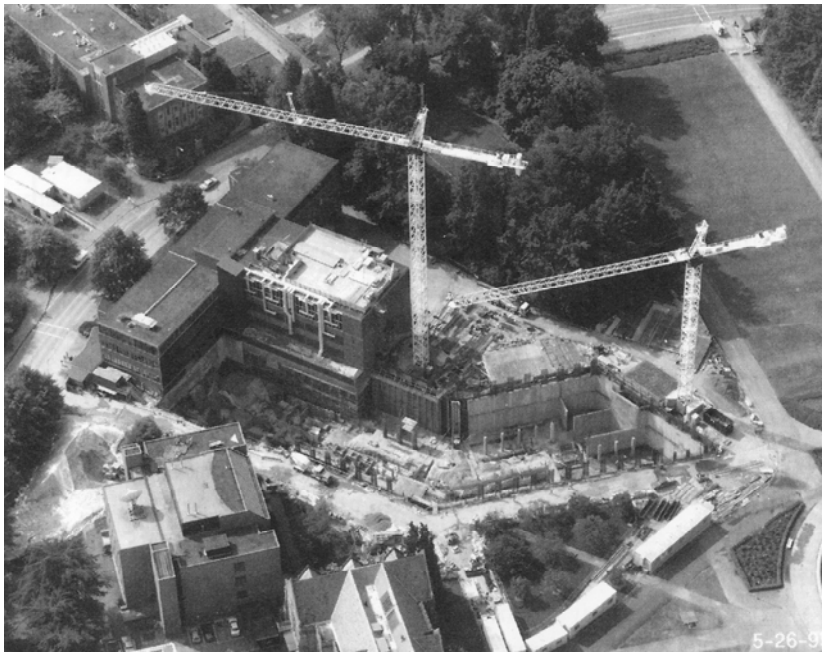

Figure 148. The new EE/CSE building Phase I under construction in May 1995. (*Trend* photo)

In spring of 1995, ground was broken and construction commenced on a new Electrical Engineering/Computer Science and Engineering building. The project was so large that it had to be broken up into phases. Phase I would construct two wings of the new building next to the existing Electrical Engineering Building. Having a building going up right next door was sometimes distracting, but the interaction was fairly well managed and serious interference with normal teaching and research activities was minimal.

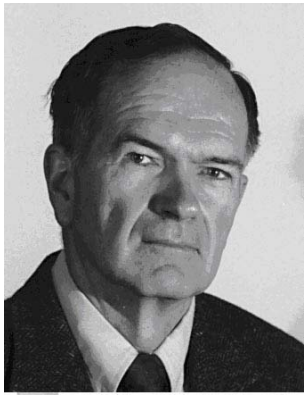

Figure 149. Professor Dean Lytle, date unknown. (EE Department photo)

In 1995 Professor Dean Lytle retired, becoming Professor Emeritus. He had arrived in 1958 as part of the controls area build up and included communications systems in his teaching and research. In 1962 he had written a textbook on mechanical and electrical networks. He had served as Acting Chair in 1988 when Robert Porter stepped down. He maintained a coffee pot in his office that was a magnet for many of the faculty.

Figure 150. Professor Dan Dow in the 1990s. (EE Department photo)

In 1995 Professor Dan Dow retired. He had served as chair from 1968 to 1977, as Associate Director of the Applied Physics Laboratory and as Director of the Washington Energy Research Center. After returning to the department in 1981 Dow had concentrated on teaching undergraduate courses and laboratories. Under his guidance as chair the department had hit a high in research funding. His direction as chair led to a rejuvenation of the energy area and a very successful expansion of the involvement of the department with bioengineering.

Professor Mohamed El-Sharkawi became a Fellow of IEEE in 1995. Assistant Professor Murat Azizoglu received a Faculty Career Development Award from the National Science Foundation. Associate Professor Kelin Kuhn received the UW Distinguished Teaching Award for her innovative and engaging classes in lasers and electronics.

On October 3, 1995, Professor Gernot Born, the Rektor of Gerhard Mercator Universität (GMU), Duisburg, visited the University of Washington to present the Honorary Seal of his university to Professor Emeritus Robert N. Clark, in recognition of Professor Clark's participation in the development of the UW/GMU exchange program. In accepting this honor Dr. Clark identified the benefits that accrue both to one who experiences an academic exchange with a foreign university and to that person's home institution. This presentation was made in conjunction with the first UW/GMU Exchange Lecture, sponsored by the Siemens Company, given by Professor Paul M. Frank of GMU who accompanied Rektor Born to Seattle. Professor Frank presented a comprehensive description of how German universities interact with industry.

During a decade of significant leadership and strategic challenges, the Department experienced both growth and significant improvement in quality, with 23 tenure-track faculty hired from 1985-1995. Only 14 tenure-track faculty departed. The wide range of interests of the new faculty suggests the lack of strategic thrust areas, which is consistent with the high turnover in department leadership. No chair served long enough to develop and implement a strategic plan. The effect was to create competition among research

areas to bring in the best new faculty. Once their research programs were up and running, this infusion of new energy lifted the entire department.

Undergraduate enrollment experienced some changes as public opinion about engineering was affected by news-making disasters or job prospects, but overall held constant. Thus, the teaching load was now shared among more instructors, leaving more time available to build research programs. Most notable is that doctoral student enrollment quadrupled from 1985 to 1994, as did the granting of Ph.D. degrees. Enrollment of underrepresented minorities in graduate programs increased significantly at the end of this decade, while their undergraduate enrollment declined somewhat, as did female enrollment, despite active recruitment efforts. These trends were seen in engineering schools nationwide. During this decade foreign citizen enrollment ranged from 3–5% for undergraduates and 31–43% for graduate programs.

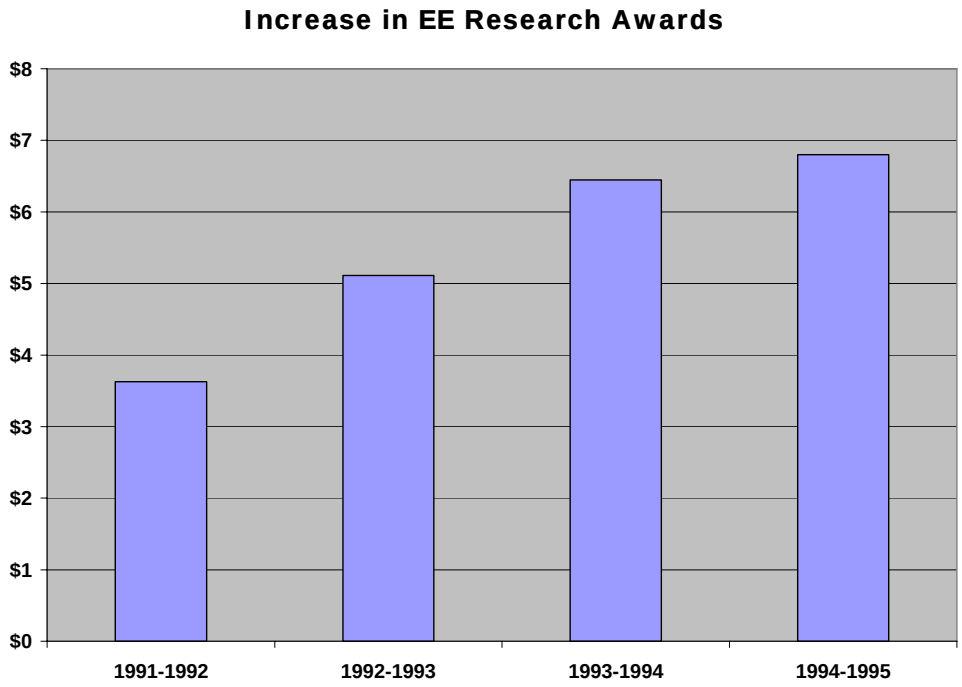

Figure 151. Electrical Engineering research awards by academic year, in millions of dollars. Prior to 1991 research award data was not broken out by department. Source: Office of Research, Annual Report of Awards and Expenditures.

1995-2005 Realized Excellence

Figure 152. 2005 Husky Dawg.

In 1995 the nation was on the edge of the era of irrational exuberance. The widely detested 55-mile per hour federal speed limit was repealed.
The Mosaic browser introduced in 1994 brought the nascent World Wide Web to the attention of the general public. Regular people were starting to go on line. The dot-com boom would start shortly, fueled by technology implemented by electrical engineers. Something called the Digital Video Disc standard claimed that a CD-sized disk could hold a whole movie. In 1994 high definition television was announced, and the JPEG standard. Cell phones were moving from ubiquitous to annoying. The nation was riveted to the O.J. Simpson trial as various exhibits appeared on the Elmo. Grunge had peaked. Hootie and the Blowfish had the top album of 1985.

Darker trends were there to see. Iraq was complaining about both sanctions and inspections. In 1993 Islamist fanatics had set off a truck bomb in the parking garage of the World Trade Center in New York. The building came close to, but did not collapse. Aum Shinrikyo conducted a nerve gas attack in the Tokyo subway. White supremacist Timothy McVeigh blew up the Alfred P. Murrah building in Oklahoma City with a truck bomb. The public watched in fascination and went back to making money.

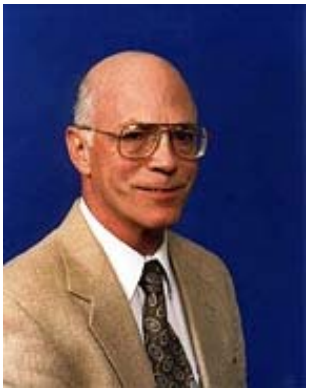

Figure 153. Lecturer Jim Peckol in 1999 (EE Department photo)

In 1995 James Peckol, B.S. 1966 Case Institute of Technology, M.S. 1975, Ph.D. 1985, University of Washington, was appointed Senior Lecturer of Electrical Engineering. Peckol had done some teaching in the Department after his Ph.D., and then in 1993 taught the basic circuits courses part time before being permanently hired with a focus on teaching digital systems. His extensive experience in industry, including work on the communications systems for the Mars Viking Lander project, his constant presence in the lab and his notorious 24/7 email availability combine with his other teaching abilities to make him a popular and effective instructor.

The hot economy was replete with startups and stock options. Neopath was a company founded by Alan Nelson, a professor in Bioengineering. Nelson had worked on medical imaging problems with Professors Yongmin Kim, Greg Zick and Bob Haralick from Electrical Engineering. In appreciation, Neopath donated stock to Electrical Engineering to fund the Peter Bartels Visiting Professorship in Imaging.

Department Chair Greg Zick took time from dealing with the construction of the new Electrical Engineering/Computer Science and Engineering building to commission a history of the Department from Professor Emeritus Rubens Sigelmann.

Figure 154. Professor Mani Soma hams it up as Acting Chair, 1996 (EE Department photo)

In the winter of 1996, Department Chair Greg Zick was diagnosed with cancer. During his absence Associate Chair Mani Soma was Acting Chair. Despite appearances, he took the job seriously and proved able and energetic in the position.

In the spring of 1996 Associate Professor Andrew Yang left for industry. Yang had formed a company, Anagram, Inc., in 1993 to commercialize his VLSI simulator work. Anagram merged with Avant! in 1996 and Yang became Vice President of the Analysis Products Division. Confident, competent and a notably elegant dresser amid the modern informality of the faculty, his departure was both regrettable and understandable in the economic conditions that prevailed.

Professor Thomas Seliga left for Ohio University to chair the Department of Electrical Engineering and Computer Science. Since stepping down as chair in 1993 Seliga had quietly pursued teaching and research activities including the use of Doppler radar to monitor rainfall and predict hazardous road conditions.

In 1996 Akira Ishimaru was elected to the National Academy of Engineering, a high honor. He was the second professor from the Department to enter the Academy. Assistant Professor Deirdre Meldrum received the University of Washington's first Presidential Early Career Award for Scientists and Engineers (PECASE), another high honor. Richard Christie was promoted to Associate Professor.

Figure 155. Associate Professor Ming-Ting Sun, 1996. (EE Department photo)

Greg Zick returned to the Chair's Office in fall 1996 to greet three new faculty. Ming-Ting Sun, B.S. 1976 National Taiwan University, M.S. 1981 University of Texas, Arlington, Ph.D. 1985 UCLA, was hired away from Bellcore, where he was Director of the Video Signal Processing Group. His work in the development of video technology and video coding standards made him a Fellow of the IEEE in 1996. He was appointed an Associate Professor of Electrical Engineering. Ben Gordon was appointed Assistant Professor of Electrical Engineering but left the next year.

Figure 156. Dean and Professor Denice Denton in 2003. (College photo)

In 1996 Denice D. Denton became the new Dean of the College of Engineering and Professor of Electrical Engineering. She earned her B.S., M.S., and Ph.D. degrees in electrical engineering at MIT and was a Professor in the Department of Electrical and Computer Engineering at the University of Wisconsin-Madison before coming to Washington. Her research work focused on microelectromechanical systems.

Professor Mani Soma stepped down as Associate Chair. The new Associate Chair was Professor Mohamed El-Sharkawi. In 1997 John Sahr was promoted to Associate Professor.

Figure 157. Professor Emerita Irene Peden in 1999. (EE Department photo)

In addition to the departure of Ben Gordon, 1997 saw four significant faculty departures. Professor Irene Peden retired. She was an accomplished and productive researcher in electromagnetics since coming to the department in 1961, and also a pioneer as the first, and for many years, the only female faculty member. Professor Peden spent her later years in administrative tasks working for the College, the Department, the National Science Foundation, and promoting opportunities for women in engineering. She had been showered with honors, including Fellow of the IEEE, Fellow of the AAAS, ABET Fellow, and the highest honor for an engineer, election to the National Academy of Engineering. As she accepted her appointment as Professor Emerita, she could perhaps gaze with some satisfaction on the many women students in the department, and on the first female Dean. While equal representation has not yet come to pass, the doors were certainly wide open, and Peden deserved much credit for opening them.

Professor Bill Moritz was retired early and was appointed Professor Emeritus. Starting as research faculty in 1973 working on medical sensors, Moritz had reinvented himself as a computer engineer in the early days of that area, and was the main impetus behind the successful creation of the Computer Engineering program in Electrical Engineering, steering it from its inception in 1977 through HEC Board approval in 1988 and ABET accreditation in 1989. An avid bicyclist, Moritz would now turn his energies to Bike 520, an effort to add a bicycle lane to the State Route 520 floating bridge. While no bicycle lane has yet appeared, every proposed reconstruction plan for the bridge has one.

Professor S.S. Mani Venkata accepted the position of Chair of the Department of Electrical and Computer Engineering at Iowa State. Brought in to revitalize the electric energy area at Washington in 1979, his guidance had built a program with nationally recognized faculty and close cooperation with local and national industry. He now sought a larger stage on which to exercise his administrative talents, and would go on to become Dean at Clarkson. Professor Chen-Ching Liu succeeded Professor Venkata as Director of the Electric Energy Industrial Consortium.

Professor Venkata also recruited Professor Arun Somani to Iowa State. Somani had worked on communications systems and reliability since arriving in 1985 and was a rising star in the department. The liberal application of salary and persuasion moved him

to the alternately frozen and frying flatlands of Ames, Iowa. Somani is now Chair of the Department of Electrical and Computer Engineering at Iowa State University.

Professor Kelin Kuhn departed for a job with Intel. Kuhn had done research in lasers, photonics and electrical sensors. Her classes were highly sought after and her students readily spent upwards of 50 hours a week on the engaging design problems she set. It had been hoped that Professor Kuhn would work with Professor Tom Pearsall, as they had synergistic research areas, but that did not come to pass. Intel offered salary, laboratory facilities and research opportunities that the Department could not match.

While each departure had its own justification, the loss of four such highly successful senior faculty was a concern, especially because no new hires occurred in 1997.

Dean Denton selected Professor Mani Soma to be Associate Dean of Organizational Infrastructure. Soma would lead a complete reorganization of College service activities. Assistant Professor Deirdre Meldrum received the College of Engineering Outstanding Faculty Award for her work on a new Control Systems Laboratory and curriculum.

Figure 158. From Left: CSE Chair Ed Lazowska, EE Chair Greg Zick, Dean Denice D. Denton, President Richard McCormick, Provost Lee Huntsman dedicate the new Electrical Engineering/ Computer Science and Engineering Building in 1998. Right: A dramatic view of the building. (EE Department photo)

Phase I of the Electrical Engineering/Computer Science and Engineering (EE/CSE) Building was completed in 1998 and the Department moved from the 1948 EE Building

into the completed portion of the new one. Rather than the symbolic carrying of chairs that occurred when the 1948 building opened, the move was marked by the packing of boxes and boxes of paper and books, which mysteriously reappeared in the appropriate location in the new building.

Ironically, the move squeezed the department slightly for space. The original plan to demolish the old building and construct Phase II had been delayed. Consequently, the Department of Library and Information Science moved in and filled building windows with its logo. Sports Medicine set up a clinic in the old electronics laboratory.

Figure 159. Professor Jim Meditch from the 1990s. The top of the picture is faded from exposure to sunlight. (EE Department photo)

Five faculty retired in the spring of 1998. Professor Jim Meditch became Professor Emeritus. He had been Chair from 1977-1986 and thereafter a teacher, administrator and productive researcher in communications. His term as chair had completed the cultural transformation to a research university despite a chronic shortage of resources. Professor Robert Porter became Professor Emeritus.

Figure 160. Professor Emeritus Akira Ishimaru in 1999. (EE Department photo)

Professor Akira Ishimaru became Professor Emeritus. Holder of the first Ph.D. granted by the Department and a member of the faculty since 1958, Professor Ishimaru was internationally renowned for his work on scattering. He was a Fellow of the IEEE, a Member of the National Academy of Engineering, and holder of the Boeing Martin

Chaired Professorship. In Professor Ishimaru's case his retirement was more of an administrative realignment than a change in his daily routine, as he continued his teaching, research and editorial activities at about the same pace as before.

Figure 161. Professor Alistair Holden in the early 1990s. (EE Department photo)

Professor Alistair Holden became Professor Emeritus. Also in the Department since 1958, Holden had developed an early interest in computers and did work on artificial intelligence topics well before they became popular in the 1980s. He helped build the computer area and then the Computer Engineering program in the Electrical Engineering Department, finally holding a joint appointment with Computer Science and Engineering. Later he was active in College initiatives to attract students from underrepresented groups to engineering by providing a summer engineering experience on campus.

Figure 162. Professor Emeritus Pete Lauritzen in 1999. (EE Department photo)

Professor Peter Lauritzen became Professor Emeritus. Hired in 1965, he worked on solid state electronic materials and devices until a funding cutoff discouraged his research program. His interests shifted to teaching and international cooperative activities. In the 1980s he restarted his research, working on device models for power electronics, which he considers his most valuable research contribution. He was active in exchange programs with the Soviet Union, especially Tashkent, and was the first EE faculty member, so far as is known, to commute to work by roller blade.

Associate Professor Chi Hou Chan resigned from the Department. Since arriving in 1989, he had conducted highly productive work in computational electromagnetics applied to

circuit boards and semiconductor layouts. He had been on leave at the City University of Hong Kong through the turnover from British rule to control by the People's Republic of China. He received a salary offer that the Department could not match, and elected to remain in Hong Kong as a full Professor. He rapidly rose to Dean at City University.

Greg Zick reached the end of his five-year term as Department Chair and elected not to continue. Hiring opportunities had been sparse, important senior faculty had left for administrative and salary opportunities elsewhere, and his illness in the middle of his term interrupted his strategic plans. His primary accomplishment, by no means an insignificant one, was the construction and occupation of Phase I of the new Electrical Engineering/Computer Science and Engineering Building. Although the full benefits would be realized only on completion of the entire project, Phase I provided a distinct improvement in the quality of the physical environment and of the laboratory facilities available for teaching and research.

Deirdre Meldrum was promoted to Associate Professor. Four faculty were hired in the fall of 1998, the first three due to the efforts and guidance of Chair Greg Zick, who had obtained the positions, secured startup money, appointed a search committee, and negotiated offers with the selected candidates, who were successful junior professors at institutions in Iowa, Texas, and Virginia.


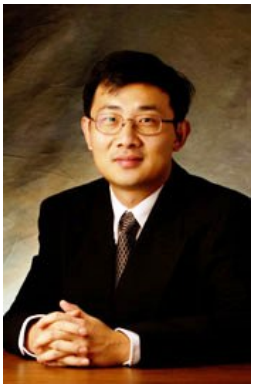


Figure 163. From Left: Associate Professor Sumit Roy in 1999; Associate Professor Hui Liu in 2004; Assistant Professor Richard Shi in 1999. (EE Department photos)

Sumit Roy, B. Tech E.E. 1983 Indian Institute of Technology Kanpur, M.S.E.E. 1985 M.A. in Statistics and Applied Probability, Ph.D. in E.E., University of California Santa Barbara, was hired away from the University of Texas at San Antonio and appointed Associate Professor. Roy's research interests are in communications systems.

Hui Liu, B.S. 1988 Fudan University, M.S. 1992 Portland State University, Ph.D. 1995 University of Texas at Austin, was a second hire in communications systems. He was hired away from the University of Virginia and appointed Assistant Professor of Electrical Engineering. His thesis was "Smart Antenna Applications to Wireless Systems." Liu continues to work in this area with interests in broadband wireless networks and array signal processing.

C.J. Richard Shi, B.Sc. in Electronics Engineering 1985, M.Sc. in Electronics Engineering 1987 Fudan University, M.A.Sc. in Electrical Engineering 1991 Ph.D. 1994 University of Waterloo, was hired away from the University of Iowa and appointed Assistant Professor. His award-winning thesis was entitled “Optimum Logic Encoding and Layout Wiring for VLSI Design: A Graph-theoretic Approach.” Shi works on computer-aided design and test of VLSI systems.

Figure 164. Professor and Chair Howard Chizeck in 1998. (EE Department photo)

The fourth hire was the new Department Chair. Also appointed Professor of EE, Howard Jay Chizeck earned his B.S. in Systems Engineering in 1974 and M.S. in Systems and Control Engineering in 1976 at Case Western Reserve University, and his Sc.D. in Electrical Engineering and Computer Science in 1982 at M.I.T. Chizeck was a successful researcher in the areas of stochastic control theory, mathematical modeling, system identification and adaptive control theory and applications to regulation of physiological variables, and the development of assistive devices for persons with physical disabilities. More importantly, for the previous three years he had been Chair of the Department of Systems, Control and Industrial Engineering at Case Western Reserve University.

Department Chair Chizeck found a department ready for change, with a Dean prepared to support him and a faculty consensus. As part of his candidacy Chizeck presented an action plan to improve the Department. The plan had three basic components: (1) Hire to fill all open faculty slots. For some time the Department had allowed a few faculty lines to go unfilled and used the salary for operating expenses. Chizeck proposed to use these positions, and those from recent retirements and departures, to hire early in his term, a plan written into his hiring contract. (2) With the faculty at full strength, reduce the teaching load. For some time, the standard load had been four courses in three quarters. Faculty with significant research money could “buy out” from one or more of these courses. For the rest, teaching two courses in a quarter often left little time for research work, and the lost momentum on research projects amplified the effect. Chizeck proposed to reduce the teaching load to three courses a year. (3) Publicize the strong points of the Department. A traditional internal view of the mid-20s rankings of Electrical Engineering in the early 1990s concluded that the Department was better than its rankings, but nobody knew this due to our location in the upper left corner of the U.S. map and the tendency of graduates to remain in the Northwest. Chizeck would test the accuracy of this view.

On his arrival in August 1998, Chizeck found numerous distractions from the master plan. He plunged into a staff reorganization, and hired good staff away from their current positions around the College and the University. Funding for a management consultant to advise on the reorganization had been part of his hiring contract. He ended up hiring the consultant, Terri Reed, to be, in essence, his chief of staff.

Chizeck started or reinvigorated several department social functions including Friday graduate student socials, hosted by students from rotating labs with department funding, sometimes supplemented by the laboratory faculty. To get things started Chizeck made use of the interesting arrangement of corridor windows in the new building's atrium to play an EE department trivia game called Holl-EE-Wood Squares. He also turned the staff loose to produce an impressive Halloween Party (some will recall the "Scary Room"), promoted EE Art Walks with exhibitions of artwork from students and staff, and expanded the annual awards beyond Teacher of the Year to include Outstanding Staff, Outstanding TA, and Outstanding Research Advisor. The purpose was to build a sense of community and Electrical Engineering identity for the people in the department.

Figure 165. Holl-EE-Wood Squares, 1999. Left: two-thirds of the square occupants look out of openings above the atrium in the new Electrical Engineering/Computer Science and Engineering Building. Right: Chair Howard Chizeck directs a question at a square while the new Director of Computer Operations, Sekar Thiagarajan, looks for early signs of deception. (EE Department photos)

Figure 166. Left: Professor John Sahr displays spaghetti chefery in 2003. Right: graduate students enjoy the results (From Left: Rachel Yotter, Melissa Meyer, unknown.) (Rich Christie photos)

A special form of social activity was the institution of visits by domestic graduate student applicants who had been admitted to the department. They were flown in and given an opportunity to meet the faculty, discuss research directions, meet each other, experience the Puget Sound region (with the Department keeping fingers crossed for half-decent weather) and subjected to a spaghetti dinner at Associate Professor John Sahr's house, among other activities. The visit program significantly improved the number of quality domestic graduate students who chose to come to Washington.

In the fall of 1998 the State of Washington passed initiative I-200, which ended consideration of race in admissions to the university and its programs. The initiative had little effect on Electrical Engineering. College-level programs such as MESA and MITE, designed to assist and attract underrepresented students, continued to operate as before.

The 1998-1999 academic year was extremely busy for faculty recruitment. Although the exact number of slots to be filled seemed to fluctuate on a daily, ultimately eight tenure-track positions and two research positions were filled. With an average of three interviews per position, a large search committee chaired by Professor Blake Hannaford was kept extremely busy with evaluations, invitations and decision making.

There was no specific strategic technical direction to the hires. The department now had well-funded research programs in VLSI, headlined by Professor Carl Sechen and Assistant Professor Richard Shi, in Signal and Image Processing with Professor Robert Haralick and Professor Les Atlas working in different areas, and in Genomics, an effort centering on Associate Professor Deirdre Meldrum with ties to many other parts of the University, as well as its traditional strengths in Electromagnetics and Energy. There was little chance that the faculty would agree on a single strategic direction, and there was an imperative to hire while the slots were available. One consequence of undirected hiring was a competition among different research areas for the best possible candidates, with the result that the Department was able to hire the best.

In 1999 Howard Chizeck became a Fellow of IEEE for contributions to the use of control system theory in biomedical engineering. Bruce Darling and Jenq-Neng Hwang were promoted to full Professor. Assistant Professor Richard Shi received the CAREER award from the National Science Foundation, the successor to the National Young Investigator award. The junior faculty had continued a 100% success rate in competition for this particular stamp of quality. Senior Lecturer James Peckol received the Department's Outstanding Educator Award.

Professor Yongmin Kim became Chair of the Department of Bioengineering. Since his hiring in 1982 his research had progressed through nine generations of graphics processors for medical imaging, each of exponentially improved performance. He had established a reputation as a formidable instructor. In his senior digital systems course students worked 80 hours a week to build different forms of microprocessor based aids for handicapped people. The workload did not discourage student interest, and Professor Kim had found it necessary to control admission to the course by competitive examination. Students planned their courses around the opportunity, viewing Kim's course as a ticket to career success. Professor Kim maintains a joint appointment and an office in the Electrical Engineering building.

Professor Robert Pinter was appointed Professor Emeritus. Since his hiring in 1964 he had taught in the Controls area and worked on understanding biological control systems. He died suddenly soon after retirement.

The strenuous recruiting effort of the previous year resulted in the hiring of eight new tenure-track faculty, and also two research faculty, who started in Autumn 1999.

Figure 167. Professor David J. Allstot ca. 2003. (EE Department photo)

David J. Allstot, B.S. in Engineering Science 1969 University of Portland, M.S.E.E. 1974 Oregon State, Ph.D. 1979 Berkeley, was appointed Professor of Electrical Engineering. Professor Allstot has held industrial positions with Tektronix, MOSTEK, and Texas Instruments, and academic positions with Oregon State, Carnegie Mellon, and Arizona State universities, from whence he was hired away. Professor Mani Soma, a long-time friend of Professor Allstot's, was instrumental in recruiting him. An outstanding researcher in analog electronic circuits and an inveterate winner of teaching awards, he

provided the department with instant credibility in an area of increasing importance in modern electrical engineering, and also a notably unselfconscious sense of humor.

Figure 168. Assistant Professor Scott Hauck in 1999. (EE Department photo)

Scott Hauck, B.S. in Electrical Engineering and Computer Science 1990 Berkeley, M.S. 1992 Ph.D. in Computer Science and Engineering 1995 Washington, was appointed Assistant Professor of Electrical Engineering. Hauck's thesis was "Multi-FPGA Systems" and he continues to direct his research toward Floating Point Gate Arrays. Hauck was hired away from Northwestern University, where he had been an Assistant Professor.

Figure 169. Professor Mari Ostendorf; Assistant Professor Jeff Bilmes. (EE Department photos, 1999)

Mari Ostendorf, B.S. 1980 M.S. 1981 Ph.D. 1985 Stanford, was appointed Professor of Electrical Engineering. She was hired away from Boston University, where she ran one of the premier speech recognition research programs in the country.

Jeff Bilmes, B.S. 1989 Berkeley, M.S. 1993 M.I.T., Ph.D. 1999 Berkeley, was also appointed Assistant Professor. His thesis was "Natural Statistical Models for Automatic Speech Recognition."

Katrin Kirchhoff, M.A. 1996 Ph.D. 1999 University of Bielefeld, Germany, was appointed Research Assistant Professor of Electrical Engineering. Her thesis title was "Robust Speech Recognition Using Articulatory Information." She did some of her thesis work at Berkeley.

These three hires taken together constituted a major strategic initiative in speech recognition specifically aimed at creating a program that would interface with Microsoft's research interests. Professor Les Atlas was instrumental in recruiting the faculty candidates and promoting them and their area inside the Department.

Figure 170. Associate Professor Scott Dunham in 1999. (EE Department photo)

Scott Dunham, B.S.E.E. 1919 Cornell, M.S.E.E. 1980 Ph.D. 1985, Stanford, was appointed Associate Professor of Electrical Engineering. Dunham was an Associate Professor at Boston University, where he worked on modeling of microfabrication processes and semiconductor device behavior.

Figure 171. Assistant Professor Karl Böhringer in 1999. (EE Department photo)

Karl F. Böhringer Dipl.-Inform. 1990 Karlsruhe, M.S. 1993 Ph.D. 1997 Cornell, was appointed Assistant Professor of Electrical Engineering. His thesis was "Programmable Force Fields for Distributed Manipulation, and Their Implementation Using Micro-fabricated Actuator Arrays." Böhringer thus introduced a focus on Micro-Electro-Mechanical systems into the Department. He was hired away from a post-doctoral position at Berkeley, where he was working on parallel micro-self-assembly. In 1999 he received the NSF CAREER award.

Figure 172. Assistant Professor Denise Wilson, with dog Trooper, ca. 2002. (EE Department photo)

Denise M. Wilson, B.S. 1988, Stanford, M.S.1989, Ph.D. 1995 Georgia Tech was appointed Assistant Professor of Electrical Engineering. Wilson was hired away from Georgia Tech where she was an Assistant Professor and had received the NSF CAREER award in 1997. Her thesis was “Analog VLSI Architecture for Chemical Sensing Microsystems.” Her research continues in sensing microsystems and she had a strong interest in service learning and K-12 outreach activities.

Figure 173. Assistant Professor Alexander V. Mamishev in 1999. (EE Department photo)

Alexander V. Mamishev, B.S. in Electrical Engineering and Physics 1992 Kiev Polytechnic Institute, M.S.E.E. 1994 Texas A&M, Ph.D. 1999 M.I.T., was appointed Assistant Professor of Electrical Engineering. His thesis was “Interdigital Dielectrometry Sensor Design and Parameter Estimation Algorithms for Non-destructive Materials Evaluation.” His research has expanded to include MEMS sensor applications, robotics and electrostatic air pumps.

To round off the year, Tai-Chang Chen, Ph.D. in Materials Science and Engineering 1997 Washington, was appointed Research Assistant Professor. His research includes MEMs devices, radiation sensing, GaN semiconductors, and chip cooling.

A review of the hiring indicates a mixed strategic plan. A hole in analog electronics was filled with a senior hire. A speech recognition program with a strategic relationship to a

major local industry — Microsoft — was brought in with a senior hire, a junior hire and a research hire. Successful junior faculty were recruited away from other schools, and outstanding new Ph.D.s were identified in the search process. Hiring Scott Hauck can be seen as creating a bridge to the Computer Science and Engineering Department as well as bringing in an outstanding young professor.

The new faculty would start work with a slightly different administrative arrangement. The former single Associate Chair position was split into an Associate Chair for Research and an Associate Chair for Education. Professors Les Atlas and Blake Hannaford, respectively, were the first appointees to these positions. The Department also started its own development effort, seeking to regain contact with its many alumni. State support for the University had been slowly eroding, causing the University to consider fundraising activities closer to those of private schools. Department Chair Chizeck's experience at a private school was helpful in getting a head start on these new development activities.

News from Seattle in the winter of 1999 featured the "Battle of Seattle." The World Trade Organization held its annual meeting in Seattle, and attracted swarms of protestors. The ones in turtle costumes were no problem, but masked anarchists broke shop windows, trashed and looted unpopular company stores, set bonfires in the streets and fought with police, who in turn started to treat every protestor as a potential arsonist. The bad press took some of the gloss off Seattle, which had been hailed as America's Most Livable City in 1989 and had gone on to benefit from the fame of Microsoft, grunge music, Starbucks, Boeing and the dot-com bubble. A local icon vanished from the scene in March 2000 when the Kingdome was imploded.

In 2000 Research Assistant Professor Randy Babbit departed for a tenure track positions in the Physics Department at Montana State University. Research Professor Darrell Jackson retired from the Applied Physics Laboratory and was appointed Research Professor Emeritus. Since his arrival in 1978 he had worked with numerous M.S. and Ph.D. candidates and with other faculty from the Electrical Engineering department on research problems in underwater acoustics. Ming-Ting Sun was promoted to full Professor, and Scott Hauck was promoted to Associate Professor.

Honors in 2000 include the award of the Boeing-Egtvedt Chaired Professorship to Professor David Allstot, in recognition of his outstanding research program and teaching abilities. Associate Professor Deirdre Meldrum was named a member of the National Institute of Health Director's Peer Review Oversight Committee. Assistant Professor Karl Böhringer was a National Science Foundation New Century Scholar.

In 2000 Professor Thomas Pearsall, who had been on leave in France since 1988, resigned his faculty position at UW.

The 1999-2000 recruiting effort sought to fill a few holes left over from the previous year. Tenure-track faculty were hired in electromagnetics and communications, and three research faculty started work.

Figure 174. Assistant Professor Vikram Jandhyala ca. 2000. (EE Department photo)

Vikram Jandhyala, B.Tech. 1993 Indian Institute of Technology, New Delhi, M.S. 1995 Ph.D. 1998 University of Illinois at Urbana-Champaign, was appointed Assistant Professor of Electrical Engineering. His thesis was “Fast Multilevel Algorithms for the Electromagnetic Analysis of Quasi-planar Structures.” He worked for Ansoft Corporation before finding his way back into academia at Washington, where he continues to work on problems in computational electromagnetics.

Figure 175. Assistant Professor Radha Poovendran ca. 2000. (EE Department photo)

Radha Poovendran, B.Tech 1988 Indian Institute of Technology (IIT), Bombay, M.S.E.E. 1992 Michigan, Ph.D. 1999 Maryland, was appointed Assistant Professor of Electrical Engineering. His thesis was “A Convex Optimization Approach for Addressing Storage-communication Tradeoffs in Multicast Encryption. His research area is communications security, including cryptographic key management.

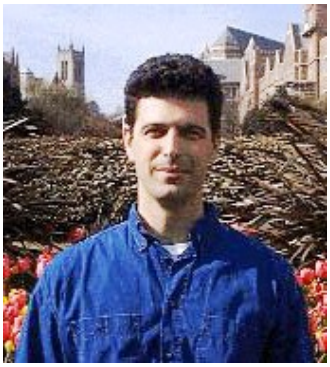

Figure 176. Research Assistant Professor Jacob Rosen ca 2003. (EE Department photo)

Jacob Rosen B.Sc. in Mechanical Engineering 1987, M.Sc. 1993 and Ph.D. 1997 in Biomedical Engineering, Tel-Aviv University, Israel, was appointed Research Assistant Professor of Electrical Engineering. Rosen works on the research problems of powered exoskeletons and surgical robots.

Figure 177. Research Assistant Professor Linda Bushnell ca. 2000. (EE Department photo)

Linda Bushnell, B.S.E.E. 1985 M.S.E.E. 1987 Connecticut, M.A. (Mathematics) 1989 Ph.D. 1994 Berkeley was appointed Research Assistant Professor of Electrical Engineering. She worked on problems in networked control systems.

Figure 178. Research Assistant Professor Tim Chinowsky ca. 2000. (EE Department photo)

Tim Chinowsky, B.S. 1989 M.I.T., M.S. 1997 Ph.D. 2000 Washington, was appointed Research Assistant Professor. Chinowsky designed research instrumentation packages for rockets and balloons for the Washington Geophysics department before becoming a graduate student. His current research is on surface plasmon resonance biosensors, cooperating with Professor Sinclair Yee.

In February 2001 the Electrical Engineering and Computer Science Building was rocked by the magnitude 6.8 Nisqually earthquake. The building rode out the shaking with no significant damage.

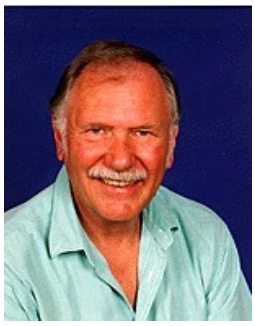

Figure 179. Professor Robert Albrecht in 1999. (EE Department photo)

A number of senior faculty retired in 2001. Professor Robert Albrecht was appointed Professor Emeritus. He had arrived in 1961 to work in the Nuclear Engineering program with an administrative appointment in Electrical Engineering. His controls background allowed him to contribute to both efforts. In 1966 he formally departed to the Nuclear Engineering Department while maintaining ties with the EE controls group. Albrecht had served as chair of and *de facto* Electrical Engineering representative to the CH^2A^2OS committee, which brought in a major College of Engineering undergraduate curriculum revision in 1971. When the Nuclear Engineering Department began to dissolve itself in 1984, Albrecht returned to Electrical Engineering and moved to the research area of autonomous mobile robots. He also served as Associate Chair for Research. Among his other accomplishments, Albrecht was the second member of the EE Air Force. He now produces video travelogs and charity DVDs.

Figure 180. Professor Frank Alexandro in 1999. (EE Department photo)

Professor Frank Alexandro retired and was appointed Professor Emeritus. He arrived in 1964 and was a member of the strong controls group of that era. He was a co-author of

the textbook *Linear Systems Analysis* of 1969. He served for many years as Undergraduate Coordinator, supervising undergraduate admissions and the curriculum.

Figure 181. Professor Jonny Andersen in 1999. (EE Department photo)

Professor Jonny Andersen retired and was appointed Professor Emeritus. He had arrived in 1967. He worked on circuit theory and taught many circuits classes.

Figure 182. Professor Robert Haralick in 1999. (EE Department photo)

Professor Robert Haralick retired and was appointed Professor Emeritus. Hired in 1986 as the Boeing-Egtvedt Chaired Professor, he had supervised an active and well-funded research program in image processing, including image recognition and computer vision. It was one of the two most significant research programs in the department in the late 1980s and early 1990s. Later, Haralick became interested in the problem of hidden messages encoded in the Bible, which he sought by using statistical signal processing techniques. After his retirement he pursued this interest at the City University of New York.

Associate Professor Murat Azizoglu resigned in 2001, moving to a career in industry with Sycamore Networks.

In 2001 Associate Professors Deirdre Meldrum and Scott Dunham were promoted to full Professors. Professor Meldrum was the Principle Investigator and Director of the National Institute of Health Center of Excellence in Genomic Science (CEGS), the Microscale Life Sciences Center. Professor Jenq-Neng Hwang was elected a Fellow of the IEEE. Validation of the continuing quality of faculty recruiting by the Department came as four junior faculty received the National Science Foundation CAREER award: Assistant Professors Jeff Bilmes, Radha Poovendran, Vikram Jandhyala and Alexander Mamishev. Assistant Professor Mamishev also received the Outstanding IEEE Student

Branch Chapter Advisor Award. Mamishev gave Chapter Chair Curtis Lu, a senior, much of the credit. Assistant professor Denise Wilson received the Electrical Engineering Outstanding Teaching Award. Professor Leung Tsang went on academic leave. He visited Chi Hou Chan at the City University of Hong Kong, where Tsang served as a Chaired Professor and Assistant Head of the Electronics Department for two years.

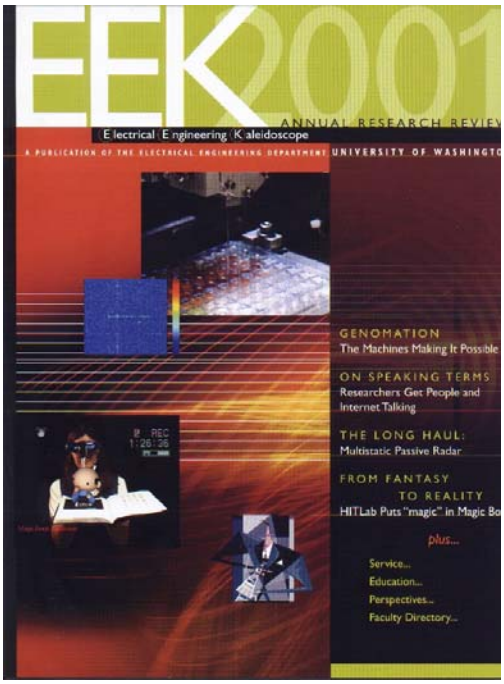

Figure 183. Cover of the 2001 EE Kaleidoscope (EEK!)

The first stage of Department Chair Howard Chizeck's strategic plan had been accomplished by the 1999 hirings. With the faculty at full strength, the nominal teaching load was reduced to three courses a year, providing more time for research and educational improvement activities. Now the third major plank in the plan was implemented. The Electrical Engineering Kaleidoscope (EEK) was published in a four-color format to inform the world of the accomplishments of the Department. EEK was distributed to deans, department chairs and other opinion leaders in academia, and used to promote the Department. It was self-funding, paid for by advertisements, and has been published annually since 2001.

The dot-com bubble economy finally started to cool off in 2001. Many Electrical Engineering graduates in the spring of 2000 had received multiple job offers and had to referee bidding wars for their services. In the spring of 2001 employers started withdrawing job offers. The demand for electrical engineers would rapidly recover to a more reasonable one-offer-per-student level, but the shock to the graduates would ripple through to cause a drop in interest in Electrical Engineering among entering students. The effect on the Department was compounded by a major increase in admissions to the Computer Engineering program, and by the start of an undergraduate program in the Bioengineering department, both of which drew students.

The events of September 11, 2001 are well known. A handful of religious fanatics seized control of four jet airliners and used these technological marvels to destroy the World Trade Center and a portion of the Pentagon, killing about 3,000 innocent people at the cost of their own lives. The “end of history” dating from the fall of the Berlin Wall in 1989 was suddenly over and a new historical era dawned. One of the many ramifications of this event is a sobering lesson about the potential for deadly misuse of technology. The principal immediate effect on the Electrical Engineering Department was a sense of unease and a general tightening of security. Over the long run, the collapse of the dot-com economy and diversion of federal funds to internal and external anti-terrorism efforts has reduced both government and private availability of research funding.

A far less regrettable building demolition occurred closer to home. The Computer Science and Engineering Department had energetically pursued private funding and now could proceed with completion of the Electrical Engineering/Computer Science and Engineering Building. The first step, which started in 2001, was the demolition of the 1948 Electrical Engineering Building. In his 1965 history, Professor George Smith remarks on the feelings of sadness experienced by older faculty watching Old Engineering Hall being torn down in 1956. (One suspects these were his own sentiments.) There may have been a few similar thoughts among the current faculty about the 1948 building, but most felt little regret to see it go. Built in the lean post-World War II years, the building had little in the way of amenities or architectural merit. Toward the end of its occupancy it had proved difficult and expensive to retrofit with the networking services that modern education and research required. The building had been home to Electrical Engineering for 49 years through a period of massive growth and cultural transformation to a funded research orientation. It had educated generations of students and was the birthplace of many valuable and important research ideas — but it would not be missed. The Computer Science and Engineering Department was almost indecently ecstatic over the destruction, as it was the next step in freeing them from Sieg Hall, the least well-liked building on campus.

Figure 184. Assistant Professor Tara Javidi in 2002. (EE Department photo)

2002 was a quiet year in contrast to the energy and events of 2001. Two junior faculty were hired. Tara Javidi, B.S.E.E. 1996 Sharif University, Tehran; M.S.E.E. Systems 1998, M.S. in Applied Mathematics 1999, Ph.D. in Electrical Engineering and Computer Science 2002 Michigan, was appointed Assistant Professor of Electrical Engineering.

Her thesis, “Optimal Resource Allocation: Issues and Applications,” dealt with important issues in communications systems.

Figure 185. Assistant Professor Kai Strunz in 2002. (EE Department photo)

Kai Strunz, Dipl.-Ing. 1996 Dr.-Ing. 2001 University of Saarland, Germany, was appointed Assistant Professor of Electrical Engineering. His thesis had dealt with simulation in power systems. Strunz has had a remarkably multi-national career, working with the English National Grid at Brunel University in London, and then with Electricité de France in Paris, from which he came to Washington.

In 2002 Sumit Roy was promoted to full Professor. Research Assistant Professor Linda Bushnell received an NSF ADVANCE fellowship. Assistant Professor Radha Poovendran received the Army Research Office Young Investigator Award. Associate Professor John Sahr became the Associate Chair for Education.

In Spring 2003 Professor Robert J. Marks II left the department to return to his native state of Texas and Baylor University. Marks had been the first “pure” signal processor in the Department when he arrived in 1977 and had done much research in the area of neural network applications to signal processing. He had formed a productive partnership with Professor Mohamed El-Sharkawi and together they operated the Computational Intelligence Applications Laboratory, or CIA Lab. Professor Marks was an outspoken advocate of rigor and selectivity in the graduate program and faculty promotion and tenure. He had directed an undergraduate curriculum revision in 1987 and was a member of the committee that redrafted the College faculty promotion and tenure guidelines.

The completion of the Electrical Engineering/Computer Science and Engineering Building project in 2003 did not adhere to the original plan. Learning from the experience of Phase I, the Computer Science and Engineering Department commissioned a new design for the building attached to the new EE building. Completion of the project made space along the interface line between Phase I available to Electrical Engineering. Electrical Engineering also was assigned main office space and a few faculty offices in the new Paul G. Allen Center for Computer Science & Engineering. For the first time in many years, space restrictions on Electrical Engineering eased rather than tightened.

Karl Böhringer was promoted to Associate Professor. Professor Deirdre Meldrum was named a fellow of the American Association for the Advancement of Science (AAAS), and Editor of the new periodical *IEEE Transactions on Automation Science & Engineering*. Assistant Professor Kai Strunz received the National Science Foundation CAREER award.

Assistant Professor Mamishev received the EE Department Outstanding Research Advisor award. Following in the footsteps of Professor Yongmin Kim, Mamishev had demonstrated the ability to motivate graduate and undergraduate researchers to pour immense amounts of time and effort into research work. He claims his personal record is three days — that is, one of his students worked three days straight on a research project without sleeping. Professor Mamishev's involvement in the FIRST robotics competition should also be acknowledged. He advised a large team of enthusiastic undergraduates and high school students through several years of high finishes in massive regional and national competitions, and organized a regional competition at the University of Washington.

Research Assistant Professor Linda Bushnell received the EE Chair's Award to recognize her development of a senior sequence of courses in mobile robots. Students built robots from Lego components that competed in robot golf and soccer competitions. The relatively inexpensive components require sophisticated design and programming to achieve high performance in the assigned tasks. The competition at the end of the class in spring quarter became a public event in the new Microsoft Atrium of the Allen Center.

The space shuttle Columbia was lost on reentry during mission STS-107. The National Air and Space Administration (NASA) convened an Accident Investigation Board. Professor Bruce Darling was asked to serve on the Board and spent much of the winter and spring of 2003 contributing to the investigation. His work with sensor readings and the sequence of sensor failures helped identify the location of the failure, trace its progress and point to the probable cause.

The payoff from the strategic plan of Chair Howard Chizeck was realized in 2003 when the Electrical Engineering Department was ranked 16th out of some 330 Electrical Engineering programs nationwide. For many years the department had been ranked in the high twenties. A rankings move of this magnitude drew notice. The move was in part a result of the excellent performance of the faculty. This in turn was based on the solid foundation laid by faculty hiring during the terms of the department chairs prior to Chizeck: Dan Dow, Jim Meditch, Tom Seliga, and most recently Greg Zick, plus the success of the many recently hired faculty. The other contributor to the rise in rankings was the result of publicizing the strengths and accomplishments of the department. A claim can be made that this ranking means that the Department is the best among its peers, in that departments with higher ratings are either private schools that do not carry the mass educational responsibilities of a state university, or are significantly larger departments.

Summer of 2003 was the end of the fifth year of Chizeck's term as department chair. He had accomplished most of what he promised when he was hired. In the course of negotiating an extension of his term he made the decision to step down. A serious illness in the spring quarter was a factor in his decision. His term was a remarkable example of what a wise and dynamic leader with a rare combination of technical talent, administrative and academic political skills, and good interpersonal relationship skills can accomplish. The accomplishments of his term far outweighed things left undone, notably an undergraduate curriculum revision.

Figure 186. Professor and Acting Chair Bruce Darling in 2003. (EE Department photo)

Professor Bruce Darling, returned from the Columbia accident and was appointed Acting Chair as the Department set out to plan its future. Professor Jenq-Neng Hwang agreed to serve the department as Associate Chair of Research and Development.

Five new faculty started in the Autumn of 2003. Their hiring had been organized and negotiated by Department Chair Howard Chizeck before he stepped down.

Figure 187. Associate Professor Lih Lin in 2003. (EE Department photo)

Lih Y. Lin, B.S. in Physics 1990 M.S. in Physics 1992 National Taiwan University, M.S.E.E. 1993 Ph.D. 1996 UCLA, was appointed Associate Professor of Electrical Engineering. After her Ph.D. she had worked at AT&T Research as a Senior Technical

Staff member on micromachining for optical switching and light-wave communications systems, and then moved to Tellium, Inc. as Director of Optical Technogies to work on high port count MEMS optical cross connects, where, to quote her web page “she had a sip of telecom start-up frenzy, was gladly terminated, and happily found her next home [in] academia.” Her hiring was part of a University level strategic program in photonics based on the work of Professor of Chemistry Larry Dalton on optoelectronic materials.

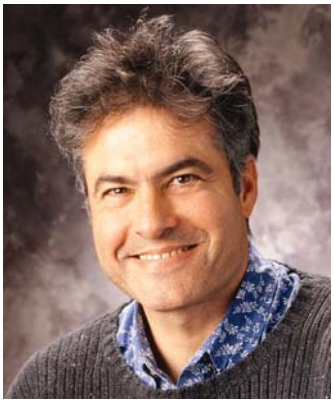

Figure 188. Lecturer Evan Goldstein in 2003. (EE Department photo)

With Lih Lin came her husband, Evan Goldstein. Initially educated in Philosophy, he holds a B.S.1975 from Antioch College and an M.A. 1977 and M.Phil 1981 from Columbia. He then earned a B.S. in Electrical Engineering 1985, M.S.E.E. 1986, and Ph.D. 1989 from Columbia. After switching electrical engineering, Goldstein worked at Bell Core, Bell Labs, and AT&T Labs on optical switching. He then joined Tellium as Director of Optical Networking Systems, suffered the same fate as Lin, and came to the University of Washington determined to teach and was appointed Lecturer in Electrical Engineering.

Figure 189. Assistant Professor Babak Amir Parviz in 2003. (EE Department photo)

Babak Amir Parviz, B.S.E.E. 1995 Sharif University of Technology, Iran, M.S.E.E. 1997 M.S. in Physics 2001 Ph.D. 2001 Michigan, was appointed Assistant Professor. Parviz was a Postdoctoral Fellow in Chemistry and Chemical Biology at Harvard before coming to Washington. His research interests include Nanofabrication, Self-Assembly, MEMS, Organic Electronics and Photonics, and he has proven to be a remarkably fine teacher.

Figure 190. Assistant Professor Eric Klavins in 2003. (EE Department photo)

Eric Klavins, B.S. 1996 San Francisco State University, M.S. 1998 Ph.D. 2001, Michigan, was appointed Assistant Professor. Klavins was a Postdoctoral Scholar at CalTech before coming to Washington. His research interests are in self-organizing systems, concurrency, distributed algorithms, robotics and control theory.

Figure 191. Assistant Professor Maya Gupta in 2003. (EE Department photo)

Maya Gupta B.S.E.E., B.A. Economics 1997, Rice University, M.S. 2000 Ph.D. 2003 Stanford, was appointed Assistant Professor. Her thesis was "An Information Theory Approach to Supervised Learning." Her research interests are in estimation and classification, image processing, information theory, and the science of color vision.

The principal topic of discussion in the Department in the 2003-2004 academic year was the search for a new chair, with some debate over the merits of an external or internal search. The former view prevailed, and an immediate consequence was that the Dean reserved two unfilled faculty positions to use as negotiating tools with the new Chair.

In 2004 John Sahr and Richard Shi were promoted to full Professor. Sahr's work on bistatic radar observation of the ionosphere had been producing interesting results for some time. Shi's work in VLSI design generated a well funded research program and kept him very, very busy.

Figure 192. Associate Professor Ward Helms in 1999. (EE Department photo)

Associate Professor Ward Helms retired and was appointed Associate Professor Emeritus. Helms had been the token Cougar in the Department since arriving in 1960 as a graduate student. He had earned his winter in Antarctica while at Washington State. His research work evolved naturally from antennas to the hardware that operated them, until interrupted by a funding cutoff. He was carrying a large instructional burden as he completed his career, and would continue to teach part time after his retirement.

In 2004 Professor Deirdre Meldrum and Lecturer Evan Goldstein were named Fellows of the IEEE. Assistant Professor Radha Poovendran received his third Young Investigator award, this one from the Office of Naval Research. Associate Professor Karl Böhringer received the Academic Early Career Award from IEEE Robotics and Automation Society. Assistant Professor Kai Strunz received the Department's Outstanding Teaching Award, and Assistant Professor Vikram Jandhyala received the Department's Outstanding Research Advisor Award.

Undergraduate interest in electrical engineering in 2004 was impacted by the publicity given to outsourcing of technical work to India and China. Some students thought that there would be no jobs for them when they graduated and sought other majors.

Figure 193. Professor and Chair David J. Allstot ca. 2005. (EE Department photo)

The external chair search had not produced any acceptable candidates. With the completion of Bruce Darling's one-year term as chair, Professor David J. Allstot agreed

to serve as Acting Chair for 2004-2005. The chair search committee was reorganized and began another external search.

Four faculty departed in 2005. Assistant Professor Tara Javidi was lured back to California to the communications faculty at the University of California at San Diego, an ideal fit for her research interests. Professor Carl Sechen departed for the University of Texas in Dallas.

Professor Chen-Ching Liu resigned to become the Palmer Chair Professor of Electrical and Computer Engineering at Iowa State University. Professor Liu had dominated the Energy Group since Professor Venkata's departure in 1997. He founded and directed the Advanced Power Technologies research consortium and served as Associate Dean of Organizational Infrastructure.

The most significant departure was that of Dean Denice D. Denton. In a terrific opportunity to further her career as an academic administrator, she left to become Chancellor of the University of California at Santa Cruz. Uncertainty about College leadership may have contributed to the failure of the previous year's chair search. Professor Mani Soma agreed to serve as Acting Dean, and Professor Eve Riskin became the Associate Dean for Organizational Infrastructure, replacing Professor Liu.

In 2005 Jeff Bilmes, Vikram Jandhyala, and Alexander Mamishev were all promoted to Associate Professor, making the much-sought-after transition to tenured status. Assistant Professor Radha Poovendran received the Presidential Early Career Award for Scientists and Engineers (PECASE), the second such prestigious award in the Department. Professor Richard Shi was named a Fellow of the IEEE.

The 2004-2005 chair search concluded by selecting Acting Chair David J. Allstot to become the permanent department chair. In his candidate presentation he identified development as a key area for improvement in the department. As this history reveals, the State of Washington has a long history of under funding higher education, especially as compared to the funding other states provide to public universities considered our peers. In recent times the shortfall has become significant enough to motivate the University to pursue funding mechanisms similar to those long used by private schools. The University has been conducting a successful multi-year capital campaign, Campaign UW (to conclude in 2008). Close to 60% of the new Paul G. Allen Center for Computer Science & Engineering was funded by private donation. The department has long depended on the generosity of its friends in industry to equip the electronics, electrical and computer laboratories necessary for effective technical education. Good faculty have departed in recent years for lucrative positions elsewhere, and in particular for chaired professorships, so it is a wise goal to obtain the resources needed to maintain the high quality of the Electrical Engineering department.

The decade of 1995-2005 was one of remarkable change and improvement in the Department of Electrical Engineering. As with many instant successes, the foundation took a long time to build and was the work of many, many people. Howard Chizeck was

the right person at the right time in the right department, and the three factors synergized to vault the Department into a top 15 rating. The improvement did not come from an increase in faculty size. During this decade, 23 tenure-track faculty were hired, and 26 departed. The number of research faculty increased modestly. A look at faculty research areas indicates growth in the new areas of MEMS and nanotechnology, but no other obvious strategic direction. While there was specific strategic hiring during the decade, the overall strategy added up to hiring the best candidates. The effect of the major hiring year of 1999 can be seen in the graph of research awards.

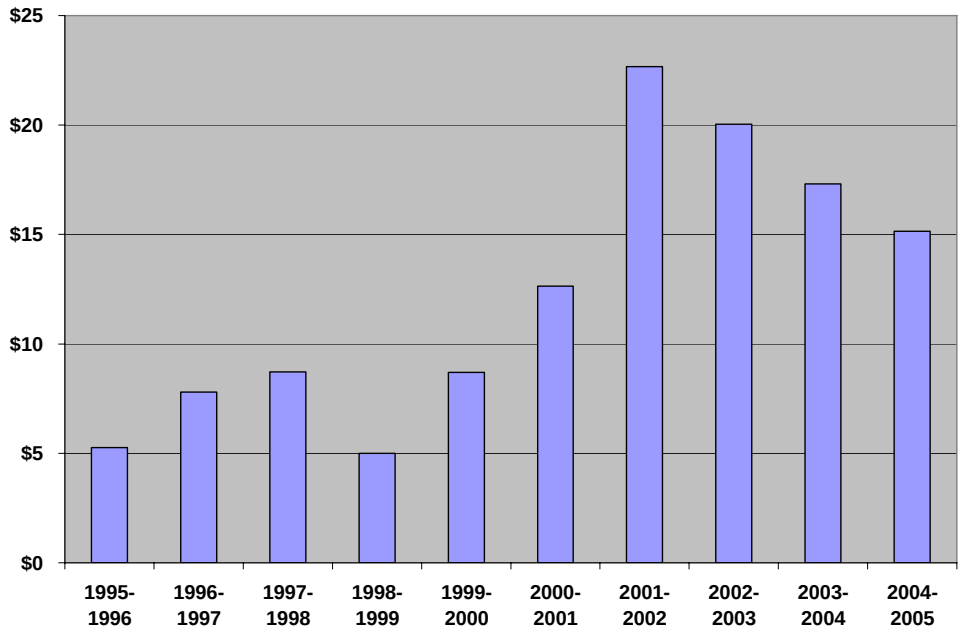

Figure 194. Electrical Engineering research awards by academic year, in millions of dollars. Source: Office of Research, Annual Report of Awards and Expenditures.

One remarkable aspect of the faculty is the high percentage of female professors. At one point in the decade the count reached a high of nine, including the Dean; in 2005, 17.5% of the faculty were female. This progress is due to a combination of assiduous recruiting and a comfortable environment for women in the faculty, as well as the achievements of the professors themselves. The path blazed by Professor Irene Peden in 1961 is now becoming well traveled, and we may look forward to a continued increase in the number of women in the faculty.

Enrollment in Electrical Engineering during the decade was roughly constant, even at the graduate level, despite the major increase in research awards. Since the late 1980s the undergraduate enrollment had been limited by agreement with the College. The number of applications, and the percentage of applicants admitted is a better measure of student interest in Electrical Engineering. As a later graph shows, interest was high until 2003, when potential EE students were deterred by the post-2001 economic slowdown, and then lured away by the enlarging Computer Engineering and Bioengineering undergraduate programs.

Curricular change during the quarter was limited. A number of new electives were introduced, and some older electives dropped, but the curriculum had remained largely unchanged since the last major reform in 1991. Interest in undergraduate curriculum revision started in about 2001. The committee found no major problems needing to be fixed, and turned its attention to innovative concepts. It eventually agreed on a radical reduction in the required core, to only three courses, to allow students more flexibility to design a curriculum to meet their needs — specialized in an area, broad for generality, or with enough room to include courses aiding later pursuit of an M.D. or LL.D. degree. The radical reduction in core size generated significant concerns among some of the faculty, and the revision was tabled for a year after the chair transition in 2003. A related but separate discussion about a freshman electrical engineering course continues.
A significant change in the curriculum that does not appear in the statistics is the rapid growth of undergraduate research activities. The department has taken steps to promote this activity to both faculty and students, and many faculty have enthusiastically embraced the idea.

The successes of the decade gave the Department significant momentum to carry forward its legacies of educational service and research excellence into the next century.

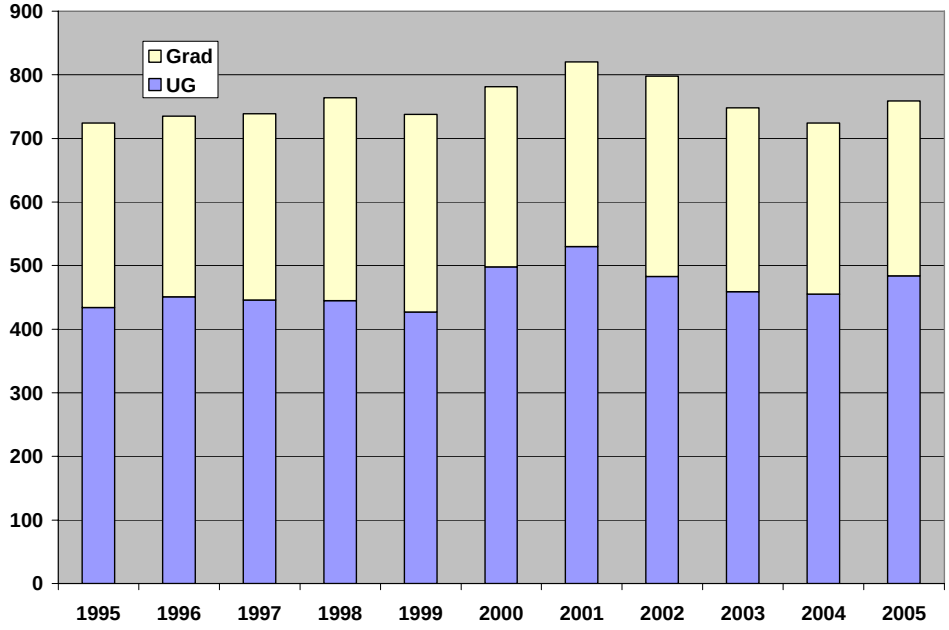

Figure 195. EE Total Enrollment 1995-2005.

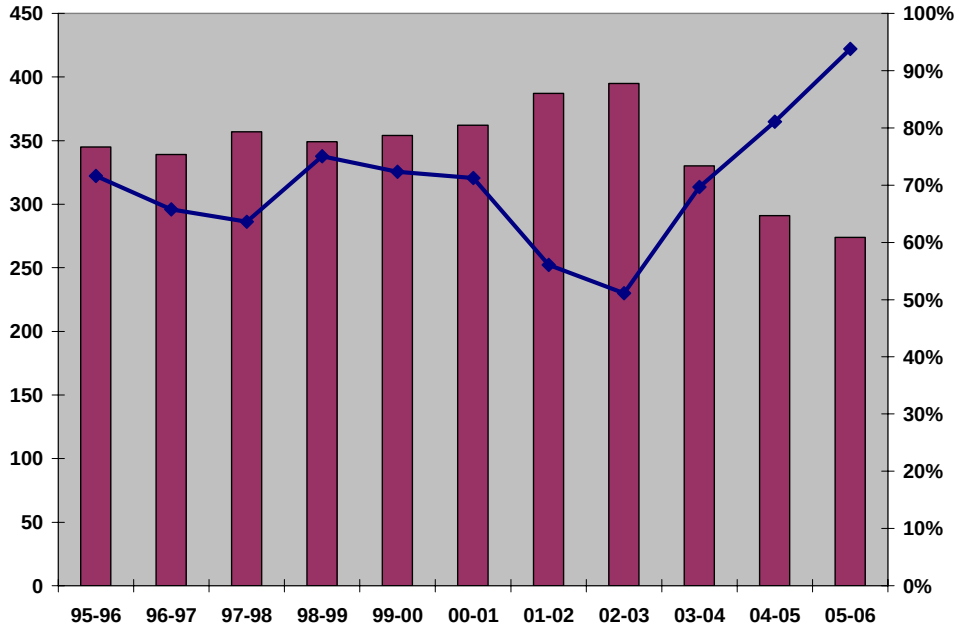

Figure 196. Interest in Electrical Engineering. The bars are the number of applicants to the undergraduate program. The line is the acceptance rate.

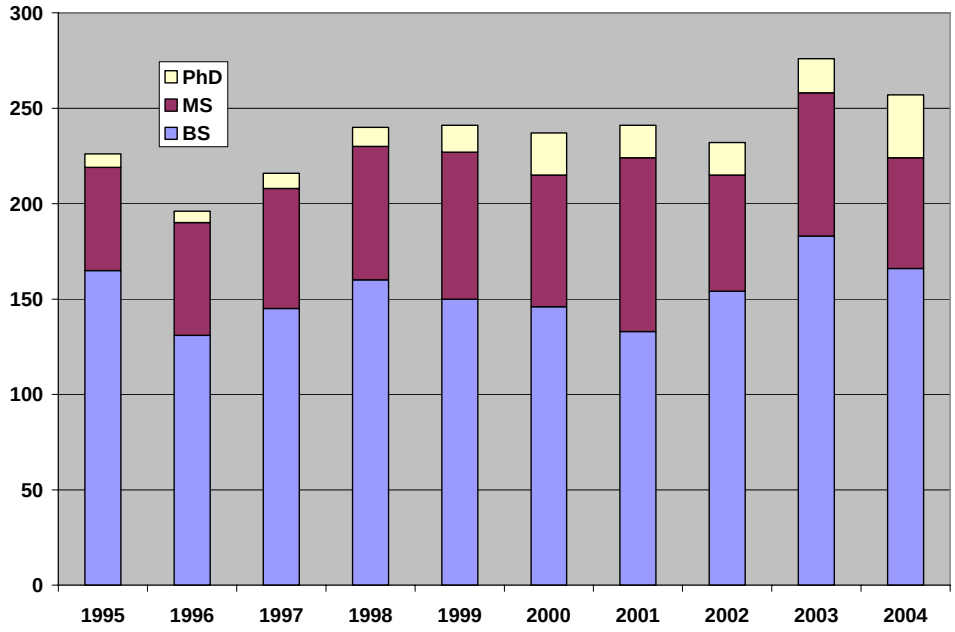

Figure 197. EE Degrees Granted, 1995-2004

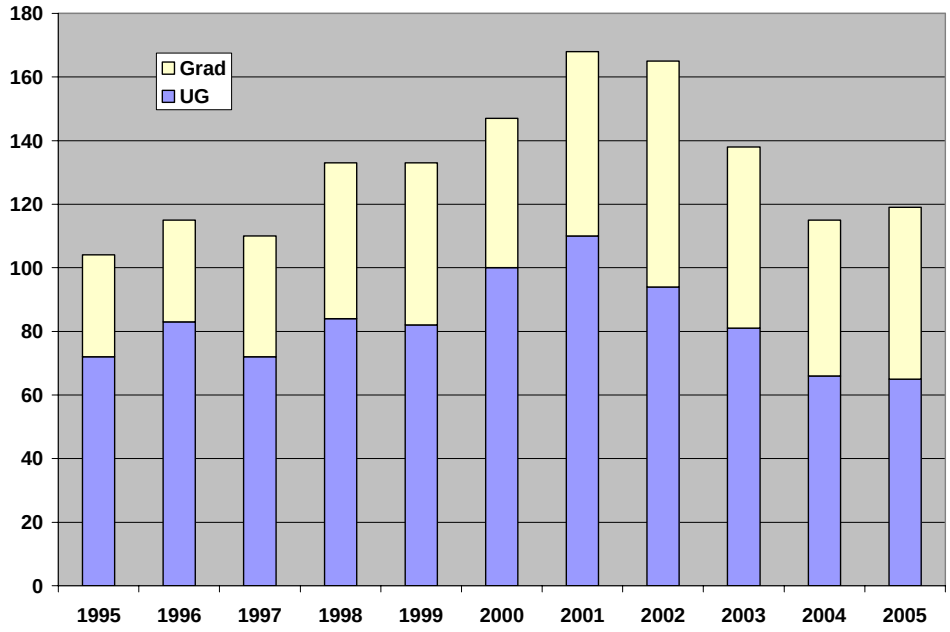

Figure 198. EE Female Enrollment, 1995-2005.

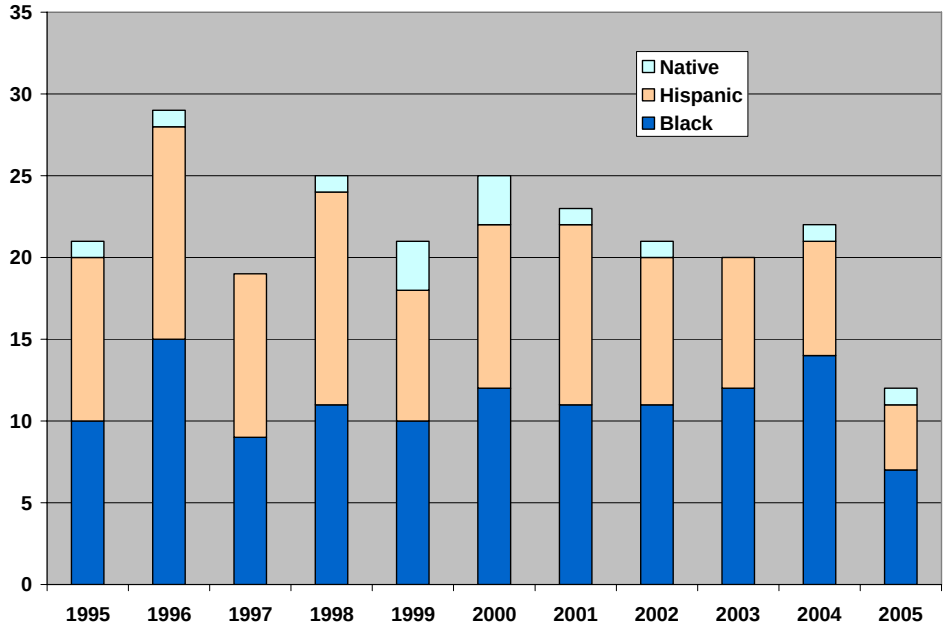

Figure 199. EE Undergraduate Minority Enrollment, 1995-2005. For comparison, the 2000 Washington State census had the state population as 3.2% Black, 7.5% Hispanic and 1.6% Native American, while the EE department was 2.4% Black, 3.2% Hispanic and 1.2% Native American.

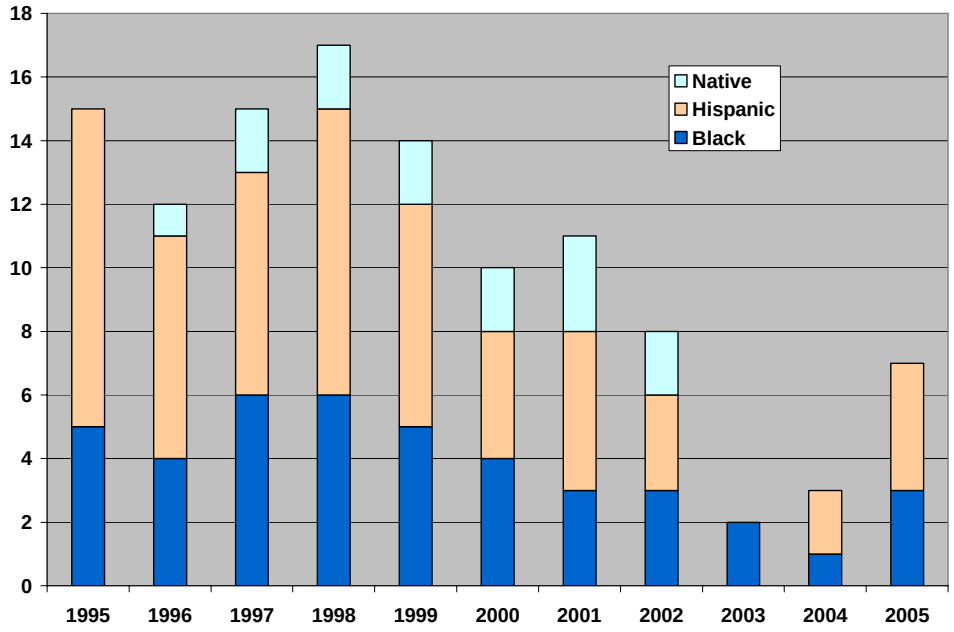

Figure 200. EE Graduate Minority Enrollment 1995-2005.

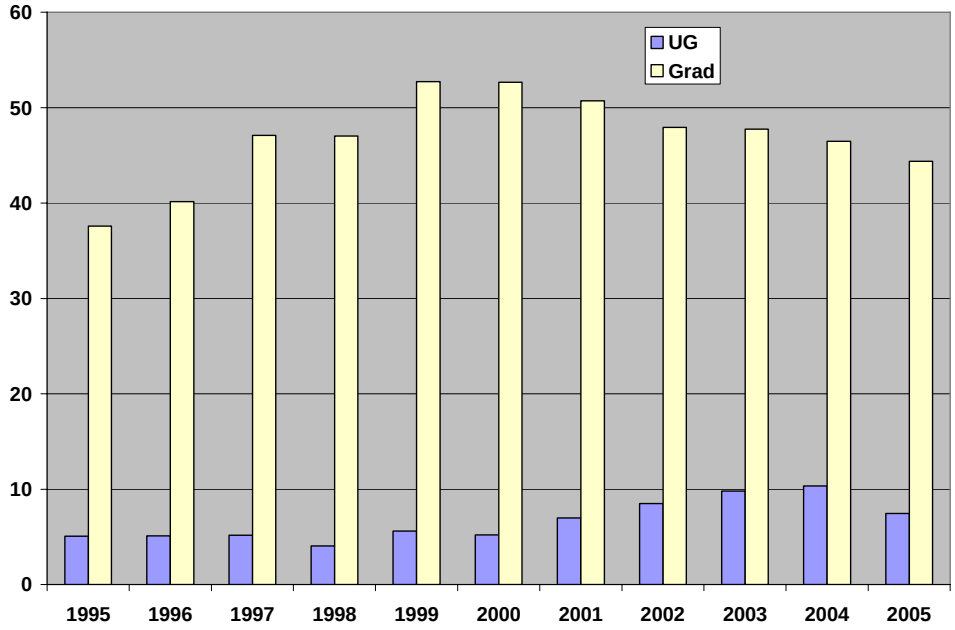

Figure 201. EE Foreign Citizen Enrollment, 1995-2005. Enrollment is shown as a percentage of total enrollment.

2005-2006 The Centennial Year

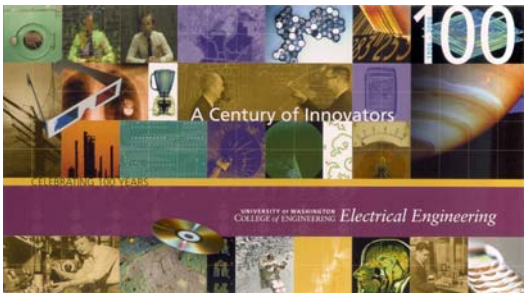

Figure 202. Electrical Engineering Centennial postcard, 2005-06.

Looking back over 100 years of department history, we see that several themes recur. The cycle of faculty activity is endless. Faculty are hired, teach, do research, are promoted, receive honors, and retire or depart. Thus, in 2005 two new faculty, Brian Otis and Jose Ammer, have joined the department, and one respected faculty member will depart in 2007.

Figure 203. Assistant Professor Brian Otis in 2005. (EE Department photo)

Brian Otis, B.S.E.E. 1999 Washington, M.S. 2002 Ph.D. 2005 Berkeley, was appointed Assistant Professor of Electrical Engineering. His thesis was “Ultra-Low Power Wireless Technologies for Sensor Networks.” His interests are analysis, design, and test of ultra-low power RF integrated circuits and systems, minimal energy operation of electronics for pervasive computing, and communication and MEMS/IC interfaces.

Figure 204. Assistant Professor Josie Ammer in 2005. (EE Department photo)

Josie Ammer, B.S. 1997 M.Eng. 1999 M.I.T., Ph.D. 2004 Berkeley, was appointed Assistant Professor of Electrical Engineering in January 2006. Her interests are integrated circuits and algorithms for wireless communication.

Departing eventually is Professor Deirdre Meldrum, who was hired as the Dean of the Ira Fulton School of Engineering at Arizona State University to start in January 2007. Her

move into academic administration caps a career of meteoric rise to prominence in the very popular area of genomics, the analysis of DNA.

Other themes continue through the history of the Department. Research has always been an interest of the faculty, although each new generation of professors thinks the older generation in not as hip. Carl Magnusson prided himself on the research performed by his faculty and students. Gedaliah Held set the department on the path to a funded research culture in the late 1950s. Dan Dow and Jim Meditch promoted the transformation, which reached its most recent peak in 2001, under the leadership of Howard Chizeck.

Its prolonged presence at the frontiers of technology, and its immense breadth, mean that many new technical areas first appear as offshoots of electrical engineering. The department has been the incubator for many other departments, including Scandinavian Studies, Aeronautics, Computer Science and Computer Science and Engineering, and a piece of Bioengineering. Other departments will certainly emerge from Electrical Engineering in the future. The most likely immediate prospect may be something like Molecular Engineering.

New areas have been added to the Department over time. Originally founded on power engineering, electronics appeared in the 1920s and took over in 1941. Electromagnetics was the premier area from the mid-1950s to the 1960s. A strong controls group appeared in the 1960s, as did the computer area that morphed into digital systems. The first signal processor appeared in the 1970s and that area has grown to one of the larger specialties, spawning communications as an area in its own right as recently as the 1990s. The latest emerging area may be MEMS and nanotechnology, or perhaps genomics.

While we rejoice in the research triumphs, the foundation of the Department, its *raison d'etre*, is education. Since the inception of the electrical engineering degree at Washington, 9,632 students have graduated with the Bachelor of Science in Electrical Engineering, 2,262 have received Master's degrees, 15 the professional degree of Electrical Engineer, and 571 the Ph.D. The work and contributions of our graduates, and the new knowledge generated by our community of innovators will carry society forward through the next century and beyond.

Figure 205. The Centennial photograph of the Electrical Engineering faculty, 2006.

Front row (sitting) left to right: Jeff Bilmes, Brian Otis, Hui Liu, Yasuo Kuga, Radha Poovendran.

Second row, left to right: Jacob Rosen, Mark Holl (in rear), Lih Lin, Howard Chizeck, Linda Shapiro, Marty Afromowitz, Bruce Darling, Mark Damborg, John Sahr, Jim Ritcey, Kai Strunz, Richard Shi, Maya Gupta (front), Vikram Jandhyala.

Third row, left to right: Tai-Chang Chen, Les Atlas, Eric Klavins, Blake Hannaford, Mohamed El-Sharkawi, Jenq-Neng Hwang, Jim Peckol, Greg Zick.

Rear row, left to right: Akira Ishimaru, Leung Tsang, Ward Helms, Sinclair Yee, Deirdre Meldrum, Babak Parviz, Rich Christie, Ming-Ting Sun.

(EE Department photo)

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Appendix – Chronological List of Faculty

Start	End	First Name	Middle	Last Name	Remarks
1896	1897	William	F.	Edwards	
1897	1900	James		Moran	Lab Tech
1897	1902	Theodore	E.	Doubt	
1899	1903	David		Kelly	
1900	1901	Jacob		Duttenhoeffer	Lab Tech
1901	1904	Rudolph	Ernst	Heine	
1902	1905	Frederick	A. (Tubby)	Osborn	To Physics
1904	1905	Henry	L.	Brakel	To Physics
1904	1941	Carl	Edward	Magnusson	Chair 1905-1941. Dean 1917-1929.
1905	1915	Frank	E.	Johnson	
1909	1952	Edgar	A.	Loew	Dean 1935-52. Emeritus.
1912	1922	Leslie	F.	Curtis	To industry.
1915	1929	Frederick	Kurt	Kirsten	To Aero full time.
1918	1919	Ludvig	Peterson	Kongsted	
1918	1919	Mr.		Guptil	
1918	1952	Gordon	R.	Shuck	Emeritus.
1919	1920	William		Spraragen	
1920	1964	George	Lisle	Hoard	Emeritus.
1921	1923	Albert		Kalin	
1921	1923	Jack	Roderick	Tolmie	
1921	1960	George	Sheridan	Smith	Emeritus.
1924	1960	Roy	Eric	Lindblom	
1924	1969	Austin	Vitruvius	Eastman	Chair 1941-1968. Emeritus.
1926	1927	Theodore		Bergstrom	
1928	1929	John		Weir	
1934	1969	Lyall	B.	Cochran	Emeritus.
1937	1941	Charles	M.	Wolfe	
1941	1976	William	Ryland	Hill	Dean 1972-1975. Emeritus.
1942	1943	Dale	G.	Sheckels	
1943	1951	Vinson	LeRoy	Palmer	
1946	1971	Floyd	D.	Robbins	Emeritus.
1946	1974	Walter	E.	Rogers	Emeritus.
1946	1979	Laurel	J.	Lewis	Emeritus.
1947	1953	Andrew	B.	Jacobsen	
1947	1955	Homer	M.	Rustebakke	

1947	1979	F.	Robert	Bergseth	Emeritus.
1947	1981	H.	Myron	Swarm	Emeritus.
1948	1949	Elder	Haldon	Smith	
1948	1949	Robert	Leigh	Tanner	
1948	1956	Thomas	M.	Stout	
1948	1973	Arthur	E.	Harrison	Emeritus.
1949	1950	Richard		Clay	
1949	1950	C.	Y.	Lee	
1953	1957	James	H.	Fisher	
1954	1957	Paul	C.	Leach	
1954	1960	Robert	E.	Wall	
1954	1960	Gedaliah		Held	
1955	1957	Jack	W.	Carlyle	
1955	1958	Harry	Robert	Fechter	Nuclear Engineering group.
1955	1961	David	D.	McNelis	
1955	1983	John	L.	Bjorkstam	Emeritus.
1955	1989	David	L.	Johnson	Emeritus.
1957	1994	Robert	Newhall	Clark	Emeritus.
1958	1965	Katsunori		Shimada	
1958	1992	Endrik		Noges	Chair 1988-1990. Emeritus.
1958	1993	Chih-Chi		Hsu	Emeritus.
1958	1995	Dean	Winton	Lytle	Chair 1988. Emeritus.
1958	1998	Alistair	David C.	Holden	Emeritus.
1958	1998	Akira		Ishimaru	Emeritus.
1959	1967	Lynn	A. K.	Watt	
1959	1975	Hellmut		Golde	To CS.
1959	1983	Donald	Kelly	Reynolds	Emeritus.
1959	1983	Edward	C.	Guilford	Emeritus.
1959	1991	Rubens	Adolpho	Sigelmann	Emeritus.
1960	1963	Charles		Wang	
1960	1965	Gordon	H.	Hanson	
1960	1971	William	E.	Creedon	
1961	1967	Robert	William	Albrecht	To Nuclear Engineering.
1961	1972	Peter	R.	Metz	
1961	1997	Mary	Irene Carswell	Peden	Emerita.
1962	1967	Robert	E.	Lindsay	
1964	1977	Betsy		Ancker-Johnson	Research, Affiliate.
1964	1999	Robert	Bartholomew	Pinter	Emeritus.
1964	2001	Frank	J.	Alexandro	Emeritus.

1965	1998	Peter	O.	Lauritzen	Emeritus.
1966	1975	Jay		Harris	To NSF. Dean at SDSU.
1966	1980	F.	Paul	Carlson	To President, Oregon Grad. Ctr.
1966	Active	Sinclair	S.	Yee	
1967	1972	Eugen	V.	Schibli	
1967	1974	Graham		Duff	
1967	2001	Jonny		Andersen	Emeritus.
1968	1973	Curtis	C.	Johnson	
1968	1975	Jerre	Donald	Noe	CS Group Chair 1968. To CS.
1968	1995	Daniel	G.	Dow	Chair 1968-1977. Emeritus.
1968	2004	Ward	Julian	Helms	Emeritus.
1969	1972	Kenneth		O'Keefe	
1969	1975	Jean-Loup		Baer	CS Group. To CS.
1969	1981	David		Auth	
1969	Active	Mark	J.	Damborg	Chair 1992-1993.
1971	1989	William		Potter	Emeritus.
1971	1989	Charles		Redeker	Emeritus.
1973	1974	Raymond		Heald	
1973	1997	William	E.	Moritz	Emeritus.
1974	1986	Patricia	D.	Daniels	EE Chair, Seattle U.
1974	Active	Martin	Alan	Afromowitz	
1974	Active	Gregory	Leonard	Zick	Chair 1993-1998.
1976	1978	Van	E.	Mablekos	
1976	1998	James	Stephen	Meditch	Chair 1977-1985. Emertius.
1977	2003	Robert	Jackson	Marks II	
1978	2000	Darrell	R	Jackson	Research, Emeritus.
1979	1997	Subrahmanyam	Saraswati	Venkata	Iowa State EE Chair.
1980	Active	Mohamed	Ali	El-Sharkawi	
1982	1985	Peter	F.	Swaszek	To U Rhode Island.
1982	Active	Yongmin		Kim	BioEng Chair 1999-Date
1982	Active	Mani		Soma	Chair 1996. Acting Dean 2005.
1983	1988	Yasuo		Kuga	Research
1983	1989	Edwin	Byron	Stear	
1983	2005	Chen-Ching		Liu	To ISU Chaired Professorship
1983	Active	Les	Eugene	Atlas	
1983	Active	Leung		Tsang	
1984	1992	Peter	Wing-Poon	Cheung	
1984	2001	Robert	William	Albrecht	Emeritus.
1985	1988	Thomas		Sloane	

1985	1988	Paul		Lin	
1985	1997	Arun	K.	Somani	
1985	1998	Robert	Philip	Porter	Chair 1985-1988. Emeritus.
1985	Active	Robert	Bruce	Darling	Chair 2003-2004.
1985	Active	James	A.	Ritcey	
1986	2001	Robert	Martin	Haralick	Boeing Egtvedt Chair. Emeritus.
1986	Active	Linda	G.	Shapiro	
1986	Active	Dale	P.	Winebrenner	Research - APL
1987	2003	Robert	C.	Spindel	APL Director Emeritus
1987	Active	James	C.	Luby	Research - APL
1989	1996	Andrew	Tien	Yang	
1989	1997	Kelin	J.	Kuhn	
1989	1998	Chi	Hou	Chan	Dean, City Univ. of Hong Kong.
1989	2000	Thomas	P.	Pearsall	
1989	Active	Blake		Hannaford	
1989	Active	Richard	Dunstan	Christie	
1989	Active	Jenq-Neng		Hwang	
1989	Active	Eric	Ivan	Thorsos	Research - APL
1990	1992	Cornelius		Leondes	Boeing Martin Chair.
1990	1996	Thomas	Anthony	Seliga	Chair 1990-1992.
1990	Active	Eve		Riskin	
1991	1993	Patrick		Carey	Research
1991	Active	John	D	Sahr	
1991	Active	Yasuo		Kuga	
1992	2005	Carl		Sechen	
1992	Active	Deirdre	R	Meldrum	
1992	Active	Brian	A	Nelson	Research
1992	Active	Lawrence	A	Crum	Research - APL
1992	Active	Daniel	J.	Dailey	Research
1993	2000	William	Randall	Babbitt	Research
1994	2001	Murat		Azizoglu	
1995	Active	Mark		Holl	Research
1995	Active	James		Peckol	Senior Lecturer.
1996	1997	Benjamin		Gordon	
1996	2005	Denise	D.	Denton	Dean 1996-2005.
1996	Active	Ming-Ting		Sun	
1997	Active	Tai-Chang		Chen	Research
1998	Active	(C-J) Richard		Shi	
1998	Active	Hui		Liu	

1998	Active	Sumit		Roy	
1998	Active	Howard		Chizeck	Research
1998	Active	Larry		McMurchie	Research
1999	Active	Karl	F.	Böhringer	
1999	Active	Denise	M.	Wilson	
1999	Active	Alexander	V.	Mamishev	
1999	Active	Scott	A.	Hauck	
1999	Active	Jeff	A.	Bilmes	
1999	Active	Scott	T.	Dunham	
1999	Active	Mari		Ostendorf	
1999	Active	David	J.	Allstot	Chair 2004-
1999	Active	Katrin		Kirchhoff	Research
1999	Active	Tai-Chang		Chen	Research
2000	Active	Vikram		Jandhyala	
2000	Active	Radha		Poovendran	
2000	Active	Jacob		Rosen	Research
2000	Active	Linda		Bushnell	Research
2000	Active	Tim		Chinowsky	Research
2002	2005	Tara		Javidi	
2002	Active	Kai		Strunz	
2003	Active	Maya		Gupta	
2003	Active	Lih	Y.	Lin	
2003	Active	Eric		Klavins	
2003	Active	Babak	A.	Parviz	
2003	Active	Evan		Goldstein	
2005	Active	Brian		Otis	
2006	Active	Josephine		Ammer	