



Department of Electrical Engineering and Computer Science

A Brief Overview: 1970-2010

by Thomas B.A. Senior

A history of the Electrical Engineering Department was written by Richard K. Brown in 1970. This was an appropriate time since it was believed to be the 75th anniversary of the founding of the Department, and celebratory lectures were given in April and May of that year. However, in 1994 when preparations began for the 100th anniversary, it was discovered that 1895 had nothing to do with the creation of the Department. The first 3 degrees of Bachelor of Science in Electrical Engineering were granted by LS&A, and the Regents' action in 1895 was to establish a Department of Engineering (later, College of Engineering). The Department of Electrical Engineering was actually created in 1905, but when 2005 came, the anniversary passed without any recognition.

In 1970 the Department was located in the East Engineering building (now East Hall) on Central Campus (Fig. 1). Its chair was Joseph E. Rowe who had been appointed in 1968, and he was assisted by Jack Cochran who had served as the Administrative Manager for the past 5 years and occupied an office next to that of the Chair. The Department had 33 full, 13 associate, and 9 assistant professors, as well as 6 lecturers. Most faculty engaged in research, and were associated with one or more of the Departmental Research Laboratories. These were the newly-formed Bioelectrical Sciences (W.J. Williams, director), Cooley Electronics (T.W. Butler, Jr., director) located in the Cooley Building on North Campus, Electron Physics (G.I. Haddad, director) located on the second floor of East Engineering, Radiation (R.E. Hiatt, director) located in the

Space Research building on North Campus, and Systems Engineering (rotating director) also located on the second floor of East Engineering. Although research support, particularly from the DoD, was becoming harder to obtain, the laboratories were reasonably stable.



Fig. 1: East Engineering Building (now East Hall)

Most of the graduate work that was not purely electrical was done as part of the CICE (Computer, Information and Control Engineering) program. This was an inter-departmental graduate program in the College. It was established in 1968, involving the Aerospace, Electrical and Industrial Engineering Departments, and soon grew to include almost 40 faculty.

The undergraduate program was in a state of almost constant change. With the recent decrease in program length to 128 hours, and the introduction of a 3-option program, many new junior level courses were being developed, with emphasis placed on computer engineering, communication systems and power systems. But even greater changes were about to occur. Because of the growing importance of computers, in July 1971 the Regents created the new degree of Bachelor of Science in Engineering (Computer Engineering), i.e., B.S.E. (Comp.E) and changed the Department's name to Electrical and Computer Engineering. The 50 or so faculty were now faced with a choice. Most chose to remain Professors of Electrical Engineering, but 16 became Professors of Electrical and Computer Engineering and one became a Professor of Computer Engineering. The distinction lasted only 5 years and by 1976 all faculty were shown as Professors of Electrical and Computer Engineering in accordance with the name of the Department.

The first B.S.E. (Comp.E) degrees were awarded in Spring 1973. Initially, the total number of bachelor degrees awarded per year was about the same as it had been, but by the end of the decade the number had almost doubled, with the computer degrees representing a third of the total. This was in spite of a decrease in the general fund allotment and the number of faculty members. The computer field was moving fast, with mainframes still dominant, but mini-computers were starting to take hold, and in 1972 the Merit Computer Network, connecting Michigan, Michigan State, and Wayne State, went on-line.

For the Fall 1972 semester Lawrence L. Rauch served as Acting Chair while Rowe was on leave and then in the summer of 1974 Rowe resigned to accept the position of Dean of Engineering and Vice Provost at Case Western Reserve University in Cleveland, Ohio. John A.M. Lyon was appointed Acting Chair for a 1-year term starting September 1974. A little earlier the Electro-optics Laboratory was moved from the IST building on North Campus to the East Engineering Building. The Laboratory was directed by Emmett N. Leith and was integrated with the Interferometry Laboratory directed by Charles M. Vest of the Mechanical Engineering Department. Technically they functioned as a single interdisciplinary laboratory. A Power Systems Laboratory directed by Mark K. Enns was also established, and Theodore G. Birdsall replaced Butler as Director of the Cooley Electronics Laboratory. Later the same year the Radiation Laboratory moved into space on the west side of the fourth floor of East Engineering, effectively trading places with the Atmospheric, Oceanic and Space Sciences Department. It was the first time the Laboratory had been in the same building as the Department, and the increased visibility had an immediate effect on the number of graduate students it was able to attract.

On 1 July 1975 George I. Haddad was chosen to be the new ECE Department Chair with a 5-year term, and Nino Masnari replaced him as the Director of the Electron Physics Laboratory. In line with a suggestion made two years earlier, the Department was now organized as two Divisions – Electrical Engineering and Computer and Information Systems – with an Associate Chair for each, and J.A.M. Lyon and Keki B. Irani were given these positions (see Fig. 1 for the organization). A Vehicular Electronics Laboratory was also established with an equipment grant of \$250K from the Bendix Corporation. Its director was Dale M. Grimes (who was later replaced by William R. Ribbens) and it was located on the third floor of the East Engineering Building next to the Electron Physics Laboratory.

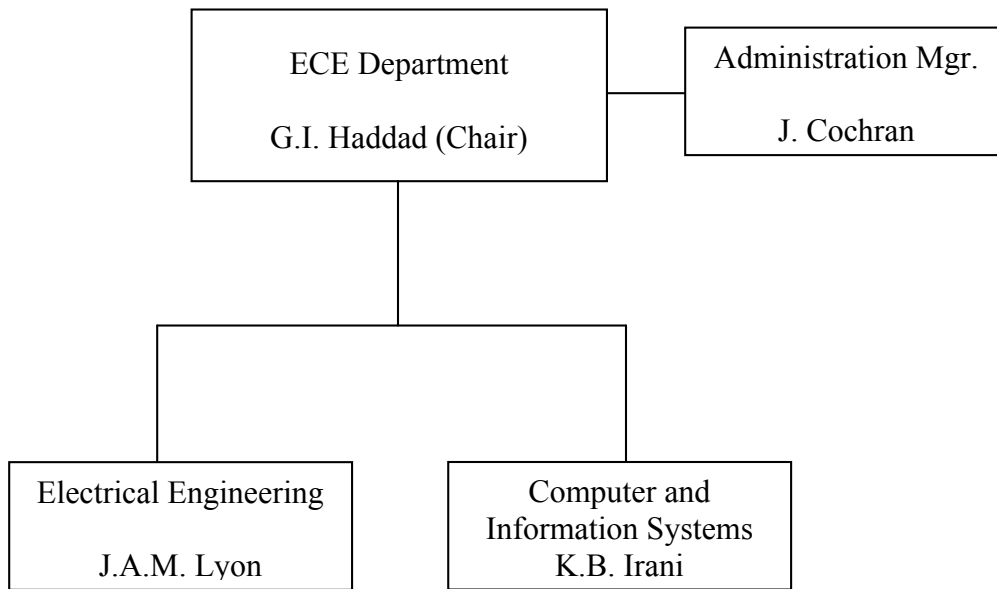


Fig. 1: ECE Department Organization - 1975

In October 1975 Thomas B.A. Senior was appointed Director of the Radiation Laboratory. Two years later the University announced its intention to sell Willow Run Airport and the Laboratory was forced to vacate its experimental facilities there. Most of these, including a large anechoic chamber and a tapered one, were located in Hangar II at the airport. In the summer of 1977 most of the facilities were moved to the (very large) Room 525 in the basement of East Engineering. Using material salvaged from the anechoic chamber in Hangar II, a new and improved tapered chamber was built in part of Room 525. The construction was largely a student project, even to the decorative paneling on the outside of the chamber. The remaining facilities at Willow Run were transferred to the Beck road side of the airport, and later expanded to include outdoor scattering and antenna ranges.

In 1977 Jack Cochran resigned his position as Administration Manager, and some of his duties were taken over by Richard A. Volz, who had earlier replaced Irani as Associate Chair.

Two years later, Irani took over from Volz who had been appointed the Director of the Computing Center in the Department. By then the increasing enrollment was placing severe strains on the faculty whose numbers had not increased, and throughout the 70s our FTE (full time equivalent) faculty members remained almost constant at about 36. Over the past 5 years the undergraduate enrollment had gone up 50 percent, to 528 in EE and 240 in CE. The graduate enrollment had also risen to 176 in ECE and 127 in the Computer, Information and Control Engineering (CICE) program, and even with the higher graduate admission standards proposed for the next year, the enrollment was still expected to increase by 35 percent. The sponsored research support per annum was \$2.5M, and most graduate students were financially supported through fellowships, RAs or TAs. The average annual salaries at about this time were \$31K, \$25K and \$19K for full, associate and assistant professors.

We had also lost some of our senior faculty. Masnari resigned to take a position at N. Carolina State University, and he was replaced by Kensall D. Wise as Director of the Electron Physics Laboratory. Enns and F. Nozari also left. They were both faculty in the power systems area, and with their departure the Power Systems Laboratory ceased to exist. Our earlier efforts to build up this area had not been successful. Because of the failure of the power industry to provide research support and job opportunities for our graduates, these areas were becoming less popular and several courses were eliminated. However, one bright spot in the picture was the award of the National Medal of Science to Emmett N. Leith. This is the highest federal government honor for scientists and engineers and was presented by President Carter.

In 1980 Haddad's initial term as ECE Department Chair came to an end and he was reappointed for a further 5 years. Lyon and Irani continued as Associate Chairs. Despite repeated requests to the College and the University Provost, the funds that the Department desperately

needed were not forthcoming. The space that it occupied in East Engineering badly needed renovation and some of it was unsafe and demoralizing. There was also a “fifth floor” on the roof consisting of the biomedical engineering teaching laboratory and several faculty offices. These were reached through an outside door at the top of the staircase and elevator shaft, and required going across the open roof – unpleasant under all circumstances and dangerous in bad weather and winter. There was also not enough room for all of the classes to be taught, and some of the larger classes had to compete for rooms in buildings across the campus. The failure to address these problems was due in part to a Dean whose primary (and almost sole) focus was on an external capital fund campaign, and for several years the College’s share of the University’s resources actually decreased. In 1981 there was a freeze on all faculty hiring throughout the College, and the Department’s request for 8 new positions was put on hold.

Fortunately, things began to change in July of that year with the appointment of James J. Duderstadt as Dean of the College. Within a year the College’s general fund allocation increased significantly, making possible the hiring of new faculty (all of the Department’s 8 requests) and the implementation of a new salary structure. This included significant increases for assistant professors to improve the quality of new hires, and for the most productive senior faculty to discourage them from leaving. These were in addition to annual merit raises, and by 1983 the average faculty salaries in the Department were \$48K, \$38K and \$35K for full, associate and assistant professors respectively.

A distraction in the early 80’s was the opposition to so-called weapons research. A vocal minority of students and faculty was demanding an extension to all university research of the “end-use” clause in the Regents’ classified research guidelines, with the particular objective of banning research sponsored by the Department of Defense. Several College faculty came under

attack for their work, and were forced to defend it before committees, in public forums and in the press. Those in the Department whose work was questioned were Birdsall, Haddad and Senior, and on 7 November 1983, 27 members of a group called the Progressive Student Network occupied the Radiation Laboratory's experimental facilities in the basement of East Engineering, seeking to end the "nuclear research" going on. The sit-in continued for two days and attracted considerable publicity, but not the support of other students and faculty that the demonstrators had hoped for. To avoid confrontation, the decision was made to give the demonstrators a reasonable time in which to leave, and they did so after 48 hrs. But when a second group calling themselves the Nuclear Saints staged a sit-in a week later on 14 November, the decision was taken to evict them. At 2:30am the next morning Senior read them the trespass law and gave them 10 minutes in which to leave. This they did in the face of a massive force of Ann Arbor police and security personnel, but only after being compelled to identify themselves and have their pictures taken. It turned out that most were not U-M students. There were no further demonstrations, but an interesting postscript came five years later when a half-dozen Nuclear Saints returned to the Radiation Laboratory (now on North Campus) for a reunion. One of them came from as far away as Boston. They handed out "twinkies" to those in the Laboratory, but this time there was no confrontation – only smiles and handshakes.

In the summer of 1982 the University approved a plan to re-start the College's move to North Campus, involving all of the College except this Department, and thereby freeing up some of the space occupied in the West Engineering Building. As part of this, the Dean's suite of offices would be moved to a much smaller area in the Chrysler Center and all that would be left in West Engineering was the ship towing tank in the basement. The vacated space was needed to accommodate the Economics Department whose building adjacent to West Engineering had

burned down on Christmas Eve 1981. The move started almost at once and though there was no immediate help for our Department, the State provided \$0.5M for planning the new Engineering Building I (EBI) that was to be our home on North Campus. Construction of the \$30M building was later approved and ground breaking took place on 17 May 1984. Major laboratories as well as computing facilities, classrooms and offices would occupy 125,000 sq. ft. of the building, with an additional 12000 sq. ft. for the Solid State Electronics Laboratory. Construction was scheduled for completion by May 1986, in time for us to move in that summer.

Before then the Department underwent a major change. For several years it had been felt that the fractured nature of computing at the University was hindering enrollment and faculty recruiting. This was stressed in the 1983 report of the CICE Review Committee, and after much discussion the Dean recommended that the CICE program be discontinued and replaced by an ECE Department reorganized to have three divisions: Electrical Sciences, Systems Engineering, and Computer Engineering. It was also proposed that the Department of Computer and Communication Sciences (CCS) in LS&A be invited to join the College of Engineering either as a new department closely associated with the Computer Engineering Division of ECE, or as a Computer Science Division of the restructured ECE Department. Those ideas were discussed throughout 1983 and in a Memorandum of Understanding dated 18 February 1986 between the Deans of Engineering and LS&A it was recommended that the CCS Department be incorporated in a Computer Science and Engineering (CSE) Division of a newly named Electrical Engineering and Computer Science (EECS) Department. This was approved by the Regents at their February 1984 meeting to take effect July 1986.

The new EECS Department would offer three undergraduate degrees: Electrical Engineering (EE), Computer Engineering (CE) and Computer Science (CS), and though the

Department would be fully responsible for the CS program, the degree would remain an LS&A one. At the graduate level the number of degrees awarded by the Department also increased, with the Master of Science in Engineering (M.S.E), Master of Science (M.S.) and Doctor of Philosophy (Ph.D.) available in three areas: Electrical Engineering (EE), Electrical Engineering:Systems (EE:S), and Computer Science and Engineering (CSE).

The CCS Department was well established by 1984, with much ground breaking research done in the 1950's and 1960's, including the programming language Michigan Algorithm Decoder (MAD), the Merit Network, and the Michigan Terminal System (MTS), which came out of a joint development with IBM for a seminal time-sharing system initially developed for the IBM 360/67 mainframe computer system. The first PhD in the computer science field at Michigan was awarded to John Holland in 1959, and CCS was founded in 1967 as an outgrowth of Communication Sciences (1964). The industry was moving quickly to the personal computer with the development of the Apple II in 1977, the IBM PC in 1981, and the Apple Macintosh in 1984. In 1983 the Computer-Aided Engineering Network (CAEN) was founded to bring the College of Engineering into the new age of distributed computing allowing personal computers and mainframes to begin to talk to one another, and establishing the early email systems, long before the Internet.

The summer of 1984 was a very busy one. To integrate the ECE, CSS and CICE courses into a new program, it was necessary to change their numbers and pre-requisites, and to better group the courses, a new numbering system was adopted:

EECS X00-X09	Mathematics and Numerical Analysis
X10-X19	Circuits and Plasmas
X20-X29	Electronic Design and Materials

X30-X39	Fields, Optics and Acoustics
X40-X49	Power and Energy Conversion
X50-X59	Communications and Signal Processing
X60-X69	Control and Robotics
X70-X79	Computer Organization and Formal Systems
X80-X89	Computer Software Systems
X90-X99	Intelligent Systems

Revision of the courses themselves was an on-going task, particularly through 1986, and creating the new graduate program was also a major job. The CSS and (most of) the CICE faculty took appointments in the new Department and as of Fall 1984 the organization was as shown in Fig. 1. The two parts of the Department were officially referred to as Divisions and the Division Chairs were Regental appointments. One of the Division Chairs would be the Department Chair, in this case Haddad. The other Chair was Gideon Frieder who had chaired the CCS Department in LS&A for the previous three years. Aside from responsibilities for their Divisions, the Associate Chairs had additional responsibilities – Senior for course and teaching assignments and Neuhoff for graduate affairs. We were by far the largest department in the College, and with the new building on North Campus little more than a hole in the ground, we now exceeded its planned capacity.

Meanwhile we had to get by in the cramped space of East Engineering. In April 1984 the College agreed to limit the number of undergraduate admissions to the Department and decided to weight the applicants based on their performance in lower level courses. Transfer students from Colleges with which we had a 3/2 commitment would not be affected. However, enrollment continued to increase. A year later restrictions were placed on the number of transfer students

and minimum GPAs were specified. Later still the minimum GPA was set at 3.8 with 20 spaces allocated to EE and 10 to CE, but when it came time to select the students, the limits had to be relaxed. This also had some unfortunate repercussions. Some of our best students were those who transferred from places like Hope College, and when we cut down on the number admitted, they reacted by instituting four-year programs of their own, thereby cutting off our supply. It is ironic that soon after the restrictions were put in effect, they were no longer necessary, and enrollments (particularly in EE) decreased of their own accord. The restrictions were then eliminated.

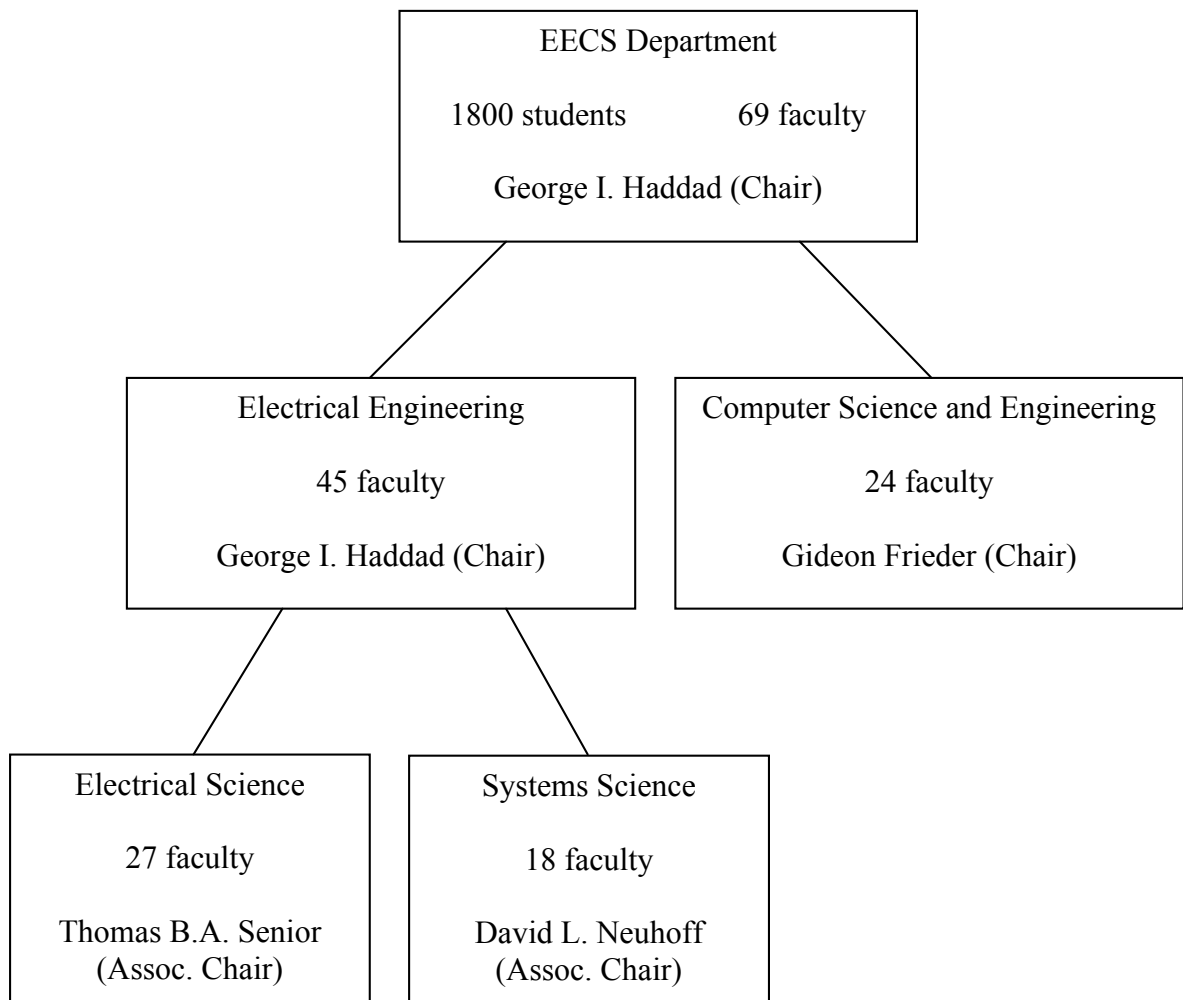


Fig. 1: EECS Department Organization - 1984

In July 1985 Haddad was re-appointed Chair for an additional 12 months, and his term was later extended to the end of 1986 to cover the move to North Campus. Frieder, Senior and Neuhoff retained their positions. In the December 1985 Report of the Department Review Committee it was recommended that the Department be split into 3 Divisions, each with an Associate Chair and an elected executive committee. The Department Chair would likewise have an executive committee consisting of the other three committees and the Associate Chairs. It is worth noting that these recommendations were not carried out. However, when Frieder was replaced by Irani in September 1986, the Department was shown as having 3 Divisions: Electrical Science and Engineering (ESE), Systems Science and Engineering (SSE), and Computer Science and Engineering (CSE), each headed by an Associate Chair, as shown in Fig. 1. This continued for the next 12 years. The Report also proposed the phasing out of the power systems and acoustics areas, and this did occur.

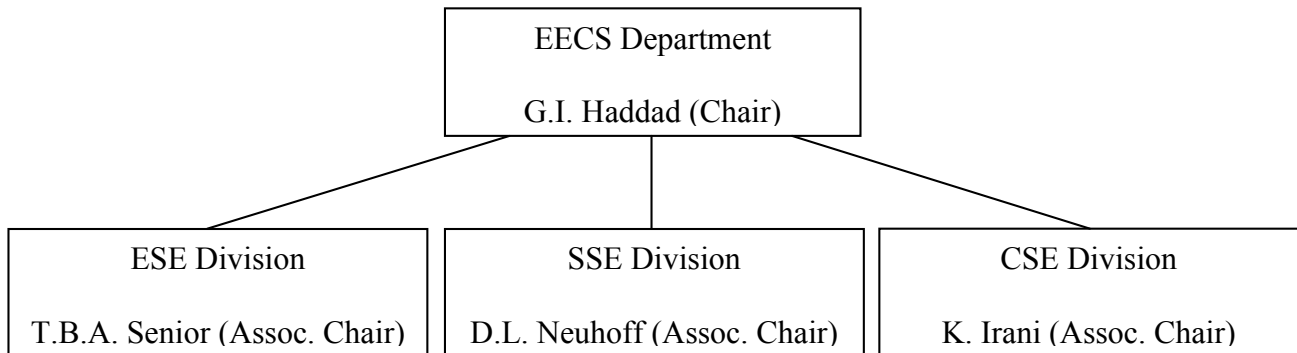


Fig. 1: EECS Department Organization - 1986

The move to the new EECS Building (formerly Engineering Building I) on North Campus took place in the late summer of 1986 (see Fig. 2). It was not a simple matter. We now had 91 faculty, and though all of the faculty offices had new furniture, each required different things in the way of bookcases, filing cabinets and shelves. The Dean moved into a suite of offices on the west side of the second floor, and the Chair into a (smaller) suite on the floor above. All of the laboratories also had to be transferred. The space allocated for optics on the ground floor needed to be altered, and until that was done, most of the optics activity remained in the basement of East Engineering. Robotics also remained there until its move into the Advanced Technology Laboratory (old ITE Building) on North Campus in May 1987.

Having been in East Engineering for 39 years during which the nature of engineering had changed completely, there was an enormous amount of discarded equipment and material stored in the basement and elsewhere. Some of this was quite valuable from an historical perspective.



Fig. 2: West side of EECS Building

All of it was sorted through by Ken McGrath (the Equipment Manager) and others, and what was worth keeping was put in storage in the basement of the Observatory. Over the years it was moved several times until, in early 2010, it was finally discarded by the College, just weeks before the Department sought to retrieve some of it for an historical exhibit.

On the computing side, several new organizations were started during this period. In 1985 the NCUBE computer was purchased, starting large-scale parallel computing research and development on campus. In 1986, the Center for Information Technology Integration (CITI) was founded by Daniel E. Atkins and Richard L. Phillips to start sponsored research with industrial partners to make distributed computing part of the Michigan computing culture. In 1987, the NSFNet was established at Michigan to build and manage a national computer network. This was also an important period for the CSE Division, with the establishment of the Advanced Computer Architecture Laboratory (ACAL) with John P. Hayes as Director, and the Real-Time Computing Laboratory (RTCL) with Kang G. Shin as Director, in 1985; the Artificial Intelligence (AI) Laboratory with Ramesh Jain as Director, in 1987; and the Software Systems Laboratory (SSL) in 1989 with Bernard A. Galler as Director. Galler founded the Software Patent Institute in 1990. A disadvantage was the geographical split in the CSE faculty, with the AI and ACAL groups joining Robotics in the ATL Building, CITI located off campus, and only Software and Theory housed with the rest of the Department in the EECS Building.

Haddad's 11 ½ years as Chair ended in December 1987. With the recent faculty hires and the new emphasis on research, sponsored research had blossomed to over \$10M per year. He had started out with a relatively small traditional engineering department and ended with a much larger one whose faculty had different backgrounds and approaches to academic life. The EE faculty believed that the best administrator was one who provided resources and then left them

alone to do their own thing. Research was key and faculty meetings should be avoided if at all possible. The EE Systems faculty were also engineers, but believed that all faculty decisions should be by consensus, which led to a large number of meetings. Finally there were the CSE faculty who sometimes seemed to be another breed entirely, and felt it appropriate to question any decisions made by the other (larger) groups. But in spite of these differences, the Department operated in a relatively harmonious manner with no overt tensions, and this is greatly to the credit of Haddad and his administration. Nevertheless, the computer (particularly CS) faculty were quite vocal in their belief that the next Chair should have a computer background.

While the search for a new Chair took place, Senior was appointed Acting Chair for 6 months starting 1 January 1987, and when the search became prolonged, his term was extended to the end of 1987. Fawwaz T. Ulaby was appointed Radiation Laboratory Director, and Neuhoff and Irani remained as Associate Chairs. In the belief that a new Chair would soon be found, Senior remained as Associate Chair for the ESE Division. The year was primarily a waiting period, but one change that was made was to improve the undergraduate counseling. Prior to that we had had just a professional Academic Counselor and a Chief (faculty) Program Advisor for each of the ESE/SSE and CSE programs, but we now added 3 more faculty positions for the first program and 2 for the second. The positions would be held by junior faculty on a rotating basis, and this had the advantage of familiarizing them with our programs. Towards the end of the year, the appointment of Edward S. Davidson as Chair was announced. He was the Associate Director of the Center for Supercomputing Research and Development at the University of Illinois, and had for several years chaired the Computer Engineering Area Committee there. His appointment was for a 5-year period starting 1 January 1988.

The job that he stepped into was a complex one. The Department had become accustomed to a Chair who, based on his knowledge of the situation, did not hesitate to make decisions, and with an executive committee that served mainly in an advisory and consultative capacity. Davidson retained the three Associate Chairs who were in place, but his previous experience in faculty governance was somewhat of a mismatch for the Department he took over. Though he made himself available to all who wished to see him, there were internal operational problems, and key decisions (including financial ones) did not always get made in a timely fashion.

There were, however, many bright spots. By the Fall of 1988 the number of faculty had increased another 16% to 101, and this, combined with a slow but steady decrease in undergraduate enrollment (about 25% over 4 years) meant fewer over-sized classes and more reasonable SCH/faculty ratios. Davidson made faculty recruiting his first priority, with the aim of putting Michigan on the map as a serious contender in CSE. Sponsored research was also increasing and several new research centers were started, for example, the NASA Center for Terahertz Technology, directed by Ulaby as part of the Radiation Laboratory and established in 1988, and the NSF Center for Ultrafast Optical Science, directed by Gérard A. Mourou, and started in 1990. This last was part of the Ultrafast Science Laboratory that was established when Mourou and his colleagues came here from the University of Rochester, and was housed in the bay area of the IST building (now Engineering Research Building I, or ERB I).

When Haddad stepped down from the Chair position, he returned to what was now called the Solid-State Electronics Laboratory as director, and Wise, the previous director, established the Center for Integrated Sensors and Circuits, focusing on what began to be referred to as microelectromechanical systems (MEMS). The Solid-State Fabrication Facility, a full processing

laboratory for sensors, devices and circuits was now in operation. It was equipped using funding obtained through the State of Michigan Research Excellence Program and included a separate instructional laboratory for two undergraduate courses. The Department was soon to realize a disadvantage in having an advanced fabrication facility as part of the building, and the all-too-frequent fire alarms that resulted from any small spill or mishap, no matter how minor, were quite disruptive to all.

In an effort to better show our appreciation to all our students it was decided to treat them to a buffet lunch at the end of the Winter term. The last day of classes is always a Tuesday and because of the other activities generally held on that day, we chose the previous day (Monday) and called it "The St. George's Day Feast." It was rumored that the name was chosen by someone of English origin who wanted to balance the attention given to St. Patrick's Day, but the choice was not inappropriate since St. George's Day (April 23) is always close in time. The name influenced what was done. Barbara Toma, the ESE/SSE Academic Counselor, sewed aprons and purchased toy medieval equipment for the 15 or so faculty who took part in the opening parade and in manning the food tables. The previous Friday afternoon many faculty and staff spent time preparing the various vegetables and fruits, and at noon on the following Monday these were set out along with meats, cheeses, breads and desserts on 6 tables along the length of the atrium. It was extremely popular and enjoyed by all, including students from departments other than ours. The food cost that year (1989) was \$618, but in subsequent years we spent \$1,500 or more to feed about 1000 people. Apart from a gap of a few years, the feast has been held every year since then.

Towards the end of 1990 it was apparent even to some of the CSE faculty that a change of leadership was desirable and Davidson resigned his position at the end of the year. Haddad

agreed to resume his role as Chair and was re-appointed for a 3-year term starting 1 January 1991. To make the task less burdensome, a new organization was chosen as shown in Fig. 2. The Associate Chair for Academic Affairs was responsible for all matters relating to courses, teaching assignments, etc., and because of the light load that the ESE Division imposed on its Associate Chair, it was reasonable to have the same person hold both positions. David J. Anderson had replaced Neuhoff as the Associate Chair for the SSE Division in April 1990, and Kang G. Shin was appointed as Associate Chair for CSE.

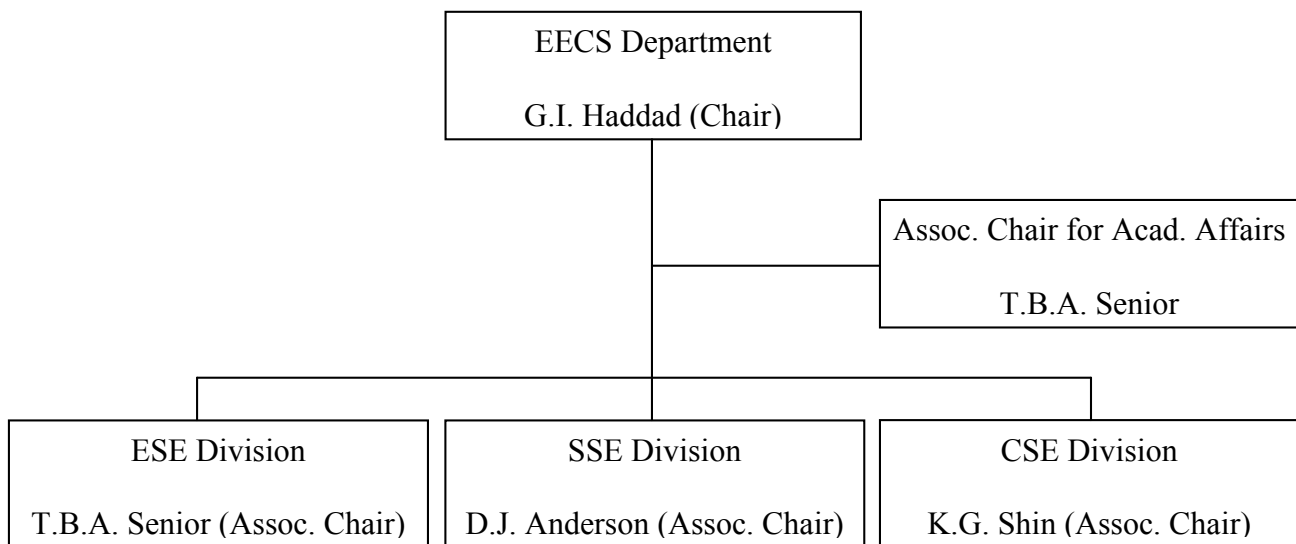


Fig. 2: EECS Department Organization - 1991

One of the first tasks confronting the new Chair was to get our finances in order. The Department had accumulated a debt of over \$1.5M, and at a time when the College (and University) were subject to budget constraints, it would take careful planning over several years to eliminate it. It was hoped to do so without major impact on our academic and research programs, and among the steps that were taken were a more equitable assignment of teaching responsibilities bearing in mind the administrative loads and research offsets of the faculty (this

would lead to a reduction in the use of adjunct faculty), delays in filling faculty slots, and a request to faculty to contribute half of the departmental cost-sharing on proposals. It would take four years to eliminate the debt.

In 1991 the Department was, by almost all measures, at least a third of the College. We had 99 faculty and \$21M of external research support of which 82 percent was federal, with more in the form of grants, fellowships, scholarships and equipment. The research volume had increased considerably in recent years, as had the number of Ph.D. degrees awarded, and the total of undergraduate degrees awarded had been maintained. Indeed, our research productivity as measured by research dollars per faculty FTE led the College, and our instructional productivity, measured by student credit hours per faculty FTE, was also high, though declining relative to other departments. The average faculty salaries were now \$86K, \$66K, and \$52K for full, associate, and assistant professors respectively.

Computing took a huge turn in 1994 with the establishment of the Internet. One of the co-founders of Google, Larry Page, was an undergraduate in EECS (Comp.E.) at that time. Google was founded in 1998. In 1995 CSE started holding annual retreats with the entire faculty together off-campus, usually for an entire day. Topics of interest included research, faculty search, new courses, and special topics of general interest to the faculty and students. The Associate Chair took a number of steps to give our CSE program more national visibility and get into the national rankings. Until then our CS program was not ranked. In 1996 our graduate program in computer science was ranked 18th by U.S. News (it was 13th in 2010). Computer Engineering, which was already ranked, was 9th by U.S. News. The Computer Research Association ranked our faculty quality as 21st (it was 13th in 2010). The Theory Group was also established in 1996.

In the other Divisions as well, research continued to increase in variety and dollar amount. On the systems side, the Cooley Electronics Laboratory had evolved into the Communication and Signal Processing Laboratory, and when Birdsall stepped down as Director in April 1994, Neuhoff replaced him. In addition, a Control Laboratory was established, as well as a Biosystems Laboratory. The optics and solid-state research were also increasing, and in FY 1995 the total research expenditure was over \$33M, with 60 percent of this in the ESE Division. The 1995-96 Departmental Review Report listed 7 Research Centers, all but one in ESE.

The organization of the Department had also changed, and a chart taken from that Report is shown in Fig. 3. Toby J. Teorey had replaced Shin as the Associate Chair for CSE in 1994, and as had become customary, the Departmental Computing Organization (DCO), located on the 4th floor of the EECS Building, reported to that Chair. Pramod P. Khargonekar had replaced Anderson as the Associate Chair for SSE, and he was also responsible for graduate affairs. The National Advisory Committee was established in 1996 to provide advice and counsel to the Chair. It had 10 members from industry and academia, and its first Chair was Joseph E. Rowe, our former Department Chair.

The Robert H. Lurie Engineering Center Building was completed in 1996. Construction of the adjacent car park had required the reconfiguration of Beal Avenue, thereby eliminating the long straight downhill road that had once been the site of the annual soap box derby (or go cart) races. That summer when the college administration vacated the EECS Building, the faculty offices for the CSE Division and the Solid-State Electronics Laboratory were consolidated in that space, thereby improving faculty interaction.