40th anniversary of EECS: How CS took its place alongside EE

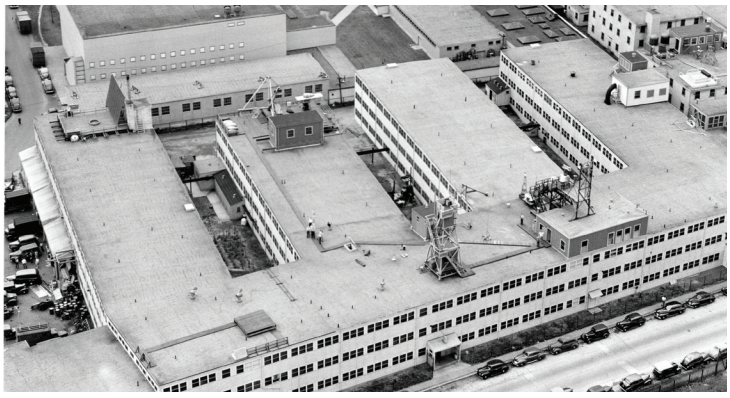
by Eric Smalley

The EECS Department owes its existence to many small things. Millions of small things, in fact.

In the 1960s, researchers who were developing circuit theory, and those who were writing software, were operating in a new, common paradigm. The ability to connect millions of simple components via simple connection rules can give rise to extraordinarily complex systems. At MIT, those people were in a single department: Electrical Engineering.

The Electrical Engineering Department was founded at the turn of the 20th century to research and develop power systems. In the run up to World War II, the government formed the Radiation Laboratory to carry out the country's radar R&D and housed the lab at MIT. The lab brought together hundreds of scientists and engineers from around the country who gained hands-on experience developing electronic systems and participated in one of the largest multidisciplinary collaborations in history.

Many in the MIT Electrical Engineering department worked at the Radiation Laboratory, and most returned to the department after the war. "That gave them a huge start in the whole process of reorganizing the department in quite a different direction" during the 1950s, said Prof. Emeritus Campbell Searle.



MIT's Building 20, home of the Radiation Laboratory

The reorganization, presaged by the rise of radio and electronics in the 20s and 30s, turned a department founded on turbines and transformers into one also dealing with circuits, signals and information. Central to the new focus was another technology jumpstarted by the war effort: computing. Computers became widespread in business, government and academia by the 1960s, and the practice of designing and programming them evolved into a full-fledged discipline: computer science.

Computer science at MIT gained a formal home with the launch of Project MAC on July 1, 1963. Among the founding organizations was

Prof. (then student) Gerald Sussman operating the PDP-6

the Artificial Intelligence Group, which Profs. John McCarthy and Marvin Minsky launched in 1959. Prof. Gerald Jay Sussman remembers his days as an undergraduate in the early years of Project MAC. He worked with Minsky, who had a single Digital Equipment Corporation PDP-6 computer that Minsky was able to upgrade, at a cost of $380,000 to a megabyte of RAM. "That was the biggest memory around," Sussman said.

Though paltry by today's standards, those resources allowed the theory and application of computer science to flourish at MIT. Because computer science developed within the electrical engineering department, the two disciplines informed each other.

Programming is about building things from a huge number of simple components, in this case logic operations. "Once you can build things with a million parts, then you've got a different kind of problem, which is how do you organize it?" said Sussman. "So what you learn from computation is very often organizational principles, which then can be used in thinking about physical systems."

Similarly, electronics is about building things from a huge number of components, in this case, circuits. One concept engineers developed to cope with this is abstraction, which became very important in computation, said Sussman. "The idea that you could wrap up something and give it a name, and then that name could be used somewhere else and have a specification, that's very important," he said.

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40th Anniversary of EE-CS, *continued*

This interrelation between EE and CS became apparent to Prof. (now emeritus) Paul Penfield, Jr., who researched circuit theory and developed one of the first circuit modeling and simulation software programs. "That convinced me that EE and CS were more tightly, strongly, intellectually connected than CS could be with any other discipline that I could imagine," Penfield said.

Independence movement

By 1970, the EE department had grown to roughly 700 undergraduates, making it by far the largest department at MIT. That year, the Artificial Intelligence Group was spun out of Project MAC to form the Artificial Intelligence (AI) Laboratory. Computer science was a rapidly growing field, which presented the prospect of a department grown too large and unwieldy. Some CS faculty argued that computer science should have its own department with its own curriculum and degree program. "Back then there was a certain amount of tension between Computer Science – people who were in Project MAC – and the rest of the department," said Prof. Alan Oppenheim. "And the computer science people felt like they were not getting their piece of the pie."

Before 1970, programmers used card punches to prepare programs to be run by mainframe computers in overnight batches. Timesharing systems like CTSS developed at MIT (see page 6), made computers much easier to use and spurred the growth of CS in the EE department.

Much of the uncertainty about computer science's future at MIT in the 1960's and early 70's stemmed from uncertainty about the discipline itself. Was computer science simply a specialized form of applied mathematics? If so, why was it in an engineering department? Many of the younger CS faculty who supported the move for a separate department had come to MIT from universities where computer science had emerged from the mathematics department.

Technology Square, home of LCS and the AI Lab

The drive to split off computer science from the EE department was fueled in part by the CS faculty's physical separation. Project MAC and the AI Lab were housed in Technology Square, not near other EE activity. "The people there felt isolated," said Penfield. "They felt out of touch with a big segment of the population at MIT, and I think they were right."

Strength in unity

However, not everyone felt that the solution was to make CS a separate department. Many of the more senior CS faculty recognized the institutional benefits of remaining unified, said Prof. Emeritus Fernando Corbató. "There was a feeling that we were a lot smarter to be part of a large complex that already had its ongoing machinery and traditions and maturity, and it would be foolish to be separate," he said.

The many connections between EE and CS convinced Penfield that the disciplines would develop in each other's context. "If we split into two, we would introduce an artificial barrier between two intellectual activities which drew so heavily from each other," he said. "That would be a very costly mistake."

The faculty whose work crossed the line between EE and CS, like Penfield and Sussman, drove the decision to keep the department unified, said Prof. Emeritus Jerome Saltzer. In addition, a major focus of CS in its early years at MIT was on designing computer hardware, which made it hard to find a bright-line boundary between EE and CS interests, he said.

Some younger faculty who came to MIT from pure CS backgrounds also saw the value of a unified department. "Having one department made it easier for people who are on the boundaries to work with one another," said Prof. Barbara Liskov. "It's not so easy if you're in different departments," she said.

A key step in addressing the needs of the CS side was the restructuring of the department leadership. In 1972, department head Louis Smullin appointed two associate department heads — Prof. Mildred Dresselhaus for EE and Prof. Robert Fano for CS. This was seen by most faculty as a move in the right direction, but some thought it did not go far enough. In 1973 some CS faculty members urged the creation of separate EE and CS departments. Most department faculty did not favor separate departments, and an overwhelming majority voted in an informal poll conducted by Joel Moses to rename the department EECS. The official renaming took place in 1975 and the urge to create a separate CS department subsided. The leadership structure with two associate department heads was popular, however, and continues to this day.

Renaming the department — the most visible aspect of giving CS equal billing with EE — was the culmination of a lot of work carried out over many years to strengthen CS. Undergraduate education is fundamental to the Institute's mission, and the CS curriculum was a measure of the discipline's maturity and status. Through the mid-1960s, undergraduate computer science education consisted of one beginning computer programming class (6.45/6.47) and two computer system design classes (6.25 and 6.251), said Saltzer.

In 1966, CS faculty members began developing a formal computer science curriculum. They started with a series of three CS subjects: a software course (6.231), a hardware course (6.232), and a systems course (6.233). Between 1968 and 1974 the CS faculty developed a full spectrum of undergraduate CS subjects, including artificial intelligence (6.234), compilers (6.235), discrete mathematics (6.043), computability and complexity (6.045), and two CS laboratory subjects (6.175 and 6.176), said Saltzer. "So by 1974 we were offering a complete undergraduate CS curriculum," he said.

The department took another crucial step in elevating CS within a unified departmental structure. It developed the Common Core requirement that EE students take the first two CS subjects and-vice versa. One of the final steps on the road to elevating CS to equal status with EE was renaming Project MAC the Laboratory for Computer Science in 1976.

Because there were multiple facets to the department's restructuring and the process unfolded over several years, the transformation might have seemed evolutionary rather than revolutionary, said Penfield. "Once the name was changed the subsequent reorganization was done in a series of steps that individually may not have seemed critical but when taken as a whole produced deep, fundamental, pervasive changes to the department."

Even as EECS looks back on 40 years, the department is preparing for a future where the physical and the digital are more closely connected. The rise of ubiquitous sensors, the Internet of Things, and the continued colonization of the nano scale and quantum domain are putting a renewed focus on electrical engineering in general and analog systems in particular. "The world is moving more and more to the integration of hardware and software," said Ray Stata, cofounder and chair of Analog Devices and EECS benefactor.

The department can once again play a key role in helping the Institute evolve, said Stata. The unified structure of EECS and the focus on materials research through MIT Nano, puts MIT "in the best position to lead when collaboration across disciplines will become even more important to success," he said.

It is an exciting time as the department expands and strengthens core disciplines while defining new opportunities and creating interdisciplinary programs.

Further Reading:

A Century of Electrical Engineering and Computer Science at MIT, 1882 – 1982
Karl L. Wildes and Nilo A. Lindgren available online (for purchase): http://books.google.com/books?id=6ZX-GwvhcnkC&pg=PA90&lpg=PA90#v=onepage&q&f=false

The Electron and the Bit, EECS at MIT 1902 – 2002
John V. Guttag, Editor [a limited supply is available through the MIT EECS headquarters]