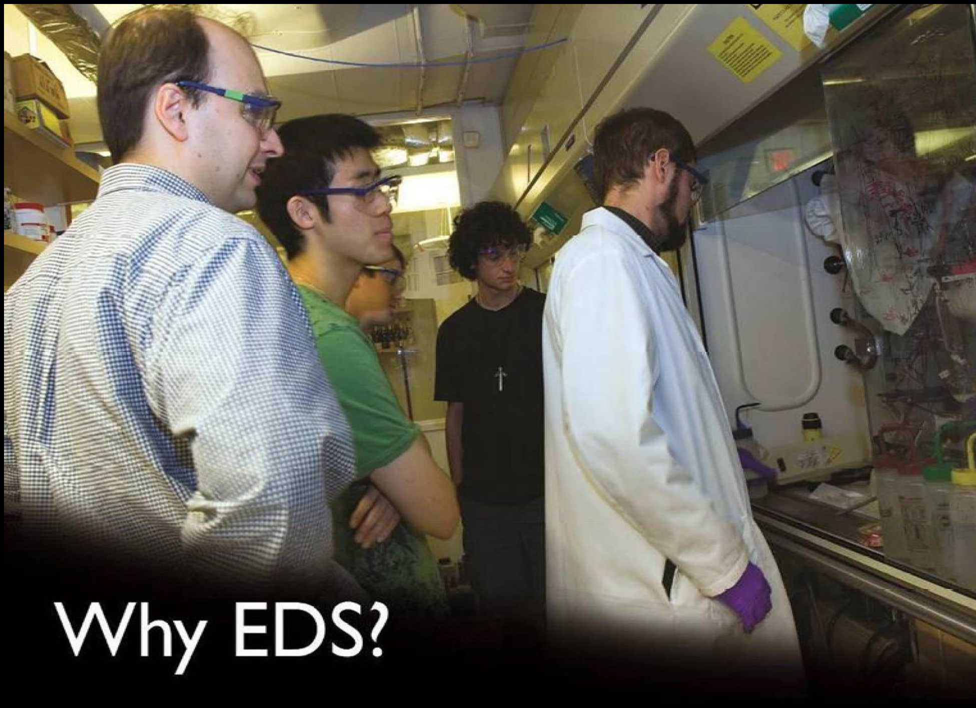


Why EDS?

It is no secret that the complexity and monolithic integration associated with modern commercial products have together eliminated many of the practical, hands-on experiences available to past students in science and engineering. The great educational challenges of the last 50 years were the formal introduction of engineering science into our curriculum, and the conceptualization and introduction of the modern computer and its applications. In the next 50 years, the press for mastery of engineering science and the pervasive application of computing will both continue. These will be accompanied by even greater demands upon our undergraduates to see and appreciate connections across diverse technical areas, and to delight in and master complexity.

Realistic operating conditions are necessary to expose the effects of parasitics and non-idealities and interactions between domains in a "real-world" design. This has never been more true or more important to commercial success as we press to develop products that demand mixed-signal functionality, high performance interfaces between electrical and mechanical components, mixed bio-electrical systems, new sources of energy, and entirely new machines for computation. Exposure to the real, hands-on world is fundamental and obligatory in the process of training world-class designers.

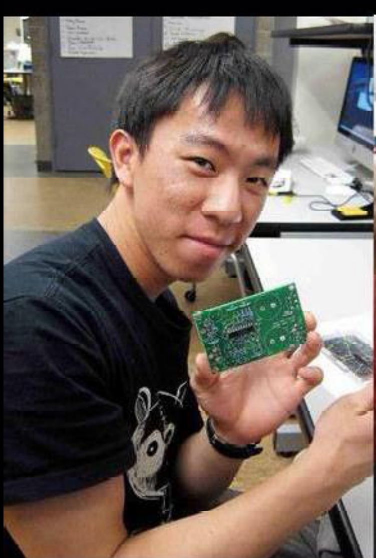
MIT's Department of Electrical Engineering and Computer Science offers undergraduates an apprentice program. The goal of this program is to encourage students and faculty and staff to learn more, to dream more, to build more, and to be more. The Engineering Design Studio or EDS is a proposal for a new set of hands-on building facilities specifically directed towards lowering the "energy barrier" that must be crossed to explore. The EDS will support teaching activities across EECS and the Institute. The EDS will enable students to experience "cross-disciplinary" product assembly, with firmware, SMT components, mechanical structure, printed circuit boards, electromagnetics, optics, chemistry (e.g., liquid crystals, ITO coatings, etc.), and software. Machines in the EDS, e.g., pick-and-place and 3-D printing machines, will themselves become laboratory activities, e.g., for software, programming, and algorithm experimentation. The EDS will consist of spaces where students build, aided by faculty, teaching staff, state-of-the-art on-line instruction and live links to alumni and industry via Skype or other channels. The EDS facility engages the opportunities and combats the challenges facing modern engineering education.

The Engineering Design Studio will permit students to develop the skill and confidence to see a race to its end. Courage, confidence, and skill are the likely roots of self-esteem and long-term success, and the surest routes to the sustainability of our graduates and our department. EDS will convey the skills necessary to develop an approach to life-long learning and a habit of courage that makes our graduates valuable to commerce and society.

BOSE-MIT Speaker Building Event

During IAP 2012, the EECS Department organized and hosted an event that typifies the type of activities that we plan to offer in the new EDS. Engineers and Alumni from BOSE Corporation came to MIT to offer an intense one day experience to 30 MIT undergraduates chosen from across the campus. Students in the class learned about manufacturing processes at BOSE, about some of the fundamentals of acoustics and sound reproduction, about the electronics of power ampliifiers for stereos, about the electromagnetic design and modeling of linear motors or “drivers” for speakers, and about the critical role of materials and design choices in assembling a successful product.

Every student in the course successfully constructed their own personal set of stereo speakers using BOSE drivers and other materials donated by BOSE. They also all successfully built their own 15 watt, 2-channel stereo power amplifier, and used their speakers and amplifier to conduct experiments with sound at the end of the day.




Build to Win

The first EDS prototyping facility will likely be built in core EECS teaching space in Building 38 on the MIT campus. EECS will deploy a highly visible, highly functional laboratory that permits flexible experimentation with modern techniques for building electronic, electromechanical, and computational systems of all kinds. Machines in the first EDS prototyping laboratory will likely include pick-and-place, 3-D printing machines, thermoforming machines, SMT mounting technology, CNC carvers, light machining tools like bands-saws, sanders, and drill presses, microcontroller and FPGA development systems, and other tools for fabrication. The goal is to permit students to imagine, design, and build complete systems. These activities will support pedagogy at every level. Imagine, for example, an introductory circuits class taught partially around the construction of an iPOD dock. Students could thermoform a dock station, pick-and-place part of a printed circuit board, and leave the rest for hand assembly. Each week, as problem sets are completed, different pieces of the dock are designed (as part of the class problems) and then built and tested in the EDS, beginning with the simplest resistor divider for a volume control and progressing through a Class-D wireless powered satellite speaker for the dock.

Consider another example: Engineers from BOSE Corporation are working with EECS to teach a one-day seminar in speaker design using PVC pipe as a "mount" for the drivers. The speakers are a wonderful example of resonant systems across disciplines. The drivers themselves don't sound fabulous until they're mounted. Why? The PVC pipes serve to embed the drivers in a resonator. The pipes function like inductors and the room itself becomes a capacitor. The "Q" of the driver is adjusted by filling the pipes with acoustic wadding with varying damping properties. The result is that the tubes (of a carefully chosen length) essentially immerse the room and the listener in a broad resonant system that couples sound beautifully into the room. Each speaker also includes an actual LC resonant circuit in the large pipe to serve as a crossover network, providing a low-pass filter between the amplifier and the large driver, and a high-pass filter between the amplifier and the small (high-frequency) driver. An amplifier board uses two more LC circuits to create two Class-D power amplifiers for the speakers.

This project is spectacular because it permits students to gain live, hands-on quantitative experience with linear network elements in several domains. EECS currently has no formal means or facilities for students to construct a system like this, or the many others shown in the photographs throughout this brochure. Innumerable faculty efforts provide these experiences as a "field of flowers," as do special activities like this one, supported by BOSE engineers visiting and working with faculty and students on campus. But there is at present no formal mechanism within EECS for enabling large numbers of students to have the experience of quantitatively analyzing a design, then building it with the types of tools and materials required for these projects.