REIMAGINING
ENGINEERING EDUCATION

The curriculum of today needs to be transformed for the engineers of tomorrow.

Educators and professionals owe it to our students to prepare them to become successful contributors to society. Today’s students will be living and working in an era characterized by what has been termed the grand challenges—in energy, health, poverty reduction, and so on. What will today’s engineering students do to address these issues?

Policy makers will make policy and scientists will investigate, but it falls on engineers to build the necessary “new machines and systems.” We use the term “machines” generally to describe all of the constructs that engineers build: mechanical, informational, biological, energetic, molecular, and infrastructural.

With this in mind, the Massachusetts Institute of Technology, where I work, is reimagining its undergraduate engineering education through its New Engineering Education Transformation (NEET) program. The aim is to reimagine engineering education—what students learn and how students learn—in a fundamental way across the school. We began by identifying four student-focused principles that are aligned with student desires, industry and societal needs, faculty ideals, and university culture.

First, we should prepare our students to develop the new machines and systems that they will build in the middle of the 21st century. These new machines will integrate disciplines, be complex and networked, autonomous, and support a sustainable environment. Much educational practice currently focuses on the “old machines” that defined the products of engineering when engineering science was codified in the mid-20th century.

Second, we should prepare our students to be makers and discoverers. Some of them will be makers, creating synthetic artifacts, while others will be discoverers, unraveling the mysteries of our world. Our students don’t know which path they will follow but want to be prepared for both.

Third, we should shape engineering education around the way our students best learn. They arrive at engineering school with a much richer set of project experiences than in the recent past, and are immersed in digital media. We must continually evolve our pedagogies to address these changes.

Last, we should prepare them in the NEET ways of thinking. In view of the exponential evolution of knowledge, the valuable long-lasting outcomes of university education are an ability to learn on your own, and to think more effectively.

We have identified 11 ways of thinking that a student should acquire, including analytical, computational, creative, critical, and systems thinking.

We also gathered evidence on the state of play of engineering education by listening to thought leaders (on TED Talks), and surveying industry, alumni, students, and faculty. Particularly valuable was a benchmarking report full of insight called The Global State of the Art in Engineering Education, available at neet.mit.edu.

Based on evidence and principles, NEET developed two “inventions”—a project-centric curricular construct and the concept of threads. Historically, the organizing armature of the curriculum was a series of courses. We propose replacing that with progressive projects linked to the new machines. Students choose a sequence of interdepartmental projects, while fundamentals continue to be learned in classes. In the projects, students are coached in personal and interpersonal skills and are challenged to develop their ability to learn by themselves. These are supplemented by digital education, peer-to-peer learning, faculty mentoring, and self-study.

Threads are pathways for interdisciplinary engineering education that cut across disciplines and departments, and link the projects. Each student still has a home department, but they use the flexibility in their degree program to take complementary subjects in other departments or disciplines, defined by the threads. Students will get a degree from the department they are majoring in plus a NEET certificate in the cross-disciplinary thread they have opted for.

MIT launched two pilot threads in Fall 2017, Autonomous Machines and Living Machines. We have learned a great deal from these pilots—most importantly that our students highly value the community that is forming around NEET.

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