Interdisciplinary product development education at MIT and RISD

by Steven D. Eppinger and Matthew S. Kressy

This popular course has a decade-long history. Students come from a range of backgrounds and explore how teamwork and a cross-section of talents are fundamental to the product design process. Steven Eppinger and Matthew Kressy summarize the main features of their class, provide examples of student projects, and thoroughly enumerate the lessons learned in this demanding but exciting teaching exercise.

As product design professionals know, effective development of products is an interdisciplinary process. That is why we believe the most appropriate educational setting in which to teach product development is an interdisciplinary one in which students from various backgrounds can experience the process. Indeed, a number of universities now offer interdisciplinary design courses. This article describes the graduate course we teach for students at the Massachusetts Institute of Technology (MIT) and the Rhode Island School of Design (RISD).

**Overview of the course**

Product Design and Development involves students who are studying engineering design, manufacturing, management, and industrial design. We build upon their disciplinary training by teaching them about the activities comprising the product development process, including product planning, customer needs analysis, concept development and testing, financial analysis of products, design for manufacturing, intellectual property, and project management.

We have been running this course at MIT for more than 10 years, with RISD students involved since 1995.¹ In 2002, we

¹ See the 1992 article in *Design Management Journal* (“Educating Product Development Leaders,” summer issue), which describes the course prior to the RISD collaboration.
we have almost 100 students enrolled in
the class, including 15 industrial design
students from RISD.

Pedagogy
The course uses several pedagogical tools,
including:

Readings. Assignments from the textbook2
provide the basics of a modern, structured
product development process.

Lectures. We provide lectures on many key
steps in the product development process (for
example, product planning, customer needs
analysis, concept development, prototyping, and
financial analysis), as well as contemporary
issues facing design teams (for example, envi-
ronmental responsibility, intellectual property).

Hands-on exercises. We have developed
classroom exercises to build skills in some of
the development steps (for example, design
of experiments, concept selection, design
for manufacturing).

Class discussion. Students are easily engaged
in discussion about product design because
there are examples of good and bad design all
around them. We are therefore able to discuss
their experiences both as consumers and as
practitioners.

Case studies and guest speakers. Published case
studies from the Design Management Institute
and other sources provide the basis for lively dis-
cussion and the opportunity to emphasize the
applicability of the methods presented in class to
the real world. Guest speakers from industry also
bring new perspectives and compelling examples.

Product examples. We show real products in
every class. This not only brings the subject to
life but also demonstrates that product design is
part of our everyday lives.

Projects. We firmly believe in the value of
experiential learning. Students undertake a
12-week, team-based product development
project that follows a schedule linked to the
class topics presented. This project is described
in the next section.

Feedback. Students receive feedback about
their project work from peers, faculty, and
outside experts.

Projects
The key learning vehicle is a team project in
which teams of 6 to 8 students collaborate to
develop new products. Each team
includes a cross-functional mix of students majoring in industrial
design, manufacturing, engineer-
ing, and business.

Projects begin with a design
brief in the form of a perceived
market opportunity. Each student
is required to present one project
proposal at the beginning of the
course. We also present design
briefs from any industrially spon-
sored projects. (Industrial sponsors
provide some of the funding for
the course. In exchange, we present
a project opportunity from the
sponsor to class.) We then
select projects and form teams
based on students’ expressed
preferences. Sponsored projects
have always been of sufficient
interest to warrant assigning teams,
but most students choose to work
on market opportunities suggested
by the class.

The teams then explore the
market, benchmark competitive
products, develop numerous con-
cepts, create working models, select
one concept to pursue in detail,
built a production-intent alpha
prototype, test the product with
customers, and finally evaluate the
business potential of the resulting
product. Completed projects are
shown in professional-quality multimedia
presentations before a cross-disciplinary
panel of experts.

Each team receives a budget of $1,000 to
cover out-of-pocket project expenses. Students
use these funds to purchase competitive prod-
ucts, model-making materials, off-the-shelf
components, and other supplies. They are also
able to contract for outside custom fabrication
services if they do not have the skills or
equipment to make certain parts themselves
(for example, CNC machining, casting, circuit
fabrication, welding).

2. K.T. Ulrich and S.D. Eppinger, Product Design and
2000).
The project schedule is set by the pace of assigned deliverables that are due every 1 to 2 weeks throughout the semester. This fairly rigid timeline ensures that teams devote roughly 40 percent of their time to front-end market analysis and concept development activities and save the remaining 60 percent for detailed design, prototyping, testing, and refinement.

Over the past 10 years, more than 100 teams have completed product development projects (see photos).

**Lessons Learned**

Our experience from 10 years of teaching this course has provided valuable lessons for both the students and the faculty instructors, who function as project advisors. We have particularly found that projects executed by the class have taught us a great deal. Several lessons are summarized here:

**Value of process.** Without guidance, every student would follow a somewhat different development process. Although the process structure we present in class is not the only viable one, it provides a useful common starting point for each team. We then encourage teams to experiment with different processes as they move through their project work. Most teams, in fact, deviate from the default process in some ways, and we require each team to critique the process they used (even if the default) and the results they obtained.

**Value of each discipline.** No student possesses all the disciplinary skills to complete an entire product development effort. Through the projects, they realize the necessity of each other’s disciplines and therefore the value of cross-functional collaboration.

**Empowerment.** The project is truly an enabling experience for students. They find not only that the process they learned in class actually works, but also that they have the talent to create a viable product even within a compressed time frame. They can then extrapolate what they are able to do with the larger resources available in subsequent employment.

**Impact of industrial design.** Most MIT students have never heard of industrial design, yet they can easily be brought to understand its impact on the products they buy and on the world they inhabit. In this course, business and engineering students are exposed not only to the results of ID in products and businesses but also to the practitioners of ID through their peers from RISD.

**Teamwork skills.** Many of our students have well-developed teamwork skills; others do not. Our MBA students, for example, have a curriculum that includes team dynamics, extensive project work, and leadership training. They are generally able to organize their project teams from the start, which then provides the opportunity for other students to take the lead at other times. We suggest that teams rotate the role of project organization among their members.

**Project management.** Even though the class projects involve only relatively simple products, with limited budget and determined timing, the challenge of coordinating eight people on a weekly basis is substantial. This experience helps our students learn valuable skills for decomposing tasks, coordinating work, reaching consensus, evaluating tradeoffs, and making decisions.

**Communication.** Each discipline uses a different vocabulary and different media to communicate ideas within its respective field. The projects force students to become somewhat proficient at communicating by using a wider range of design representations. At first, students are self-conscious, but they soon discover that the rewards of effective communication far outweigh their discomforts.

**Risk management.** Due to time and funding constraints, students must make trade-offs that affect how much time they can spend on concept development, how far they deviate from the structured process, and how many assumptions they are willing to tolerate. This forces them...
to become sensitive to how far they can adjust the timeline and budget to achieve the best possible solution.

**Resources.** Project courses require extensive resources in time, energy, and funding. Although the course can be organized and taught by one or two faculty members, we use a larger team of MIT and RISD instructors to advise on the projects (grading assignments and providing feedback to the teams). We have been able to raise the necessary funds to support the project budgets through a combination of industrial sponsors, foundation grants, and internal sources.

**Outsourcing.** We generally prefer students to fabricate their prototypes using team resources, and most of the construction is indeed done on campus. However, we also encourage teams to use outside vendors when appropriate. In general, MIT and RISD have adequate facilities, and students often have all the necessary skills. However, we believe that working with vendors and outsourcing a complex component or process provides a valuable learning experience.

**Collaboration technology.** The Internet has brought about many new media for team collaboration. Our students make greater use of them every year, using e-mail, video conferencing, file sharing, threaded discussions, and more. In general, we have not had to make special arrangements in order for teams to gain access to the latest groupware.

**Summary**

Product development is vital to the achievement of business success. In the quest to satisfy increasingly sophisticated market needs, cutting-edge product development must rely heavily on the contribution of many disciplines. Therefore, we believe an interdisciplinary setting is the right one in which to train the next generation of product development professionals. The combination of project experience and process training encourages students to integrate their intuitive and analytical skill sets, positioning them for growth and success. We have found teaching this course to be tremendously rewarding, and we think it has been equally rewarding for the students.

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**For more information**

http://web.mit.edu/15.783j/www/
The course Web site at MIT includes a complete syllabus that is available for download, and also a gallery of class project photos.

http://www.ulrich-eppinger.net
The Product Design and Development textbook Web site includes links to product development resources and services. There is also a special site for support of instructors teaching product development courses.