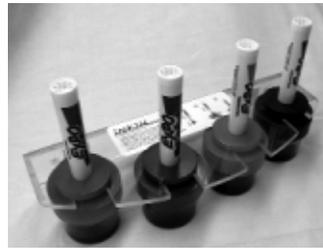# Interdisciplinary product development education at MIT and RISD

by Steven D. Eppinger and Matthew S. Kressy

*T*his 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

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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,

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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 textbook[2] 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, environmental 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 discussion 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, engineering, 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 sponsored projects. (Industrial sponsors provide some of the funding for the course. In exchange, we present a project opportunity from the sponsor to the 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 concepts, create working models, select one concept to pursue in detail, build 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 products, 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).

Bartender's Pour Spout

Red, yellow, and green LEDs signal the bartender when the right amount of liquor has been dispensed.
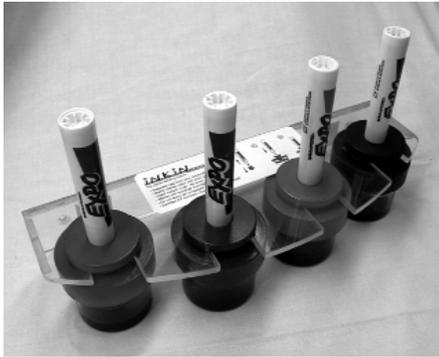
Birder's Tripod

Provides quick and quiet setup on rugged terrain. (Sponsored by the Massachusetts Audubon Society.)

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2. K.T. Ulrich and S.D. Eppinger, *Product Design and Development,* 2nd edition (New York: McGraw-Hill, 2000).

Whiteboard Marker Refill Station
Fills the markers while you sleep.

Heated Ice Cream Scoop
Super-cooled salt solution inside the handle heats the scoop for 10 minutes, recharges in the dishwasher, and holds the charge until you're ready to serve.

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

Coffee Press
Improves the popular French press by capturing the coffee grounds in a basket for easy removal and cleaning.

In-Line Skate Brake

Soft mode limits speed on steep hills; stiff mode provides normal braking.

Laptop Cable Organizer

Holds the cables in place on your desk when you remove the laptop computer.

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. ■   *Reprint # 02133EPP58*

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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.