

November 1, 2012

## Classroom evolution: Collaboration at the core of IE curriculum



The Collaboratorium in Grissom Hall provides more space for students in the design class to have interaction with customers and partners, both physically in the room and digitally worldwide. (Purdue University photo/Mark Simons)

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*Editor's note: This story originally appeared in the fall 2012 issue of Industrial Engineering Impact.*

Just as the profession of industrial engineering changes, so must the ways in which students are educated. Graduates must not only have strong technical skills but also an understanding of the human and social dimensions of their decisions in order to attack the grand challenges facing the world. The global marketplace demands real-time collaboration with multicultural teams dispersed throughout the world.

Abhi Deshmukh, the James J. Solberg Head of Industrial Engineering, says the school is creating opportunities for students to learn skills beyond the classroom to be successful in their careers. "Leadership, collaboration, global perspective, entrepreneurship and

ethics -- all of these added dimensions are creating a new kind of industrial engineer," he says.

Just as the world is evolving at a rapid pace, the School of Industrial Engineering (IE) is rethinking how it trains students to be successful engineers and leaders.

### Training the engineer of 2020

Barrett Caldwell, professor of industrial engineering, focuses on including the human element in systems education. As a student, he dreamed of working in the space program after hearing Apollo 8 astronaut Frank Borman speak from lunar orbit. As an engineer, he became increasingly disconcerted when talking with other engineers who didn't want to think about the psychological or social factors influencing astronauts on long duration missions, he says.

"As a systems engineer, you can't simply ignore a critical component of your system and refuse to learn anything about that component's behavior," Caldwell says. "So I continued my training in psychology to be a systems engineer for whom humans were my subsystem area of expertise."

In addition to understanding how humans integrate with the systems of the future, the IE of 2020 will need to collaborate with other humans on multidisciplinary teams to create solutions. That concept is what drives IE education through the IE senior design course, the Collaboratorium, HUB-CI (Collaborative Intelligence) and the PRISM (Production, Robotics and Integration Software for Manufacturing and Management) Center.

IE's senior design course has students working in teams to resolve design and operational issues for companies. These companies vary from parts manufacturing to continuous process production to health care providers and other forms of service. Students are exposed to the way real companies operate, and the companies discover how industrial engineering methods can help their operations and bottom line.

The Collaboratorium is a teaching laboratory in Grissom Hall specifically constructed to support these senior design projects. It provides a unique space for students in the design class to have interaction with customers and partners, both physically in the room and digitally worldwide.

Caldwell says learning there can be done anytime. "They can do videoconference conversations and record videos for their customers at 8 in the morning or 8 at night."

Past versions of the senior design projects were limited to locations within a reasonable drive to campus. Now, through the Collaboratorium, students can interact with companies and organizations anywhere to expand opportunities for projects in their area of interest.

"I can walk down the hall and see a team working on a senior design project on one of the shared screens," Caldwell says. "I can stop in, hear what they're doing and give them a hint or piece of advice. That 10-minute interaction can be worth more than a week of scheduled class because it ties directly with what that team is doing while they're working on the problem." It also provides closer connection to faculty.

HUB-CI, an extension of Purdue's HUBzero computer platform, makes it easy for project teams to share analytical results and create consensus while interacting with their clients in real time through the Internet. It is one of the tools used for collaboration, analysis and presentation by Purdue students.

Mark Lehto, professor and director of industrial engineering's Discovery-to-Delivery Center, says HUB-CI has greatly enhanced the senior design class. HUB-CI technology allows clients and students from around the world to monitor the work being done on the project and to make comments and suggestions.

Lehto says it provides a benefit for IE students and partner companies in learning from each other. "Instead of waiting a couple of weeks after the students have done their presentations to access information, our partner companies are able to access it immediately," Lehto says. "During the presentation, the client is able to see streaming video, the final reports and all of the different projects' analysis."

### Global partnerships enrich learning

Shimon Nof, professor of industrial engineering and director of PRISM, says center researchers have partnered with other researchers around the globe to improve efficiencies for companies.

"We developed the theory and support systems for collaborations with industries and research centers over the past 15 years," he says. One of those collaborations has been with Kimberly-Clark Corp. in its Latin American operations thanks to Juan Ernesto de Bedout (BSIE '67, MSIE '68), retired group president, who chairs the College of Engineering's Advisory Council.

HUB-CI enables students, researchers and companies to view the work each team is doing, monitor progress and discuss projects in real time. The outcome is a virtual laboratory where students and industrial engineering clients can come together.

The Purdue HUB infrastructure provides unique features that keep those shared interactions private and secure, just for those team members and partners who share the project.

One of the advantages of the HUB infrastructure is "tool networking," where students and researchers can apply the best available simulation tools. These tools are made available both to researchers and to senior design class participants.

"We are introducing and experimenting with these as part of the college's strategic action called Cyber Reach and in collaboration with Purdue's information technology office," Nof says. "Other engineering senior design projects also will benefit from the HUB-CI in the near future."

An example is a tool developed in the PRISM Center that enables students to be matched better -- based on their skills, experience and interests -- with other students and company partners at the beginning of the semester. The tool will be applied throughout the semester to match teams with overlapping problems and solutions.

"All of these practices are evolving the design project team experience from the traditional ways to the competitive, agile and collaborative work methods of the future," Nof says.

Students learn computational competencies beyond information and data sharing that will be practiced in the industry of 2020, Nof says. They also learn how to work with and leverage cyber-based collaboration and design-tool sharing.

"Until we have industrial, service or educational systems that don't have any humans in them anywhere -- or systems that don't care about cost and efficiency," Caldwell says, "this ability to integrate the range of IE tools and techniques to solve problems will continue to be relevant to fill educational, professional and societal needs."

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