

# ECE 411

# Industry Design Processes

Portland State University  
Mark G. Faust

# Survey

- How many are full-time students?
- How many are working in addition to going to school?
- How many are working or have worked in a technology or engineering oriented company or capacity? Where?
- How many of you have taken or are now taking WR technical writing class?
- Does everyone own a laptop?

# Introduction

- Professor Mark G. Faust

- Office: FAB 160-16 e-mail: faustm@ece.pdx.edu
- Office hours: (and by appointment)
- 10<sup>th</sup> year at PSU
  - Teach digital design, computer architecture, product design
  - Supervise Senior Capstone Program
- > 20 years experience in industry
  - 3 startups (one failure, one IPO, one acquisition)
  - 2 large public companies
  - Extensive consulting
  - Product design and development
    - Engineer, Manager, Vice-President Engineering
    - Technical Product Marketing Manager
  - Sales/service/technical support of complex technical products
    - General Manager, Asian Operations
  - Lived and worked extensively in Europe and Asia



# Outline

- Motivation (why study this stuff)
- Purpose of the course
- Course overview
- PSU ECE Capstone Project
  - Objectives and expectations
  - Past sponsors
  - Recent Capstone Projects
  - Timetable and resources
- Recent student survey results

# Motivation



	Stanley Screwdriver	HP DeskJet Printer	Volkswagen Beetle	Boeing 777 Airplane
Annual production volume				
Sales Lifetime				
Sales Price				
Number of Unique Parts				
Development Time				
Internal Development Team (peak size)				
External Development Team (peak size)				
Development Cost				
Production Investment				

From Ulrich & Eppinger, Product Design and Development, 3<sup>rd</sup> edition

# Motivation



	Stanley Screwdriver	HP DeskJet Printer	Volkswagen Beetle	Boeing 777 Airplane
Annual production volume	100,000 units	4 million units	100,000 units	50 units
Sales Lifetime	40 years	2 years	6 years	30 years
Sales Price	\$3	\$300	\$17,000	\$130 M
Number of Unique Parts	3 parts	200 parts	10,000 parts	130,000 parts
Development Time	1 year	1.5 years	3.5 years	4.5 years
Internal Development Team (peak size)	3 people	100 people	800 people	6,800 people
External Development Team (peak size)	3 people	75 people	800 people	10,000 people
Development Cost	\$150,000	\$50 million	\$400 million	\$3 billion
Production Investment	\$150,000	\$25 million	\$500 million	\$ 3 billion

From Ulrich & Eppinger, Product Design and Development, 3<sup>rd</sup> edition

# Purpose of the Course

## 1. Fulfill ABET Accreditation Requirements

Accreditation Board for Engineering and Technology (ABET)

“Engineering design is the process of devising a system, component, or process to meet desired needs. It is a decision-making process (often iterative), in which the basic sciences, mathematics, and engineering sciences are applied to convert resources optimally to meet a stated objective. Among the fundamental elements of the design process are the establishment of objectives and criteria, synthesis, analysis, construction, testing, and evaluation.”

## 2. Prepare Students for Senior Capstone Project

## 3. Prepare New Engineers for Life in Industry

# ABET 2000 Desired Program Outcomes

- A. An ability to apply knowledge of mathematics, science, and engineering
- B. An ability to design and conduct experiments, as well as to analyze and interpret data
- C. An ability to design a system, component, or process to meet desired needs
- D. An ability to function on multi-disciplinary teams
- E. An ability to identify, formulate, and solve engineering problems
- F. An understanding of professional and ethical responsibility
- G. An ability to communicate effectively
- H. The broad education necessary to understand the impact of engineering solutions in a global society context
- I. A recognition of the need for, and an ability to engage in life-long learning
- J. A knowledge of contemporary issues
- K. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

# This Course

- ECE 411 Content

- Course Web Site: [www.ece.pdx.edu/~faustm/ece411](http://www.ece.pdx.edu/~faustm/ece411)
  - Syllabus
  - Lectures, Readings, Handouts, Assignments
- Homework
  - Individual
  - Team (as part of mini-project)
    - Maintain engineering logbooks
    - Create/send weekly progress reports
- Final Exam, Final Project

- Capstone Project

- Capstone Web Site: [www.ece.pdx.edu/~faustm/capstone](http://www.ece.pdx.edu/~faustm/capstone)
- List-Serve
- Preparation
- Team Formation
- Project Assignments

New:

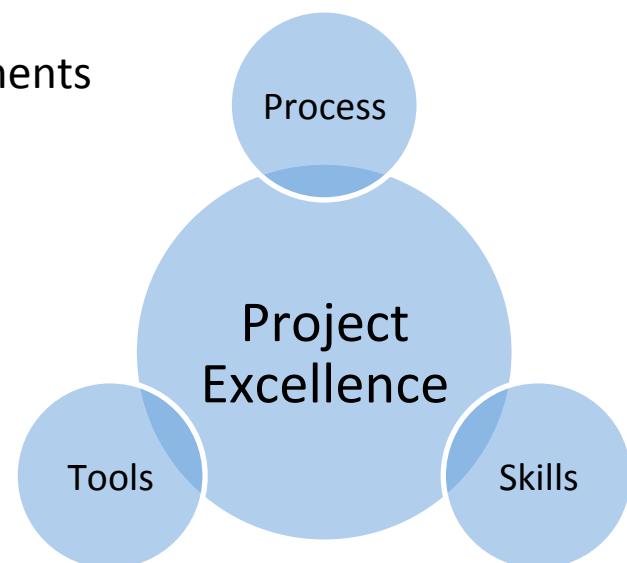
2 → 4 Credits

Additional Material

80% Revised Material

Next Textbook

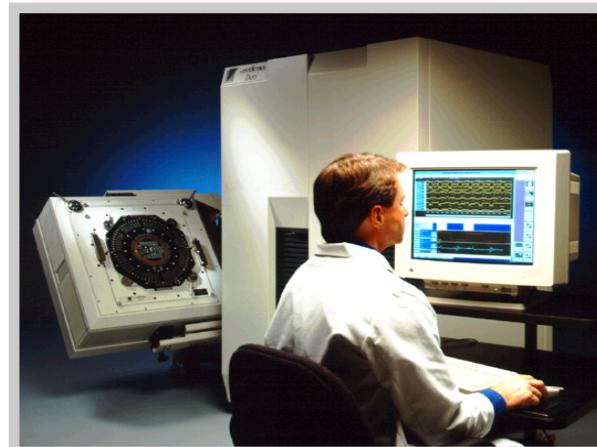
Practicum



# New Component in Design

- We will be talking about and working extensively with a new component in the design process
- Haven't explicitly studied this component in ECE curriculum yet
- Often unpredictable (some would say unstable), no good equations exist for modeling behavior
- Produced in every country in the world with no accepted standards or tolerances (no two identical)

## People!



# ECE 411

- Topics not usually covered in other courses
  - Ethics
  - Globalization
  - Teams
  - Effective Meetings
  - Time Management
  - Scheduling and Project Management
  - Requirements Definition
  - Writing Requirements, Specifications, Test Plans
- Preparation for Capstone Project
- Emphasis on communication
  - Brief status reports
  - Proposals
  - Written reports
  - Classroom practice

# Final Practicum Project

- Using the techniques and methodologies taught in the class
  - Form teams of 4 students
  - Identify several product ideas
  - Select the best
  - Research
  - Create a project proposal
    - Product Design Specification
    - Project Plan
    - Project schedule
- Team-building
- Communication (Weekly Progress Reports)
- Documentation (Project Notebook, Engineering Logbooks, Wiki)
- Idea generation and evaluation
- Research
- Requirements and Specification writing
- Scheduling
- Presentation skills

# PSU Capstone Program

[U.S. News.com Home](#) | [About the Rankings](#) | [Help](#)

## America's Best Colleges 2007

Best Colleges Home | College Search | Student Center | Honor Rolls

### Academic Programs: Senior capstone

- Allegheny College (PA)
- Alverno College (WI)
- Ball State University (IN)\*
- Bethany College (WV)
- Brown University (RI)
- Calvin College (MI)
- Carleton College (MN)
- College of Wooster (OH)
- Columbia University (NY)
- Davidson College (NC)
- Duke University (NC)
- Earlham College (IN)
- Elon University (NC)
- Grinnell College (IA)
- Hampshire College (MA)
- Harvard University (MA)
- Kalamazoo College (MI)
- Massachusetts Inst. of Technology
- Portland State University (OR)\*
- Princeton University (NJ)
- Reed College (OR)
- Southern Illinois U.–Edwardsville \*
- Stanford University (CA)
- Swarthmore College (PA)
- Truman State University (MO)\*
- Univ. of California–Los Angeles \*
- University of Virginia \*
- Wabash College (IN)
- Yale University (CT)

\* denotes a public school.

## America's Best Colleges 2

### Academic Programs: Senior capstone

- Alverno College (WI)
- Brown University (RI)
- Carleton College (MN)
- College of Wooster (OH)
- Dartmouth College (NH)
- Davidson College (NC)
- Duke University (NC)
- Elon University (NC)
- Grinnell College (IA)
- Harvard University (MA)
- Kalamazoo College (MI)
- Massachusetts Inst. of Technology
- Pomona College (CA)
- Portland State University (OR)\*
- Princeton University (NJ)
- Reed College (OR)
- Southern Illinois U.–Edwardsville \*
- Stanford University (CA)
- Swarthmore College (PA)
- Truman State University (MO)\*
- Worcester Polytechnic Inst. (MA)
- Yale University (CT)

\* denotes a public school.

**U.S. News & WORLD REPORT**  
usnews.com Friday, August 06, 2010

Home | Politics & Policy | Health | Money | Education | Science | Travel | Cars | Rankings |

## Best Colleges 2010

Home > Education > Best Colleges

### Best Colleges: Senior capstone

Whether they're called a senior capstone or by some other name, these culminating experiences ask students nearing the end of their college years to create a project of some sort that integrates and synthesizes what they've learned. The project might be a thesis, a performance, or an exhibit of artwork.

<a href="#">Alverno College</a>   Milwaukee, WI
<a href="#">Belmont University</a>   Nashville, TN
<a href="#">Brown University</a>   Providence, RI
<a href="#">College of Wooster</a>   Wooster, OH
<a href="#">Elon University</a>   Elon, NC
<a href="#">Georgia Institute of Technology</a>   Atlanta, GA
<a href="#">Harvard University</a>   Cambridge, MA
<a href="#">Kalamazoo College</a>   Kalamazoo, MI
<a href="#">Massachusetts Institute of Technology</a>   Cambridge, MA
<a href="#">Portland State University</a>   Portland, OR
<a href="#">Princeton University</a>   Princeton, NJ
<a href="#">Reed College</a>   Portland, OR
<a href="#">Southern Illinois University--Edwardsville</a>   Edwardsville, IL
<a href="#">Stanford University</a>   Stanford, CA
<a href="#">Swarthmore College</a>   Swarthmore, PA
<a href="#">Worcester Polytechnic Institute</a>   Worcester, MA
<a href="#">Yale University</a>   New Haven, CT

# Key Elements

- “Capstone Experience”
  - Leverage technical knowledge from prior courses
  - Undertake significant team project
- Student teams working on real design projects
  - Significance to sponsoring organization/company
  - Reflect real world issues, trade-offs
  - Outcome matters to someone (though not critical path project)
- Strive for successful completion of project
  - Commitment to team and project
  - Expectation of at least 10-12+ hours/week
- Equal focus on disciplined design methodology & teamwork
  - Written project proposal, design specifications (PDS)
  - Schedule with milestones
  - Documentation, test plans
  - Maintain engineering log, project notebooks
  - Weekly progress reports

# Some Past Sponsors



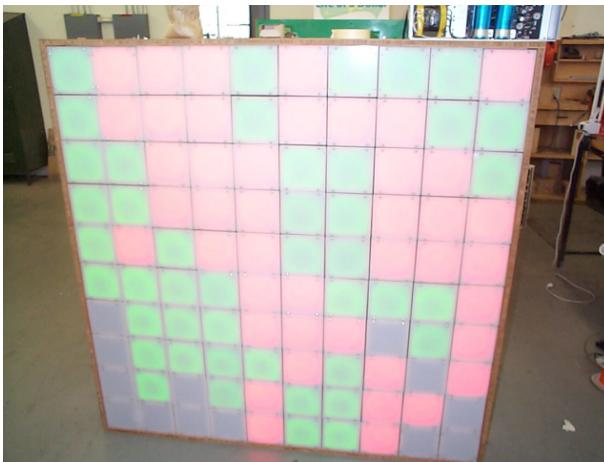
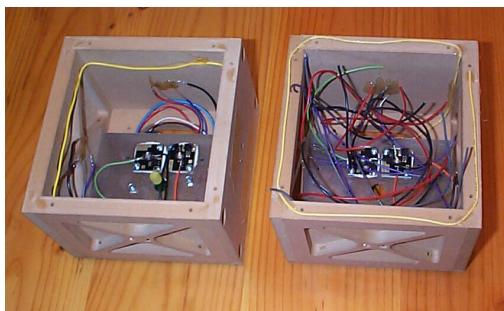
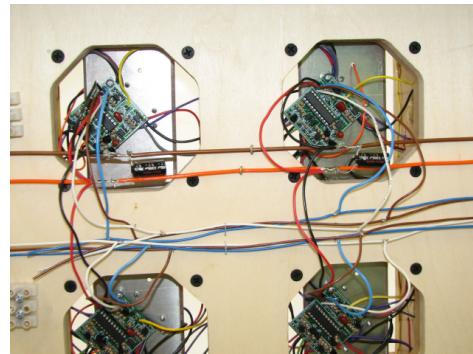
Bonneville  
Power  
Administration



# Recent Projects Undertaken

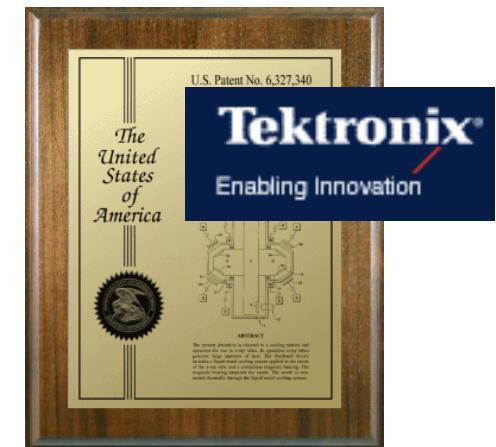
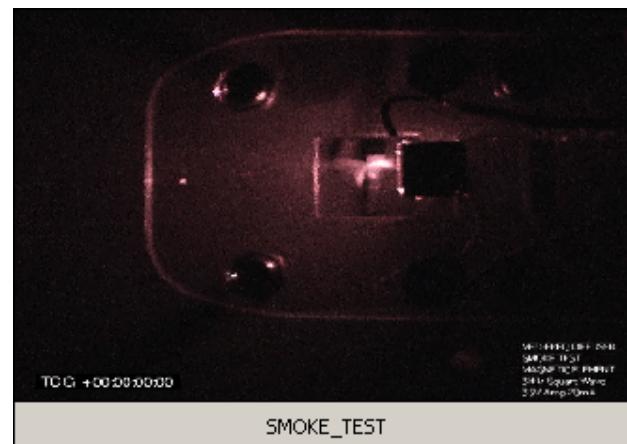
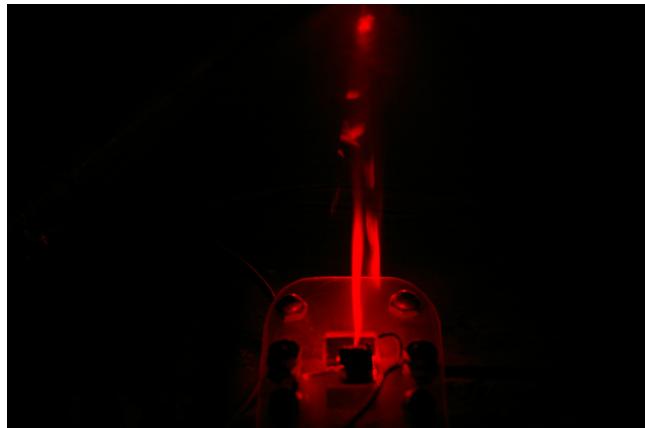
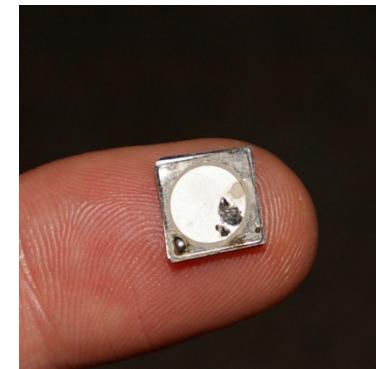
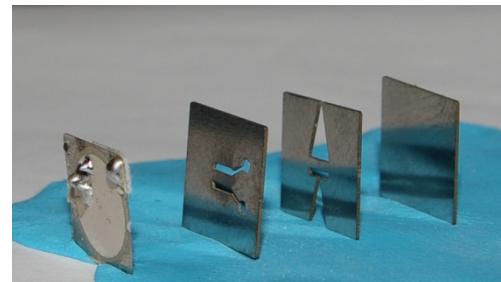
Generic Four Chamber Semiconductor Tool Simulator	BOC Edwards*
Design Power Circuit Breaker Simulator	BPA
Oscilloscope Probe Interface Verification Fixture	Tektronix
Data Acquisition for Wind Generation	Oregon Wind
Line Differential Cable Protection	PacifiCorp
Audio Control Panel Interface	ST Microelectronics
Class D Amplifier EMI Investigation	ST Microelectronics
GUI and Database for Microprocessor Control Registers	Tyzx
Electronic Foot Impression Device for Orthotics Manufacturing	CVN Orthotics*
Revolutionary Heart Rate Monitor	Nautilus
Voice Command for Embedded Systems	Nautilus
Weight Scale Function for Exercise Equipment	Nautilus*
Test Relay Control Circuit Production Retrofit	Maxim
Low Power Embedded Device for Insect Waveform Capture	APTIV
Zigbee RF Radio Tracking	Solutions Works
Overhead Disribution Feeder Circuit Analysis	PGE
SAE Baja Car Competition	SAE*
Docking Station for Medical Monitoring Device	OHSU
Power Harvesting Thermostat	Local Startup
Electrical Design for School Building	Mazzetti

# Recent Capstone Projects

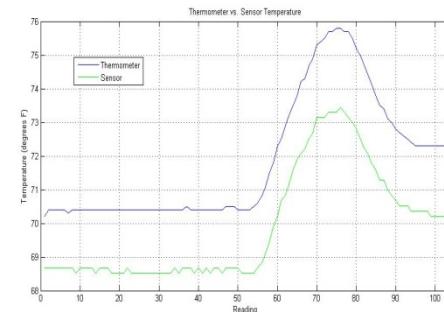
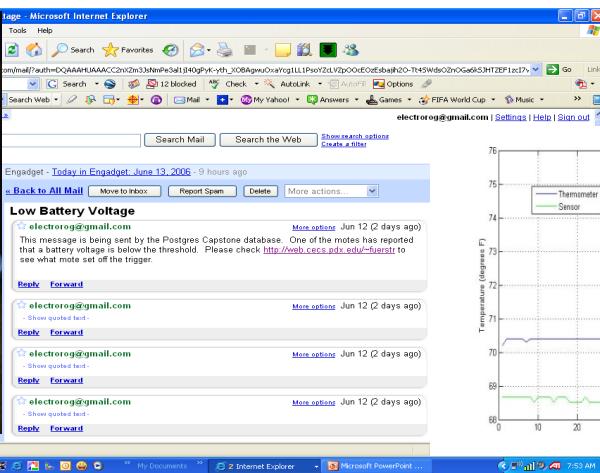
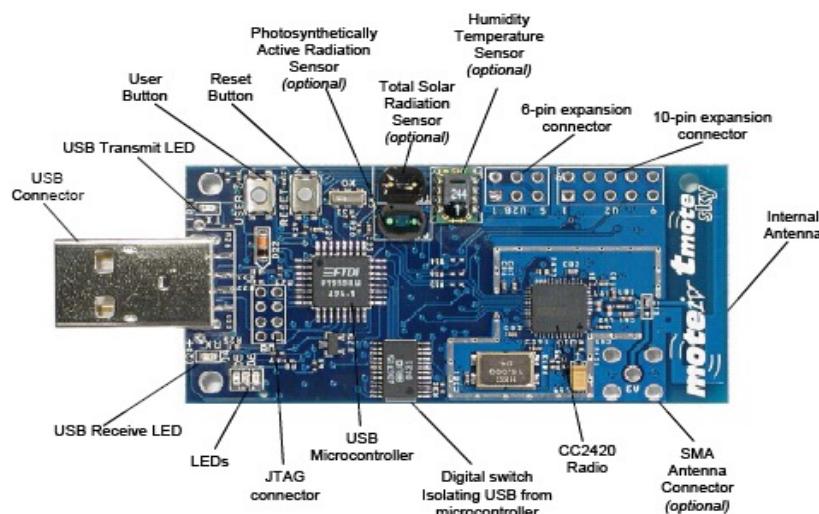


**OMSI**

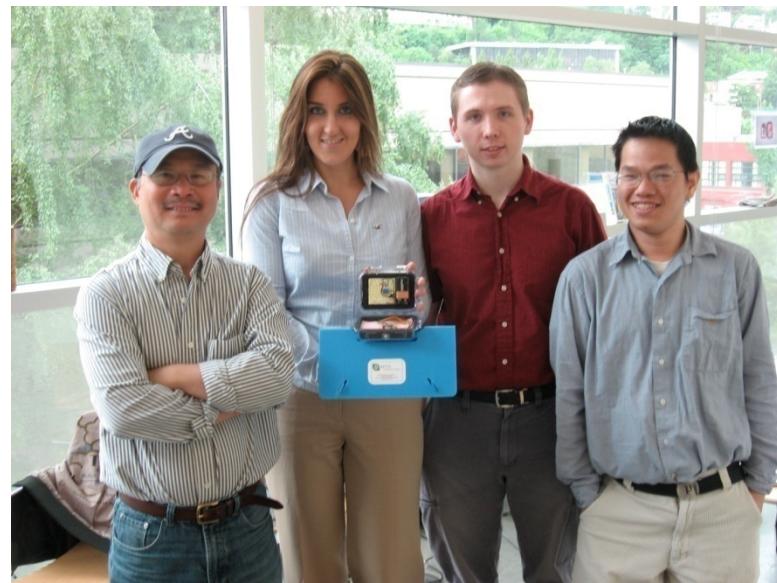
# Recent Capstone Projects



# Recent Capstone Projects



# Recent Capstone Projects



\$50,000 savings to sponsor



APTIV

## Four Portland State University engineering students win top national prize for design

Published: Wednesday, May 09, 2012, 12:16 PM Updated: Wednesday, May 16, 2012, 9:00 AM

Suzanne Pardington, Portland State University



By



Cornell University

Portland State electrical engineering students accept the \$10,000 first-place prize for winning the Cornell Cup USA, presented by Intel.

"We are filled with pride in this hard-won prize in a first-class competition," said Renjeng Su, dean of PSU's **Maseeh College of Engineering and Computer Science**. "It shows that the Maseeh College is a place where students can ignite their imaginations and become top achievers."

**Cornell Cup USA, presented by Intel**, is a new college-level competition that invites students to design and construct innovative applications of embedded technology, computer systems built for specific tasks. The PSU team, which was not identified as affiliated with Intel, created a device to instantly identify an image of a pill from a database of 16,000 prescription drugs and provide the latest detailed information about it. The device is designed for busy emergency rooms and medical offices, where patients often don't know the names of the drugs they are taking.



## Portland State University students' invention tops the field at national engineering competition

Published: Thursday, May 17, 2012, 9:30 PM Updated: Thursday, May 17, 2012, 10:28 PM

Nick Budnick, The Oregonian



By



[View full size](#)

Alysha Beck/The Oregonian

Thang Vo, (from left) assistant professor Mark Faust, professor Marek Perkowski, Hung Nguyen, Hop Nguyen, and Anh Ngo, all of Portland State University, developed a prescription drug identification device that recently won the Cornell Cup USA national design competition. The students invention beat out 23 other teams, including from top engineering schools, to win the \$10,000 top prize.

Four jeans-wearing **Portland State University** seniors spent hundreds of hours this year building a **computer-aided pill identifier** to help doctors and nurses act quickly in emergencies.

The device could save lives, but that's not why they did it. Earlier this month they competed in a battle of computer-aided inventions at **Walt Disney World**, facing students from the nation's top engineering schools.

The four 23-year-olds returned to Portland exhausted but happy, bearing the **Cornell Cup USA** top prize and a \$10,000 check, **beating out powerhouses** like the Massachusetts Institute of Technology and the University of California, Berkeley.

"We drank a lot of Coke," Hoa Nguyen said of their months of long nights.

The four were not just any students, but among two dozen **Intel scholarship students** from Vietnam at PSU's **Maseeh College of Engineering & Computer Science**.

The team's advisor, assistant professor Mark Faust, says the scholars were selected through tests administered at Vietnam's top technical universities. "We're getting the absolute best of the best," Faust said.

Last October, Faust sent an e-mail to engineering seniors suggesting the Cornell Cup as a senior project. Hung Nguyen, an outgoing fellow from the Vietnamese coast, promptly signed up with his friend Anh Ngo from Hanoi, a hipsterish sort with a fondness for hair product.

# Overview: Timetable & Resources

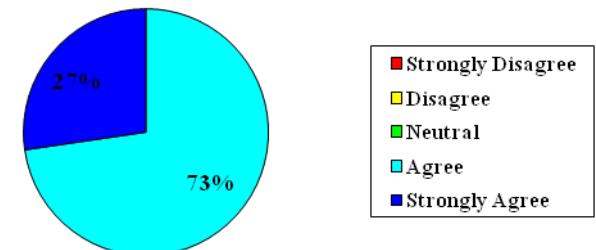
Detailed timetable at: [www.ece.pdx.edu/~faustm/capstone](http://www.ece.pdx.edu/~faustm/capstone)

ECE 411	August 31	Request for proposals	Where will work be done? Sponsor's site At home Capstone Lab
	September 25	Proposals from sponsors	
	November	Project teams and faculty advisors assigned	
	December	First meeting with sponsor	
	Winter break	Research Write project proposal Write product specification	
ECE 412 ECE 413	January	Present project proposal Complete self and team appraisals	Where will resources come from? Sponsor Sponsor's customer Team members
	May/June	Capstone poster session and competition	
	June	Final project reports and presentations Complete final self and team appraisals Complete on-line survey	

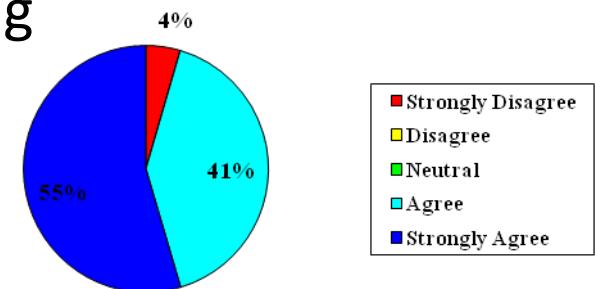
# Student Survey Results

22 Anonymous respondents after completion of Capstone Project

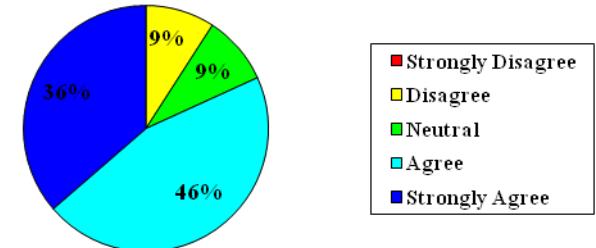
1. Our team met the goals of the sponsor



2. Our project was interesting and challenging

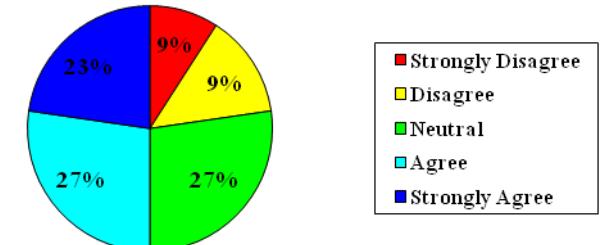


3. Our team was cohesive and worked well together

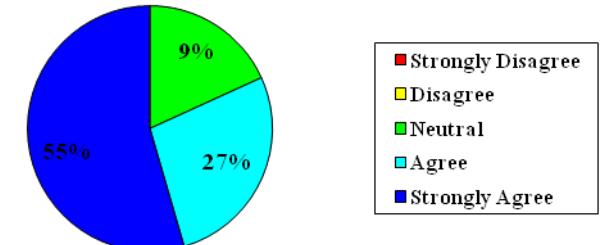


# Student Survey Results

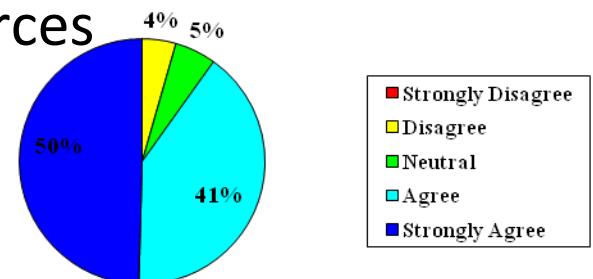
4. Our team's faculty advisor was engaged throughout the project



5. Our industry sponsor was engaged and committed to the success of the project

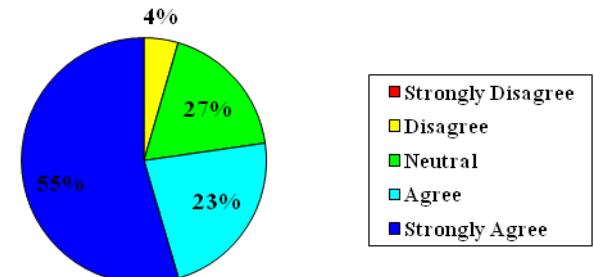


6. Our industry sponsor provided the resources we needed to succeed

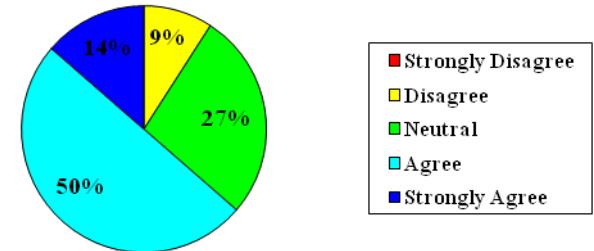


# Student Survey Results

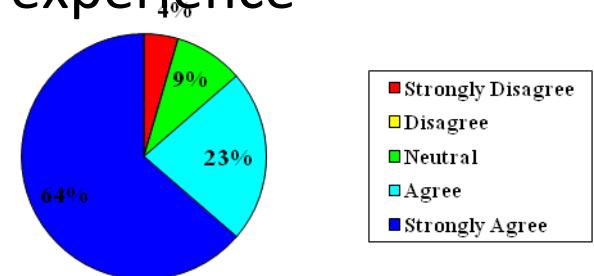
7. Our industry sponsor provided at least one technical contact who was available when needed



8. ECE 411 adequately prepared me for the capstone project

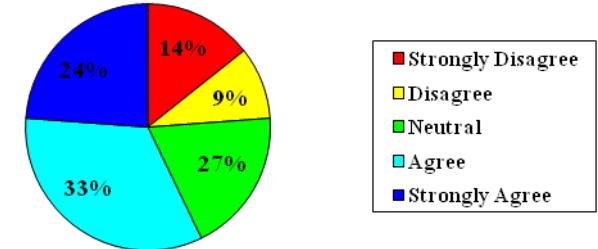


9. I found the capstone project to be a good experience



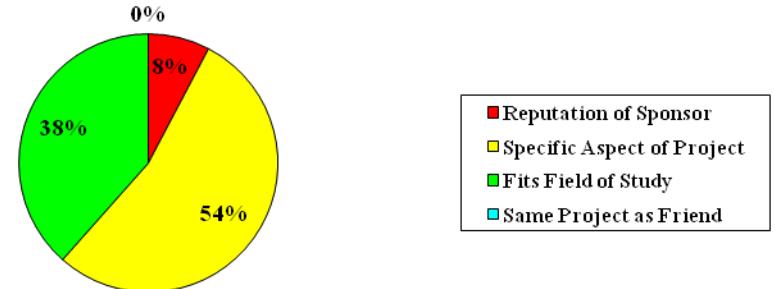
# Student Survey Results

10. The project description on the capstone web site was an accurate description of the actual project

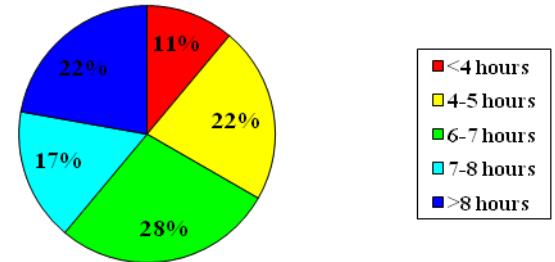


# Student Survey Results

12. Which factors affected your priorities for choice of project?



13. How many hours per week on average did you spend on your project?



# Student Survey Results

14. What topics or exercises in ECE 411 best prepared you for your capstone project?

- *Group meeting and taking minutes, managing groups*
- *Logbook note-keeping*
- *Motivating team members to do their portion of the work.*
- *PDS and Project management*
- *PDS, Timeline, Technical papers search*
- *Team work*
- *Developing a PDS, Discussion of how to deal with team members, communication, etc., Weekly progress reports, How to use research tools*
- *Team meetings*
- *How to work in teams*

# Student Survey Results

15. What topics or exercises in ECE 411 were least helpful in preparing you for the capstone project?

- *Does not apply*
- *Environment*
- *Logbook*
- *N/A*
- *none*
- *I think some of the subjects were not particularly useful for the capstone project but will come in handy later on in the real world. So too early to say at this point*
- *Really nothing*

# Student Survey Results

16. What additional topics should be covered in ECE 411 to better prepare students for the capstone project and for work in industry?

- *I've worked at Intel for seven years as a technician in design and engineering and have noticed a trend towards electronic documentation in the form of email and presentations, documents, schematics, etc. When I first started seven years ago, most people carried a notebook. Now, few people carry notebooks and most people just carry their laptop. Previously, people would have many binders and documents of information and now everything is almost entirely electronic. When patents are required, documentation is retrieved through daily time stamped backups, etc. ECE 411 made it seem like you have to have things written in a notebook when perhaps a large part of the industry may actually be moving towards electronic documentation. I think this should be investigated and talked about additionally in 411.*

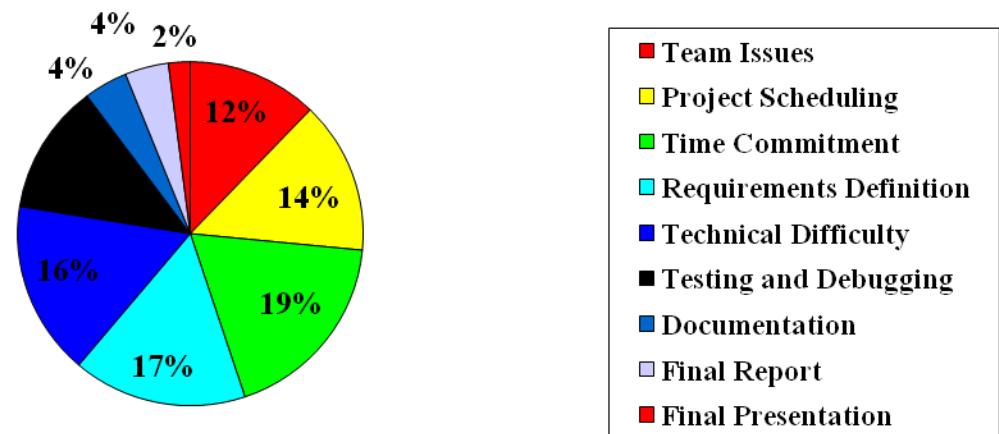
# Student Survey Results

16. What additional topics should be covered in ECE 411 to better prepare students for the capstone project and for work in industry? *Continued...*

- *A little more focus on patent research and processes could be useful*
- *Team work*
- *more examples of teamwork*
- *Professional communication skills including - language tone – style – manners and responsibility*
- *More about working as a group. What to do if somebody is not pulling their own weight. That was covered, but maybe in a more specific way in regards to the senior project*
- *No comment*
- *Presentations. How to, and give a presentation*
- *Manage time and learn new material asap*
- *How to solve problems effectively*

# Student Survey Results

17. What were the most challenging aspects of your capstone project?



# Student Survey Results

18. Use this space for any comments or feedback on CE 411 of the ECE Capstone Program

- *I think it is a great program giving people who don't have any work experience in the field an example of what it is really like to work on a real project.*
- *The Capstone project was a fantastic learning experience for me.*
- *A forced periodic comprehensive review of progress could be very useful*
- *Our Capstone project was 100% suitable for Computer Science senior students , while for EE students with only one course in programming (C++), it was like asking an engineer to prescribe medicines.*
- *It was a very good experience. It would be nice to have more faculty around and willing to answer questions regarding the project design.*
- *It is a good program.*

# Student Survey Results

19. What advice would you give a senior about to start his or her capstone project?
  - *Find out how all your team members act.*
  - *Spend time to read the description of the projects so you would make a right choice. Manage to update an Engineer Log book and the WPR every week. Those will tell you where you're at, what need to do next, and keep you on the right track and time frame.*
  - *Start the project as soon as possible, Define clearly deliverables with the sponsor.*
  - *You need to work at it and be self-motivated*
  - *Get working as soon as possible.*
  - *Schedule plenty of time, both for yourself and for your team, to work on the project every week. Communication is paramount to team success. Expect some conflict within the team and be prepared to deal with them.*

# Student Survey Results

19. What advice would you give a senior about to start his or her capstone project?
  - *Don't make approximate or floating deadlines. Push people and yourself to make commitments and to honor them*
  - *You should know the topics related to the project before starting it*
  - *Know exactly what are you getting into. Document everything . If you sense bad communication skill among the team, change your team instead of trying to fix your team. People enjoy free rides.*
  - *Choose something you will enjoy working on and find challenging*
  - *Manage your time and love the project*

# Student Testimonial

*"I wanted to take the time to share with you my success and to thank you for the part that you played in making it happen. I'm not sure if you remember but back in late Feb-early Mar I asked if I could use you as a reference for a potential job. I am not sure if anyone called you or not but I got the job.*

*Since late Mar I have been working as an electrical engineer at \_\_\_\_\_ in \_\_\_\_\_, OR and it is amazing how fast things can change. I am now solely responsible for all ... electrical systems for an entire plant (10 models) of \_\_\_\_\_ ranging from just over \$200,000 to \$700,000+.*

*I have come to appreciate the skills and knowledge that I have gained during my time as grad and undergrad student, but nothing has been more valuable than the time I spent working on my senior project. The most complicated part of my job is, by far, the logistics, planning and tracking involved in integrating new components into an existing product plan. Without the experience of planning a project in MS Project, an understanding of product lifecycle and especially practical experience in keeping a logbook, I would have been quickly overwhelmed.*

*I look back on my time working on the [title of capstone project] with great fondness and I wanted to thank you for the part you played in my development as an engineer.*

*Thank you very much."*

# Student Testimonial

“ I just wanted to give you guys a little feedback. I’m currently employed by Lockheed Martin working on an FAA contract. I’m working in production and systems integration that generates all the engineering transmittals for the West Mountain Region. These engineering transmittals deal with all aspects of the design and installation of the air traffic control infrastructure nationwide. I just want you guys to know not to decrease the workload or your standards on these capstone projects. You required us to give you more formal briefings and progress reports than any of the other groups had to give on their projects. Although the workload was overwhelming at times, I’m grateful that your standards were as high as they were.

The PowerPoint presentations and briefings I have to give and the formal engineering reports I have to write are so similar to those you required for capstone that I feel like this is all “old hat”. The standard is quite high where I work and you guys set the bar so high for us that I truly feel that you have been a big part in my success here. I want to thank you both for how challenging you made the capstone project and how “real life” and professional you made it. It remains the highlight of my bachelor’s degree program. Please don’t lower the bar. The students can handle it and will be much better prepared if people like you continue to hold them to a greater standard.

I just wanted you both to know that I appreciate what you have and continue to do for me and the students there at PSU.”

# Student Testimonial

"Prof. Faust,

I wanted to let you know that Intel is hiring me full time. I am hoping to take advantage of their educational opportunity and take more courses at PSU when I have time.

I also wanted you to know that the PMTA is continuing to be a useful tool to several groups here. The opportunity to work on your Capstone project has lead me to a career at Intel, and for that I will be forever grateful.

Thank you,"