

The Rutgers E&CE Capstone Program

Rutgers E&CE Faculty

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1 Introduction

Rutgers E&CE Capstone Design is intended as our senior-level culmination of student-directed learning. Teams of E&CE students are required to undertake an open-ended design problem (preferably of their own choosing, but projects may also be assigned) and not only apply the skills they have acquired from their coursework, but develop new skills on their own as part of the process. E&CE Capstone Design is our attempt as faculty to prepare you more fully for the world you will face after graduation. After graduation there are no carefully controlled curricula and you must become adept and efficient at acquiring new skills which suit the task.

The Rutgers E&CE Capstone Design experience has been revised and existing spring term Capstone course sections merged into exactly FIVE design areas entitled:

- Sensor, Control and DSP Systems (Pompili – 332:418)
- Communication (Rose – 332:428)
- Computer Systems and Software (Parashar – 332:438)
- Robotics, Vision and Virtual Medical Systems (Dana – 332:438,478)
- Circuit and Microelectronic Systems (Zhao 332:468)

Explicit fall-term pre-requisites for Capstone Design are no longer required (except where noted). In general, E&CE faculty expect students to examine the many possible area-specific offerings and select as electives those which will best prepare them to tackle the design problem they choose. (See suggested courses below.) Owing to space limitations, **enrollment in a particular capstone is not guaranteed**, though strong preference will be given to students who have completed suggested coursework relevant to their chosen capstone.

NOTE: It is very important to remember that Capstone Design instructors hold capstone students to a high standard of performance regardless of previous courses taken. Diversifying one's technical background through various electives – especially those suggested for the capstone section of interest – will greatly increase your odds of successfully completing Capstone Design. Or put more bluntly, without the proper background, it is possible that your spring term Capstone Design project will be rejected and your graduation delayed.

2 Administrative Process

2.1 Overview

We will open up a web site (most likely on Sakai) where you can state your spring-term capstone design course preferences. This web site will open on October 10 and the due date for preferences is October 14. You will be informed of your preliminary capstone section assignment by November 15. Your team roster and proposal for your team's capstone design project must be submitted to the web site by December 15 for evaluation. Your proposed project topic should fall roughly in the area of the spring term capstone course to which you have been assigned. However, most projects are multidisciplinary so some area overlap is likely. Final capstone assignments will be posted by January 15.

2.2 Team Formation

Informational lectures will be given by capstone instructors during the Fall term to help describe their capstone predilections, potential project ideas as well as to provide advice about team formation. You should begin forming your teams as early as possible. Students teams must have a minimum of 3 and a maximum of 5 members. (Note: team composition can be modified at the discretion of the instructor.)

2.3 Requirements

Teams are required to do midterm and final project presentations and demonstrations and submit a midterm and final project report.

2.4 Grading

Grades for the capstone project will be determined by the quality of the project presentations, demonstrations and reports. However, students will also be graded **individually** based on their contributions to the project team. Departmental recognition for best team projects will be awarded near the end of the term and/or at graduation.

2.5 Important Dates

- Capstone Information Lectures: Various – TBA
- Capstone Web Site Opens: October 10
- Capstone Course Preferences Due: October 14
- Preliminary Assignments Posted: November 15
- Capstone Design Proposal Due: on or before December 15
- Final Course Assignments and Proposals Posted: January 15
- Capstone Mid-term report presentation: on or before March 11
- Capstone Final Project Report+Presentation: on or before April 20

3 Suggested Area-Specific Electives

Taking one or more of the courses marked in bold is **strongly suggested**

- **SENSOR, CONTROL & DSP SYSTEMS**
 - Sensor-Based Systems and Applications (**332:493**)
 - Control System Design (**332:417**)
 - Digital Signal Processing (**332:346**)
- **COMMUNICATION**
 - Wireless Communication Systems (**332:421**)
 - Communication System Design (**332:427**)
 - Computer and Communication Networks (**332:423**)
 - Wireless Revolution (332:301)

- Linear Algebra

- **COMPUTER SYSTEMS & SOFTWARE**

- **Software Engineering (332:452) (CRITICAL COURSE)**

- Intro to Parallel and Distributed Programming (332:451)

- Digital System Design (332:437)

- **ROBOTICS, VISION & VIRTUAL MEDICAL SYSTEMS**

- **Robot and Computer Vision (332:472) (CRITICAL COURSE)**

- Virtual Reality (332:376)

- Linear Algebra

- **CIRCUIT & MICROELECTRONIC SYSTEMS**

- Analog Electronics (332:463)

- Microelectronic Processing (332:467)

- Opto-Electronic Devices (332:466)

- Physical Electronics (332:465)

- VLSI Design (332:332:479)

- DSP Design (332:447)

- Digital System Design (332:437)

- Linear Algebra

A FAQ

Please feel free to email me crose@winlab.rutgers.edu with questions.

Week 1

- **Does my project have to be written up in the newspaper or appear in a conference proceedings to qualify for capstone credit?**
 - No. However, we still exhort you to think big. This is the time in your life when the intellectual shackles are most loose. Live it up intellectually a little! Also, as adults you should start thinking about sharing your discoveries with the world. Press coverage and conference proceedings are great ways to do this.
- **What if my capstone proposal is rejected!!!!?????**
 - Capstone proposal preparation is an *iterative and collaborative process*. As a worst case, suppose you see all E&CE professors teary-eyed some day because they read and could not stop laughing at your project proposal. You will get feedback about how to fix/improve the proposal and you'll do a revision. In addition, you should be running project ideas by your professors as the term progresses. That way at least one professor will be dry-eyed after they read your submission. :) **Seriously:** Proposal preparation is an iterative process, so if your proposal is flawed in some way we will collectively work to make it better if not a model of technical beauty.
- **Am I guaranteed to get into the capstone section of my choice?**
 - No. Section enrollment will be limited. However, preference will be given to students who have completed coursework which supports their capstone choice and, ultimately, their capstone proposal. em That said, a given project will often fit into more than one capstone area.
- **Do capstone courses have pre-requisites?**
 - No and Yes. We are moving toward a prereq-free capstone program. However, this year, both the Robotics, Vision & Virtual Medical Systems (Dana) and the Computer & Software Systems (Parashar) have prerequisites of 332:472 and 332:452 respectively. Note, not CO-requisite but PRE-requisite. HOWEVER, for the RV&VMS capstone, if you pursue the virtual medical portion, you'll need to consult with Prof. Burdea who will be supervising most VR-related projects.
- **Will I ONLY be able to work with Professors Dana, Parashar, Pompili, Rose and Zhao?**
 - No. All E&CE faculty will supervise at least one capstone project this year. MOST projects will be supervised by the five capstone instructors, but some projects will be supervised by other appropriate faculty. That said, you will STILL need to enroll in one of the capstone sections even though your capstone project advisor might be another professor.

- **Can I do a capstone project all by myself (no team)?**
 - Frowned upon. The whole idea of capstone design is to work in teams. However, at faculty discretion there may be a limited number of projects that can be pursued by a single student.
- **What if my capstone project topic does not fit completely into one area?**
 - CONGRATULATIONS! Discipline-spanning projects are great (and difficult and rewarding)! You'll be nominally placed in the most appropriate section and appropriate supervision will be arranged.
- **What if my proposed capstone project topic is not covered by ANY of the five general areas?**
 - That is virtually impossible – the capstone areas are VERY broad. However, special cases could arise and will be considered on an individual basis. For good projects, we will FIND a way to make it work.

Week 2

- **What if some of my team members are in other departments?**
 - FANTASTIC! For good projects we will find a way to make this work.
- **The word “Capstone” seems so limiting – like it MUST be ONLY about EXACTLY what I learned during my time in E&CE. What if I want to start the next FB as a capstone project?**
 - We could just as easily change the course name to **Build Our Dreams**. We're looking for really creative projects. Faculty will beat projects into something doable, so don't self-censor. Think BIG and then start laying out achievable steps toward your goal. The bigger your success the bigger all our successes.
- **Who owns my work if I work on a project using, say, National Science Foundation-supplied equipment?**
 - This is a variant of the question, “who owns what?” This is also an ethical question. For instance, if you work in someone's lab and discover something wonderful, it's only right that the person guiding the work be given SOME credit since they had substantive input into the creative process. However, if you, say, discover a new type of artificial blood while working on a project dealing with internal combustion engines, I'd say your idea is all yours.
That said, intellectual property (IP) is often a thorny area. Right now, here's what we know:
 1. If you are not paid by a grant which SPECIFICALLY retains IP rights, you own your IP.

2. If you work with equipment supplied by grant money – I DON'T KNOW YET BUT WILL POST HERE WHEN I DO

But again, it's worth emphasizing – you can try to be an island, but it's often not worth it. Collaboration is a good thing and if you hit it REALLY big there will always be enough credit and lucre to go around. Rutgers as an institution is not going to try to rip you off. Your success is Rutgers' success and for good ideas, Rutgers can be a useful ally.

Let me be a little more specific

1. Patents cost money (typically between a \$3k and \$10k PER PATENT)
2. Patents take TIME (years typically – which through refilings/revisions after initial rejection can run to a significant sum)
3. A patent only gives you the right to sue an infringer. If your idea is stolen and you don't have VERY deep pockets, you'll have to convince an attorney to sue “on spec.” A typical patent trial costs the litigants around \$5M each.
4. **Moral:** yes, get a patent on good ideas. However, hieing thy tail to MARKET is MUCH more important. For that you generally need help of some sort and Rutgers and your professors' contacts can help. So don't worry TOO much about who gets what just yet.

B Spring 2010 Capstone Project Titles

Following is a list of capstone project titles from the Spring 2010 term. The titles should give you an idea of the sorts of things one might do for capstone projects. They are arranged by the (then) course number and then also by project “type.” Both faculty and students have a strong preference for “blue sky” projects in which students/professors come up with project ideas that might span a number of areas. In contrast, there are also what might be called “cookie cutter” projects in which students essentially design/build something that’s already very well known. This year, professors and students are strongly encouraged to develop projects that ask and answer a new question, or do something well known in a new way.

B.1 Projects by Capstone Number and Instructor

(N) =number of students per project

- **418: Trappe**
 - Babel Fish (language translator a la Hitchhiker’s Guide ...) (2)
- **418: Gajic** (9)
 - Design of an Electronic Controller for a Ship Stabilization Problem - Project 1 15 points = 15% of the course grade
 - Robot Submarine Controller Design - Project 2
 - Design of a Controller for a Vehicle Lateral Dynamics Stability Control - Project 3
 - Dynamics and Control of HIV Virus - Project 4
- **428: Daut**
 - Novel Two-Way Car Alarm Responder System (2)
 - Wireless Security Key (WiSe-Key) (4)
 - Open Source Cisco Discovery Protocol Analyzer (1)
- **428: Rose**
 - Eco-Home (4)
 - Mobile Repeater (6)
- **438: Dana**
 - Interactive Computing (3)
 - Trajectory Estimation with Auto Targeting (3))
 - Self-Piloted Vehicle (3)

- RooMonitor: A Robot Utilizing Depth Perception and Object Recognition to Develop Mobile Autonomy (2)
- Augmented Reality Robot Mapper 3D Mapping and Data Visualization (2)
- Augmented Reality Path Guided Robot Control (2)
- **438: Pompili**
 - Activity Classification using wearable Accelerometers (3)
 - Capstone Design Sensor Networks (content-free report) (3)
 - Capstone Design - Sensor Networks: Trajectory Capture Using Wearable Wireless Devices (3)
 - Sensor Networks Group 4 Wireless Vital Signs (3)
 - Acoustic Modem Project (tied into rutgers ocean glider project) (3)
 - Wireless Sensor Network for Digital Media Acquisition (3)
- **438: Rodero**
 - Advanced Android Barcode Scanner (5)
 - Team Cirrus (volunteer computing) (5)
 - GS Common App (graduate school application) (6)
 - Poker Vision (6)
 - Inventory Management Using RFID Technology (5)
- **438: Chakraborty**
 - Electronic Home Automation Project System Timing Report (5)
 - Real-Time Audio Effects Processing Synthesizing Digital Audio Effects on an FPGA (2)
 - Senior Design Project Arm7TDMI Microprocessor (1)
 - Electronic Classroom Automation System Controller (2)
- **468: Caggiano**
 - Audio Amplifier Systems (3)
 - Power Amplifier Design with Active Filters (2)
 - Audio Amplification Circuit (4)
- **468: Hanafi**
 - D Flip Flop (1)
 - Full Adder (1)
 - J-K Flip Flop with Clear (1)

- 4 Bit Parity Generator (1)
- **468:**
 - White Light Via Multiple LED Combinations (3)

B.2 Projects by “Type”

Here we group capstone projects by whether it appears that the student developed the idea *de novo* (without explicit instructions or a palette of choices provided by the instructor) or not. We have titled the former type of project as “Blue Sky” and the latter as “Cookie Cutter.”

- **Blue Sky Projects**

- Babel Fish (language translator a la Hitchhiker’s Guide ...) (2)
- Novel Two-Way Car Alarm Responder System (2)
- Wireless Security Key (WiSe-Key) (4)
- Open Source Cisco Discovery Protocol Analyzer (1)
- Eco-Home (4)
- Mobile Repeater (6)
- Interactive Computing (3)
- Trajectory Estimation with Auto Targeting (3)
- Self-Piloted Vehicle (3)
- RooMonitor: A Robot Utilizing Depth Perception and Object Recognition to Develop Mobile Autonomy (2)
- Augmented Reality Robot Mapper 3D Mapping and Data Visualization (2)
- Augmented Reality Path Guided Robot Control (2)
- Advanced Android Barcode Scanner (5)
- Team Cirrus (volunteer computing) (5)
- GS Common App (graduate school application) (6)
- Poker Vision (6)
- Inventory Management Using RFID Technology (5)
- Electronic Home Automation Project System Timing Report (5)
- Real-Time Audio Effects Processing Synthesizing Digital Audio Effects on an FPGA (2)
- Senior Design Project Arm7TDMI Microprocessor (1)
- Electronic Classroom Automation System Controller (2)
- Activity Classification using wearable Accelerometers (3)

- Capstone Design Sensor Networks (content-free report) (3)
- Capstone Design - Sensor Networks: Trajectory Capture Using Wearable Wireless Devices (3)
- Sensor Networks Group 4 Wireless Vital Signs (3)
- Acoustic Modem Project (tied into rutgers ocean glider project) (3)
- Wireless Sensor Network for Digital Media Acquisition (3)
- White Light Via Multiple LED Combinations (3)
- **TOTAL STUDENTS: 92**

• **Cookie Cutter Projects**

- (9)
 - * Design of an Electronic Controller for a Ship Stabilization Problem - Project 1
 - * Robot Submarine Controller Design - Project 2
 - * Design of a Controller for a Vehicle Lateral Dynamics Stability Control - Project 3
 - * Dynamics and Control of HIV Virus - Project 4
- Audio Amplifier Systems (3)
- Power Amplifier Design with Active Filters (2)
- Audio Amplification Circuit (4)
- D Flip Flop (1)
- Full Adder (1)
- J-K Flip Flop with Clear (1)
- 4 Bit Parity Generator (1)
- **TOTAL STUDENTS: 22**

C Spring 2011 Capstone Project Titles
COMING SOON