Senior Design Lab
2016-2017
ECEN-4610 / 4620
Senior Preparation Meeting
What does complex system development look like?
What do you imagine it to be?
What does hardware design look like?
How about software design?

What are you really capable of??
Don’t you want to find out soon?!

In Senior Design Lab, we will explore and experience this in-depth...
I came from another world... one much like earth called "industry."

My perspective is just one among many... with 25 years behind it.
Andrew Femrite

- UCB ECEE  
  4.5 years
- Embedded Design, Pentax  
  6 years
- Field Apps. Engineer, Wyle  
  2 years
- RTM, Wyle / Arrow  
  9 years
- Engineering Solutions Center  
  7 years
- UCB ECEE (again!)  
  Aug’14 to present

- BS ECE
- First pocket printer design: PocketJet
- #1 TI and Intel demand creation
- Multiple regions, founded Career Strata
- Envisioned and implemented diverse technical team of specialists (> 35)
- Architect of Arrow Centralized Training

- Senior Design Lab Program /
  Professional Master’s Program in Embedded Systems Engineering
- Direct extension of FAEs
- Centralized applications engineering team
- Objective technical perspective
- Cypress and Altera Specialists
ECOO Professional Masters Program
Embedded Systems Engineering (ESE)

Previous State (AY2014/15 and prior)
• Embedded Certificate only (9 credit hours)
  • Embedded Systems Design (ECEN-4/5613)
  • Real-Time Embedded Systems (ECEN-4/5623)
  or
  • Real-Time Digital Media (ECEN-4/5653)
  • 1 Elective
• Limited ECEE graduate-level courses with embedded design focus

Accelerating Forward (click here for more info)
• Enough ESE to fulfill Masters Degree (30 credit hours)
  • 4 ESE core courses + 6 electives (ESE or others)
  • 5 NEW core courses, 20+ electives (including 5 new)
• Main thrust is practical, application-centric curriculum
• Core courses span all embedded essentials rigorously
• Direct industry engagement
• Calibration on current trends, tools and technologies
• Comprehensive, contemporary engineering education

ESE program is a non-thesis, workforce preparation track towards a full Masters Degree
Agenda

• What is Senior Design Lab?
• Course preview (high level)
• Forming teams
• Project funding options
• What makes a good project
• Checkout Boards!

• Critical course logistics
• Expectations of students and what students can expect
• What makes a good project (samples [here](#))
• Choosing projects and teams
• Interdisciplinary teams
• Project funding
• Industry sponsorship guidelines
• Initial project pitches from sponsors
What is Senior Design Lab?

Your team will participate in the end-to-end process of:

- Proposing
- Specifying
- Designing
- Building
- Testing
- Demonstrating
- Delivering
- an embedded system prototype
What is an Embedded System?

An intelligent electronic system dedicated to one primary function
Embedded System?

Actually a collection of embedded systems. So is your computer.
Senior Design Lab

• Transition experience
• Required of all Seniors
• Intro to real world
• Students choose their projects
• Integrative **TEAM** engineering experience

Student choice, wide scope of each project, and intense team experience is unique in the curriculum
Why Senior Design Lab??

What will we do there?  
Curricular fantasy meets practical reality!

Why this curriculum?  
Nexus of electronics, software and mechanics!

What really matters?  
Printed circuit board traces and ICs get fried!

Who will hire you?  
Manufacturer device specs get debunked!

The Reference Design myth is revealed!

Software “envelopment” vs. development

Students fail and learn fast hands-on
What talent do employers crave?

*Same aspects you encounter in Senior Design Lab!*

- Critical thinking and complex problem solving
- Ability to apply skills and knowledge in real-world setting
- Collaborative interpersonal skills
- Effective communication skills
- Self-starting resourcefulness
- Awareness of leading technology, markets and trends
- Thought leadership and creative ideas
- Integrity
- Engagement
- Flexibility
- Domain technical expertise is a GIVEN
The Design Process

Diagram showing the design process with the following stages:
- Problem Identification
- Research
- Requirements Specification
- Concept Generation
- Prototype and Construct
- System Integration
- System Test
- Delivery and Acceptance
- Maintenance and Upgrade
- Design
- Requirements Specification
- Concept Generation
- Prototype and Construct
- System Integration
- System Test
- Delivery and Acceptance
- Maintenance and Upgrade
- Problem Identification

Design for Electrical and Computer Engineers, McGraw Hill
Ralph Ford and Chris Coulston, Copyright 2007
Course Outlines*

**ECEN 4610**
- Project pitches (industry/faculty)
- Team formal product description
- PCB development
- Requirements Specification
- System Diagram / Func. Decomp.
- Ethics
- Preliminary Design Review
- Proof-of-Concept Testing

**ECEN 4620**
- Critical Design Review
- Acceptance Test Plan draft
- Unit Testing
- Integration Testing
  - Test Plans, then Integration Test Demos
- Acceptance Testing
  - Test Plan refinement, then Acceptance Test Demos
- EXPO!
  - THIS YEAR’S IS THUR 4/28, 8am-1pm at the Idea Forge (Fleming)

*CAUTION: Rubrics, dates and exact course composition are subject to change from previous years! Syllabi will be available at the outset of the respective courses.*
About defining products

• *Product Description* (formal document) required in D2L Friday of 2\textsuperscript{nd} week
  - Teams missing this deadline \(\rightarrow\) Every member administratively dropped from course.

• Formal *Requirements Specification* Version 1.0 required in D2L Tuesday of 4\textsuperscript{th} week

• *System Diagram* and *Level 1 FD* required Tuesday of 5\textsuperscript{th} week. *Level 2 FD* 6\textsuperscript{th} week

• *Preliminary Design Review* (PDR) occurs Tuesday of 8\textsuperscript{th} week
Key takeaway

• System Definition phase of the formal design process taught in Senior Design Lab starts **fast**
  • Have your team ready....
  • Have your product and project fleshed out.....

**EARLY!**

Be prepared to go like a for first 8 weeks
Beware The Deadly Trap!

Year long course, and in Oct the initial rush has eased. Then....

• Dec, right after fall break: Proof-of-Concept Demonstrations
• Jan: Critical Design Review
• April: Integration and Acceptance Testing
• April/end: EXPO

......All feel like they are infinitely far away.....

......plenty of time.....

......so work on your project next week.....
Biggest hurdles seem to be...

- Software / Firmware
- Power
- PCB re-spinṣ
- Reliably flashing the MCU
- Mechanical design and implementation

- Not understanding reference designs, & using aspects of them in spite of this
- A word about “Googling” your project...
- You have value!! Don’t you want to know what it is??!
Rules about Teams

• Tuesday 5pm of 2\textsuperscript{nd} week:
  - Team members must register under their official team name on D2L
    - This includes telling us if you are participating on a team in another dept
    - Unregistered students are administratively dropped

• Teams of 4 to 6 members
  - Instructors won’t put you on a team; \textit{SOLELY} your responsibility

• Team membership is immutable
  - Problems down road can’t be solved by jumping ship or evictions
  - Team experience is integral to Senior Design
  - Projects must have contingencies for successful completion even with interpersonal dynamics
Interdisciplinary Teams

• If you’d like to work as part of an Aero, CS, or ME team in that Dept’s Senior Design Lab...

   Can be accommodated most of the time. **Discuss with instructor(s) in person or by e-mail.**

• Conversely if you want to form an ECEE team that includes AE, CS or ME seniors......

   That can happen too. **E-mail or talk to instructor(s).**
Grading

- Your individual grade starts from team grade as a base
- Peer evaluation process is also integral

For you to succeed individually, your team must succeed.
Conclusions around Choosing Teams

*Which comes first, the team or the project?*
*Which comes first, sponsorship or the project?*

• Seek your team members NOW.
  • You have very little time for this at start of the course

• Seek those you are most comfortable with

• Avoid any single “indispensable” members
  (Single point failure mode)

• **Balance!!**
  • Organization, software, hardware, mechanical aspects...
  • Specialists around Controls, Power, Wireless...
  • Those who know MATLAB, SolidWorks, Mentor Graphics...
# Project Funding Options

<table>
<thead>
<tr>
<th>Industry Sponsorship</th>
<th>Faculty Sponsorship</th>
<th>UROP Sponsorship</th>
<th>Engineering Excellence Fund</th>
</tr>
</thead>
<tbody>
<tr>
<td>• $15k contract/IP</td>
<td>• Project materials <em>usually</em> covered</td>
<td>• Up to $1000</td>
<td>• Up to $5000, but...</td>
</tr>
<tr>
<td>• Sponsor owns IP</td>
<td>• Terms per faculty advisor</td>
<td>• Submit proposals in Sept</td>
<td>• Submit proposals in Sept</td>
</tr>
<tr>
<td>• ~$1500 to OCG if contract needed</td>
<td></td>
<td>• Students retain IP</td>
<td>• Must benefit a broader audience</td>
</tr>
<tr>
<td>• ~$1500 for project materials</td>
<td></td>
<td></td>
<td>• Students retain IP</td>
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<tr>
<td>• “9-month” interview</td>
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Senior Design Course does NOT provide project funding. Teams that are diligent with funding options above should not incur out-of-pocket expenses.

**TEAM PROJECT FUNDING SELECTION MUST BE PRE-APPROVED BY PROF. FEMRITE**
ECEE Senior Design Industry Sponsorship

Program Outline
• Sponsor Guidelines
• Sponsor Benefits
• Agreement Contract
• Process and Timeline
  • Notice of intent
  • Project proposals by June 1st
  • Engagement

Fee Structure
• $15,000 for project IP and prototype hardware retention
• ~$1500 for team project materials*
• Supports lab equipment, tools and supplies, project materials, development kits, classroom teaching aids, teaching assistants
• Spring semester EXPO sponsorships also available

*Teams must provide a justified project budget
Project Options

1. Select a faculty sponsored project proposal
2. Select an industry sponsored project proposal
3. Propose your own project idea to faculty
4. Propose your own project idea to an industry sponsor
5. Originate your own project and funding
Choosing Projects

• Instructors will not choose a project for you or assign you a project

• Try getting out of your comfort zone

• Learn a technology, tool, device... that will differentiate you

• Arduino, rPi, BBB are popular for proof-of-concept
  • Move beyond these for your end product

• A senior design project should be a custom application and not integration of off-the-shelf modules

• Professor Femrite is available by e-mail or appointment to discuss project ideas. Even over the summer.
Project Example 1: Eraser-Bot

- Motor Control
- Route Planning Algorithm
- Embedded software
- Imaging / Camera Module
- Android App
- Wireless Control
- Mechanical Fixture
- Drama! Will the eraser-bot fall? If it does, will it survive?

The eraser-bot by Team Ohm-bres
Using image processing on a simulated tattoo image on a curved surface of a fake human limb, we’ll implement control of a *Cartesian* robot to demonstrate that the procedure may be performed using a robotic method.

- Sensors
- Image Processing
- Robotic Movement / Motor Control
- Microcontrollers
- Embedded Software
- Mechanical Fixture

Project by Team SKINlapZ
Project Example 3: Plasma Speaker

- Tesla coils produce loud, bright sparks
- Can be controlled to produce music
- This can inspire younger students about engineering
Project Example 4: AHA!

Image Processing
Embedded Linux Software
Motor Control
Mechanical Design
Camera Module
Vector Prediction Algorithm
Taunting (stretch goal)
Drama!

AHA! Air Hockey Autonomous
By Turn Down For Watt
What really makes a good project?

• Exciting, innovative, inspiring
• Something you are interested in
• Really challenging but feasible
• Product fulfilling an actual need
• Product a real customer wants
  • Company or research project
• Affordable*

• One that Senior Design Instructors Approve
  • Appropriate scope for team size
  • Involve hardware, software, and mechanical aspects
  • Include at least one custom PCB
  • Not just a system integration, but actual HW/SW development

Projects will be evaluated on a balance or sum of these

* There are several funding options. Unless a potential project is fairly expensive (>2K), cost should not be your first decision factor.
Project Ideas

Previous Senior Design Lab projects
• http://ecee.colorado.edu/academics/ugrad/expo-sp16.html

Great projects done at Cornell with Altera donated boards
• http://people.ece.cornell.edu/land/courses/ece5760/FinalProjects/
• https://www.youtube.com/watch?v=o-id_F1htPc&list=PL2E0D05BEC0140F13 (Youtube channel for same)

Altera University Program boards
• https://www.altera.com/support/training/university/boards.html

IDT Wireless Power Contest

Example of an end-to-end development
• http://www.instructables.com/id/Interactive-LED-Beer-Pong-Table/
So, what to think about now?

We covered:

• SDL Overview : Teams : Funding : Projects

• For Questions:
  • Andrew.Femrite@colorado.edu

• Current project descriptions can be found at: http://ecee.colorado.edu/academics/ugrad/expo-sp16.html
  (On ECEE home page, look for “Senior Design Projects” link)
Thank you!

• Now soliciting project proposals
  • Faculty Advisors / Sponsors
  • Industry Sponsors

• Check Out Development Boards for Projects!
  • Stop by my office (ECEE 1B71) to check my inventory
  • Email me with requests – perhaps I will acquire over the summer for Aug availability

• Project Pitches coming!!
  • Watch for an email from me in May with an update
  • You must formalize a team to claim a project!

Questions??
Summary of Faculty Project Proposals

• Congestive Heart Failure Monitor [Dr. Kimberly N. Frey, Dr. Frank Barnes]
  • Wearable phono-cardiogram monitor for congestive heart patients; sends the data to the doctor’s office

• Biological Cell Monitor [Dr. Frank Barnes]
  • Find a simple way to monitor metabolic rates in cells, oxygen content and membrane potentials in cells

• Disposable Radar/Lidar [Dr. Al Gasiewski]

• Yard Rumba [Dr. Al Gasiewski]

• Project 1 [Dr. Milos Popovic]

• Project 2 [Dr. Milos Popovic]