Senior Design Lab
2015-2016
ECEN-4610 / 4620
Senior Preparation Meeting
What does complex system development look like?

• What does it look like to you?
• What does hardware design look like?
• How about software design?
• What *should* these look like??

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

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
Agenda

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

Why this curriculum? Curricular fantasy meets practical reality!
Where are we going? 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
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
What talent do Employers crave?

• 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

- Problem Identification
- Research
- Requirements Specification
- Concept Generation
- Prototype and Construct
- System Integration
- System Test
- Delivery and Acceptance
- Maintenance and Upgrade
- Design
- Requirements Specification
- 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 Test Checkoffs
- Acceptance Testing
  - Test Plan refinement, then Test Checkoffs
- EXPO!

---

*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.*
## 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>• $7k gift-only</td>
<td>• Project materials covered</td>
<td>• Up to $1000</td>
<td>• Up to $5000</td>
</tr>
<tr>
<td>• Students retain IP</td>
<td>• Terms per faculty advisor</td>
<td>• Submit proposals in Sept</td>
<td>• Submit proposals in Sept</td>
</tr>
<tr>
<td>• $15k contract/IP</td>
<td></td>
<td>• Students retain IP</td>
<td>• Must benefit a broader audience</td>
</tr>
<tr>
<td>• Sponsor owns IP</td>
<td></td>
<td></td>
<td>• Students retain IP</td>
</tr>
<tr>
<td>• $1500 for project materials</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• “9-month” interview</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
ECEE Senior Design Industry Sponsorship
New Model Effective AY2015-16

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

Fee Structure
• $7,000 philanthropic
• $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
About defining products

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

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

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

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

- System Definition phase of the formal design process taught in Capstone starts **fast**
  - Have your team ready....
  - Have your product and project fleshed out.....

**EARLY!**

- Be prepared to go like TPBOOH for first 8 weeks
Don’t fall into...The Deadly Trap

• Year long course and in Oct of 2015 initial rush has eased. Then....
  • Dec 2015 (Proof-of-Concept Demonstrations)
  • Jan 2016 (Critical Design Review)
  • April 2014 (Integration and Acceptance Testing)
  • May 2016 (EXPO)

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

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

......so work on Capstone next week.....
Biggest Hurdles seem to be...

- Software
- Power
- PCB re-spin

- 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 interdisciplinary team
    • Unregistered students are administratively dropped

• Teams as small as 3 (special permission), no more than 6
  • 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 Capstone
  • 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 team, or ME team in that Dept’s Senior Design Lab…

  Can be accommodated 99% of the time. Discuss with instructor(s) in person or by e-mail.

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

  That can happen too. E-mail or talk to instructor(s).
Key takeaway........

- Your individual grade starts from team grade as a base
- Peer grading 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…
Measured and steady progress...

Wins this race.
What makes a good project?

- 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
What makes a good project?

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
What makes a good project?

• Tesla coils produce loud, bright sparks

• Can be controlled to produce music
  (plasma speaker)

• This can inspire younger students about engineering
What makes a good project?

- 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 makes a good project?

- Exciting
- Really challenging but feasible
- Something you are interested in
- 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

Projects will be evaluated on a balance or sum of these

* We help you find a sponsor or funding. Unless a potential project is fairly expensive (> $2K), cost should not be your first decision factor.
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

• Professor Femrite is available by e-mail or appointment to discuss project ideas. Even over the summer.
Thank you

So, what to think about now?
We covered:
• Funding : Teams : Projects : Key Advice

• Remember, reachable by e-mail with questions:
  • Andrew.Femrite@colorado.edu

• Current project descriptions can be found at:
  http://ecee.colorado.edu/academics/ugrad/expo-sp15.html
  (On ECEE home page, look for “Senior Design Projects” link)
Thank you

Quick Questions??

- Presentation from faculty advisors is next
  - They’d like to recruit/interest you

- Check Out Boards for Projects!
  - Development Boards available!!
  - NXP Boards, Altera DE1-SoC, Freescale tower...

- **More Project Pitches coming!!**
  - Watch for an email from me with a URL