Introduction to the Capstone Project Course

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The Capstone Project Course – What it is and the Choices for it
There are two choices for the Capstone Project Course: An ECE departmental course, with student teams from ECE (ECE496) and a multidisciplinary engineering faculty course, with student teams from across the faculty (APS490). Most of this document is about ECE496, as APS490 will have/has its own website (under construction as this is being written). Most students will take ECE496, but students interested in projects from industry where ECE activity is an important part should strongly consider APS490.

What You Do Over the Year in ECE496
In ECE496 you will be working with a team on a project unique to your team. It will take you more than just the full academic year, it will be largely self-directed, you will be responsible for most of the decisions and for the ultimate success of the project.

What follows is an overview – there is more specific information attached to the descriptions of each deliverable. You should come back to this document through the year, as it contains information on the usual problems that we see in the various deliverables, and suggestions on how to concentrate your efforts in the projection of these deliverables.

Remembering ESP – The Basics, Very Briefly
It may seem like forever since first year and ESP (Engineering Strategies and Practice -- APS111, APS112, APS113) but in those years you learned some basics which you will put into play. You might remember this basic sequence:
• Goal: In technical terms, describe the client’s problem. No potential solutions should be part of the goal.

• Requirements: In measurable statements, describe how the design will have to perform, without being implementation-specific. These were divided into:
  o Functions: those requirements, directly under the control of the designer, that the design must perform or it won’t satisfy the client and the goal.
  o Constraints: those requirements, not directly under the control of the designer, that the design must perform or it won’t satisfy legal requirements or be able to be done inside the design environment being allowed. This includes specific restrictions set by the goal, such as “an Android app”.
  o Objectives: also called “measures of effectiveness”, these may be targets to be met or they may be sliding scales that will be used to decide which potential design is best, before execution begins. They will ultimately determine whether the design is a huge success or something that does what it is supposed to, but barely. If they are not met, the design does not fail, unlike with the functions or constraints.

  If you do not pay attention to this step, your design could be deficient at meeting the goal because something is forgotten.

• Solution: Brainstorming and more sophisticated techniques are used to generate many potential solutions at a system level. (Detailed design is done later, during the execution stage. This detailed design work is sometimes done incrementally, particularly in software designs.) From these, a few “best” solutions are selected for close analysis, and from these few a final solution is determined. As you think about solutions, you may realize that some requirements are missing from your list and you should return to the requirements step and add those requirements.

  If you do not pay attention to this step, and particularly if you try to bypass the work by guessing at a best solution without generating a good solution set beforehand, you stand a good chance of not getting the best solution.

  Note that iteration is expected to be part of the goal-requirements-solution process. Even experienced designers seldom get it right the first time.

• Execution: Where you implement the design. Most of your time will be spent here, but success and efficiency will depend on how well you did the previous steps. This is why ECE496, like ESP, places such emphasis on the early steps. In ESP you did not do the execution, only the plan.
The Groundwork
Likely you already have attended the opening seminar, which happens early in the winter term. If you missed this seminar, you should check out the posted information from this seminar.

The expectation is that well before September, and hopefully before the end of the spring term, you will:

- Form teams of 2-4
- Find a supervisor from the ECE faculty and a project to work on
- Register the team, the supervisor and the project online to officially start the project (see links on the website)
- Form a plan to start gathering background information for the project

Note that once registered with a supervisor and a team you cannot change these, but you can change the project should your initial project prove unworkable.

Some Common Mistakes Made Early On
- Delay in finding partners and a project. The longer you wait, the less time you will have to organize and execute.
- Often teams, once they have a project, will immediately jump to a potential solution for the project, ignoring any other possible solutions, including ones that might be better than the one jumped to. Please see the preceding information!
- Failure to start and maintain an engineering notebook. You are expected to report on your progress, and to include information on the process in your final report. Guaranteed your memories are not as good as you think!

September
In September you will work on a plan for the project, called the Proposal. When you first get established on campus there will be a few lectures, usually on Thursday evenings, to get you started. After that there are lectures intermittently to guide you through the other aspects of the course.

The Proposal
The proposal contains the plan for the rest of the year as best can be determined without the hands-on work. It will answer the following questions:

- What is the essence of what is being done? (background / motivation / goal)
- What will the design have to do to fulfill this aim? (requirements)
- What designs are possible, and which design was chosen to be worked on and why? (alternatives / proposed design)
- How will the design be executed, how much will it cost, what problems could arise? (time plan, budget, risks)

If you do not do the background work on your proposal well you can expect the following unless you work hard to break the cycle:
• A poor mark on your proposal
• A poor mark on your design review (you can’t justify what you didn’t support or include in your proposal)
• A poor mark in your progress report (you can’t indicate progress against a standard that you didn’t properly lay out in your proposal)
• A poor mark in your final design (you can’t indicate success if your proposed testing and measures of success in your proposal were deficient)

Some Common Problems with Proposals

- Executive Summary written as an introduction (It’s a summary!)
- Executive Summary did not cover all aspects of the documents, e.g. budget, major risks.
- Requirements; not verifiable (ie testable) or abstract in nature.
- Testing: was performed on requirements that never mentioned before.
- Tests not possible or not practical
- Some requirements don’t have associated tests
- Requirements and tests have implementation details (They are system tests)
- Skills and risks: were not specific.
- Figures: were included but hardly referred to and then discussed or introduced late, almost as afterthoughts.
- Proposed designs too similar and have underlying implementation assumptions. Not different at a system design level.
- Design does not include setup, maintenance and similar activities that must be functions. Missing at least one major “actor” in the design.

Working on Your Final Design

As you work on your final design, you may come across problems such as a proposed part of the solution will not work as intended (very common in research-based projects). This is acceptable, but you must justify any changes you make to your original plan. (Lack of work on the project is not an excuse, of course)

You will meet regularly with your supervisor during this period, and will give a progress report to your administrator and be evaluated mid-project by your supervisor. In addition, each team will give an oral presentation on their project during the second term.

Meet regularly with your team during this period to avoid mismatches in modules and to keep everyone inspired and working.

Some Common Problems with Work During the Term

- Putting off work on the project because other courses have things due earlier.
- Not keeping records of decisions, changes, unexpected problems encountered. (Engineering notebook!!)
- Team problems.
- Unequal balance of work; unequal balance of effort
- Doing too much work on the project and doing poorly in other courses as a result.
- Interactions between modules of your design not well-enough defined (wrong voltage / power levels, data format incorrect, etc.)
- Modules put together without module testing, extending debugging time
The Finish
At the end you will submit a final report and show your work at the Design Fair. The Design Fair presentation will include a demonstration and a poster, and you will have the opportunity to present your project to your peers and to others.

Some Common Problems with Final Projects
- No demonstrable element. A screen full of numbers is a poor demonstration.
- No validation proof – does not show that original goal is met
- Very cursory testing
- Project significantly and unnecessarily watered down from original

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