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### Tablets for Timely Design Documentation


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### Overview

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### Digital Systems Senior Design

A structured approach to the development and integration of embedded microcontroller hardware and software that provides senior-level students with significant design experience applying microcontrollers to a wide range of embedded systems. The fundamental course objective is to provide practical experience developing integrated hardware and software for an embedded microcontroller system in an environment that models one which students will most likely encounter in industry.

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### Digital Systems Senior Design

- Each team of four students must:
  - Propose a product to develop
  - Propose success criteria for evaluation
  - Select devices and technologies to be used
  - Make use of a microcontroller, FPGA, or DSP
  - Design a custom printed circuit board
  - Design and fabricate packaging
  - Demonstrate the final product in its packaging
  - Satisfy a variety of professional requirements (patent liability, reliability, safety, environmental impact, etc.)
  - Exercise communication skills (design review, TCSP)
  - Do all this in 15 weeks

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### Course Outcomes and Assessment

1. An ability to apply knowledge obtained in earlier coursework and to obtain new knowledge necessary to design and test a system, component, or process to meet desired needs – **design component report**
2. An understanding of the engineering design process – **individual lab notebook**
3. An ability to function on a multidisciplinary team – **project specific success criteria (functionality)**
4. An awareness of professional and ethical responsibility – **professional component report**
5. An ability to communicate effectively, in both oral and written form – **formal design review, final written report, and final presentation**

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### Individual Lab Notebooks

- Key to successful project completion
- Must be readily available on-line to teammates and course staff
- Must be updated on a regular, consistent basis
- Typically contain a variety of data types
  - design documentation (text and illustrations)
  - data sheets (PDFs)
  - testing and debugging setups (photos, screen shots)
  - success criteria demonstrations (videos)
  - schematics (OrCAD capture files)
  - PCB (OrCAD layout files)
  - software (source code files)

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### The Dilemma (Circa 2001)

*“Individual lab notebooks varied greatly in quality – some of them were simply ‘narratives’ of group meetings, while others appeared to be transcribed ‘after the fact’. We attempted to address these issues by evaluating each student’s lab notebook tear-out sheets several times throughout the semester (on a total of four different occasions). While this rather significant effort on the our part lead to notable improvements in the lab notebooks relative to previous offerings, there is still room for improvement— especially for team members charged with software development, who generally kept the ‘worst’ notebooks. The fundamental problem appears to be getting students to: (a) appreciate the value of a good lab notebook, and (b) take it seriously.”*

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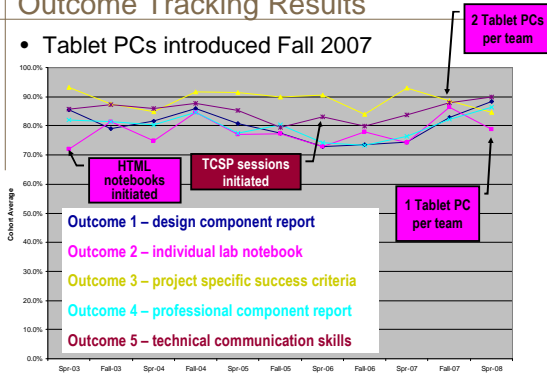
### The Hypothesis (Circa 2007)

“Equipping each project team with wireless Tablet PCs should not only significantly improve the spontaneity (and regularity) with which the on-line lab notebooks are updated, but also facilitate collaboration among team members working on the design project at different locations.”

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### Outcome Tracking Results

- Tablet PCs introduced Fall 2007



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### Reflections

- Confounding factors
  - one Tablet PC per four-person team proved insufficient to impact lab notebook quality (two per team did appear to have an impact)
  - HTML format utilized was cited as the primary factor that hindered students’ ability to maintain their lab notebooks
- Unanticipated side benefits
  - notable improvements in written reports and oral presentation skills (Outcomes 1, 4, & 5)
  - enhanced impact of TCSP sessions

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### Future Work

- Identification and adoption of a commercial ELN (electronic lab notebook) software package
- Develop tutorials on use of Tablet-unique features for maintaining lab notebooks
- Small (off-season) F-08 cohort will allow a trial in which every team member will have exclusive use of a Tablet PC

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### ELN Feature Comparison Chart

	web based (no client)	HTML tags	HTML reduced	21 CFR Part 11	Notebook Searchable	Database Searchable	Visual Imports	Editable Imports
LABTrack	x	x	x	x	x	x	x	x
NoteBookMaker		x	x	x	x		x	
Contur ELN		x	x	x	x	x	x	x
Nexxis qELN	x	x	x	x	x	x	x	
Infotrieve		x	x	x	x	x	x	x
idbs E-Workbook		x	x	x	x		x	
ORNL ELN	x		x	x	x		x	
Wiki HTML	x		x		x			
HTML	x							

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