*Balancing the ECE Curriculum with the Kolb Learning Cycle**

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Overview

- Introduction
- Kolb/4MAT learning theory
- *Introduction to Robotics* pilot course
- NSF curriculum planning grant
  - Reordering of systems core with signal processing first
  - Kolb/4MAT introduced into these courses
  - Design of “curricular threads” including robotics, software-defined radio, and core electronics
- NSF curriculum implementation proposal

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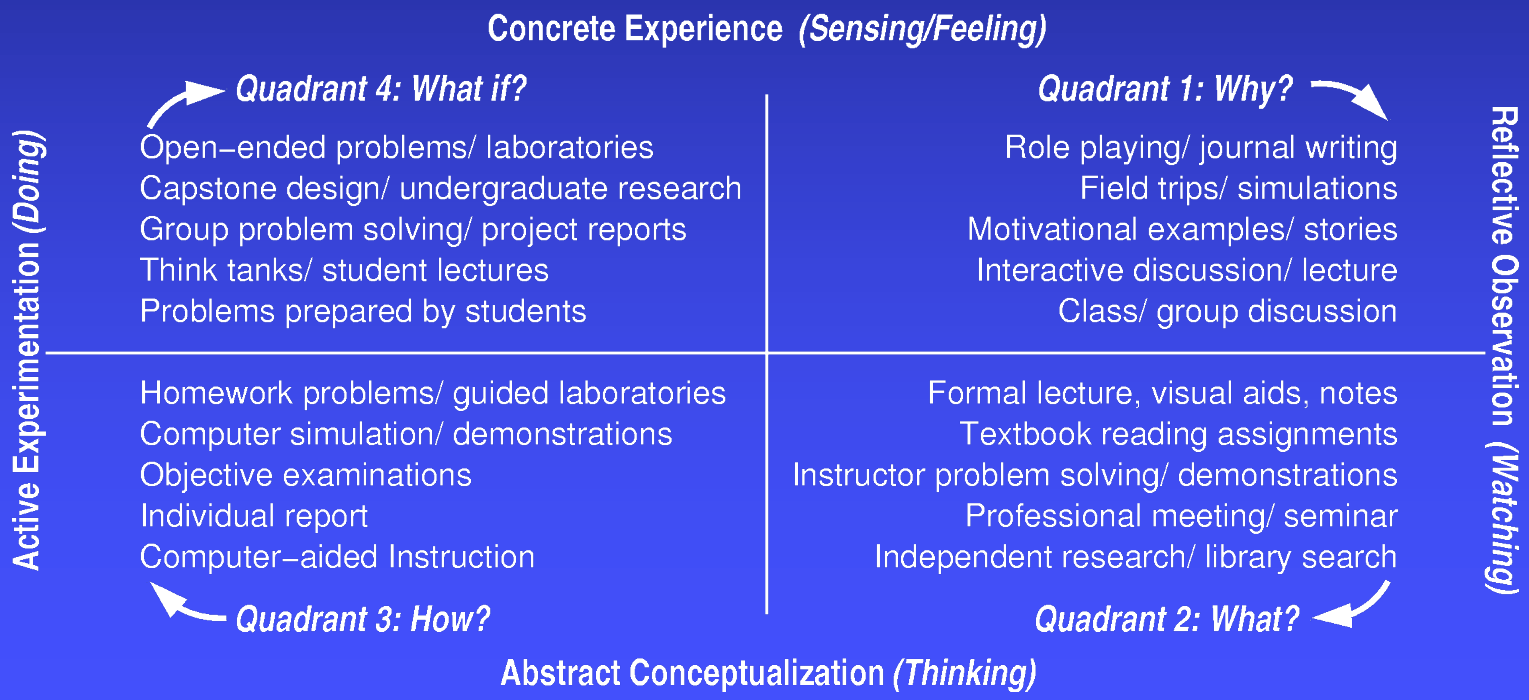
Introduction

- We are undergoing a curricular change in the ECE department to “reach, reinforce and challenge all students”
- Pedagogy updated to reflect modern research in how students learn
- Proposed curriculum change to add “threads” of content through a cross-section of the program to add coherence
- Re-structuring of systems core to introduce signal processing concepts early on

Pedagogy: Kolb Learning & 4MAT

- **Learning styles: Perception (taking things in) and Processing (making it part of yourself)**



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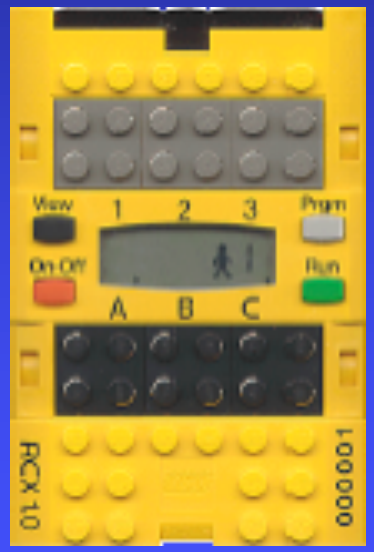
Pilot Course: Intro. to Robotics

- A team-based engineering design and competition course at the freshman level:
  - Excite students with engineering
  - Give them a feel for a real engineering project
  - Get them "hooked up" with other students
  - Aid retention and give non-engineers an engineering elective course
  - A new experience for us using Kolb/4MAT

- ***Use*** technology to ***learn*** technology, preparing to ***design*** technology

Technology Used

- Use LEGO Mindstorms *Robotic Invention System* as a basis for an engineering design course that includes hands-on labs and a final competition
  - 8-bit on-board microprocessor
  - 3 sensor inputs and 3 actuator outputs
    - Outputs: Motors up to 8 speeds, 2 directions
    - Inputs: 10 bit A2D—Rotation, light, touch
  - 4 on-board timers
  - IR link for bidirectional messaging
  - Sound generator, clock, multi-tasking



- Funded by ECE Department, UCCS Teaching and Learning Center, UCCS Instructional Fee

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Syllabus

- **Course is 50% lecture; 50% hands on**

Lecture Period		Hands-on Lab Period	
1. Getting started	8/23/04	1. Nobot	8/25/04
2. The RCX	8/30/04	2. Tankbot	9/1/04
[Labor day holiday]	9/6/04	3. Bumpbot	9/8/04
3. Introduction to NQC	9/13/04	4. Bugbot	9/15/04
4. Intro. to NQC (cont)	9/20/04	5. Linebot	9/22/04
5. Robot construction	9/27/04	6. Scanbot	9/29/04
6. Robot construction (cont)	10/4/04	7. Steerbot	10/6/04
7. Basic control	10/11/04	8. Diffbot	10/13/04
8. Basic control (cont)	10/18/04	9. Quiz on NQC. Work on project	10/20/04
9. Basic electronics	10/25/04	10. Quiz on construction. Project	10/27/04
10. Basic sensors	11/1/04	11. Quiz on control. Project	11/3/04
11. Basic sensors (cont)	11/8/04	12. Quiz on electronics. Project	11/10/04
12. Microprocessor designs	11/15/04	13. Quiz on sensors. Project	11/17/04
13. Microprocessors (cont)	11/22/04	[Thanksgiving holiday]	11/24/04
14. Cybernetics	11/29/04	14. Quiz on microprocessors. Project	12/1/04
15. Robot qualification trials	12/6/04	15. Final competition (8:00am)	12/10/04

- **Evaluation: “prelabs,” quizzes, lab reports, project**

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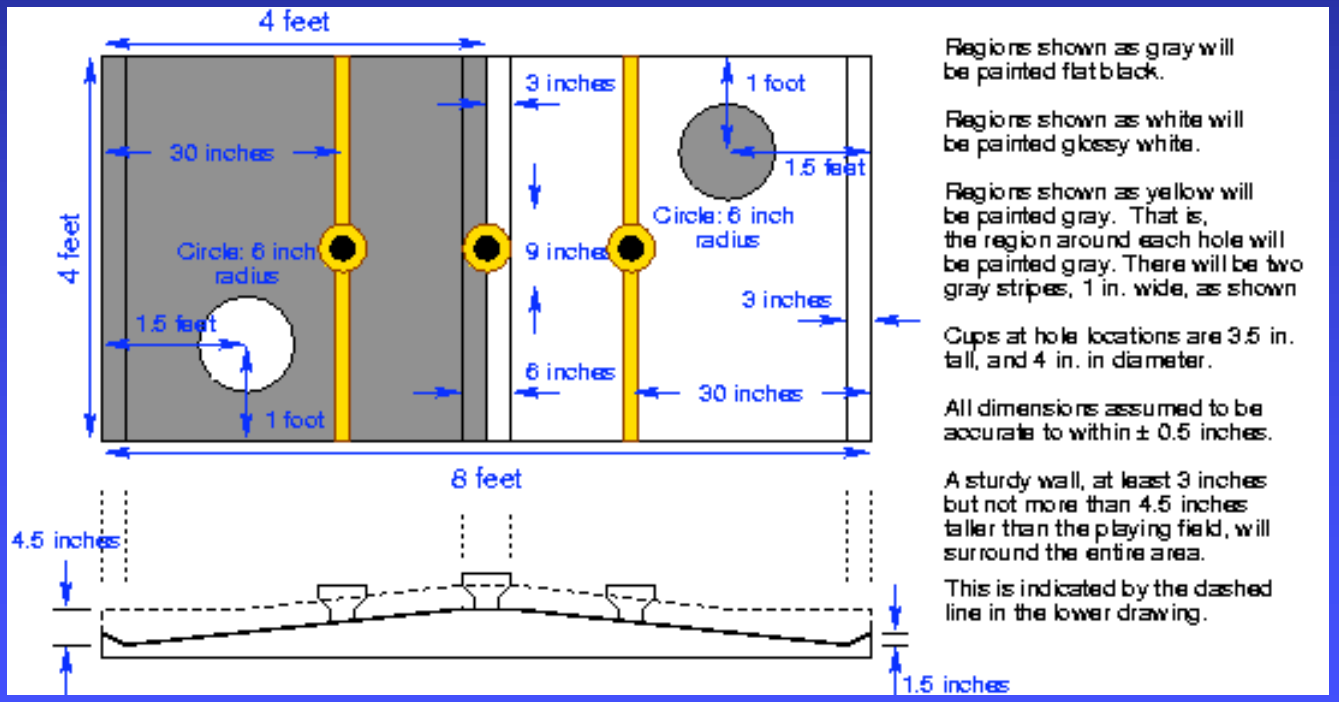
Nobot, Tankbot, Bumpbot, Bugbot, Linebot, Scanbot, Steerbot, Diffbot

Final Design Project

- **Engineering design under severe constraints**



Kolb Compliance

- Quadrant 1: The “Why?” question
  - Motivating stories, news items, point to advanced courses
- Quadrant 2: The “What?” question
  - Formal lectures, reading assignments, demonstrations
- Quadrant 3: The “How?” question
  - Eight team-based guided laboratory exercises
- Quadrant 4: The “What if?” question
  - Team-based robot design project for final competition

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Outcomes 1:

- **Instructional goals accomplished!**
- **Students with backgrounds only in high-school Math and English are:**
  - **Writing their own computer programs**
  - **Building robotic structures and mechanisms**
  - **Designing feedback control systems**
  - **Learning about the theory of electronics, sensor design, and microcontroller-based systems**
  - **Cooperating in inter-disciplinary teams**
  - **Writing proper lab reports (with attention paid to correct grammar, spelling, word usage)**

Outcomes 2:

- Surveys and quiz results showed a very high level of learning
  - Significant improvement in technical knowledge
  - Moderate improvement in non-technical components of the course
- Every student completed all labs successfully
- All design teams qualified for final contest
- Contest winner was able to beat professor-designed robots (!)

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Ongoing Change…

- **Received NSF planning grant proposal to "balance" ECE curriculum**
  - **New courses: *Introduction to Signals and Systems, Circuits and Systems I, Circuits and Systems II***
  - **These courses will comply with Kolb/4MAT**
- **Submitted NSF implementation grant proposal to restructure entire systems area of curriculum (pending)**
  - **Will introduce Kolb/4MAT to remainder of systems core**
  - **Will allow improved hands-on exercises in "threads"**
  - **Will aid retention efforts**

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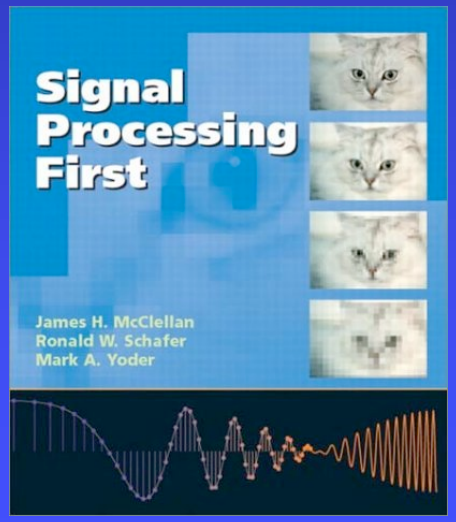
Signal Processing First

- Course re-ordering rotates sequence:
  - From: Circuits I, Circuits II, Linear Systems
  - To: Intro. to Signals & Systems, Circ. & Systems I,II
- We feel that present students better understand CD-players and iPODs than electric circuits
- Allows CpE/ Bio/ etc/ engineers to learn DSP concepts
- Courses will be taught with Kolb/4MAT compliance



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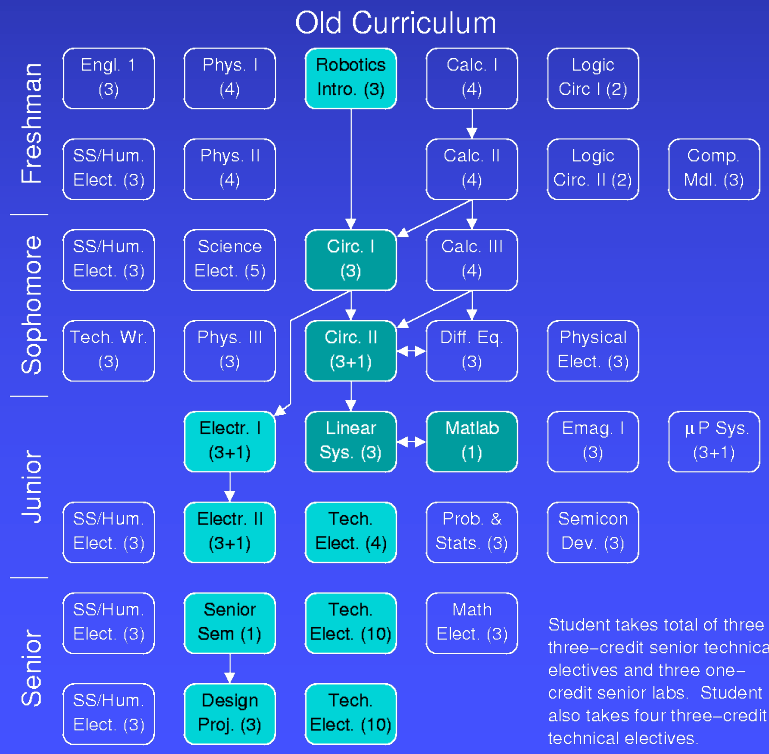
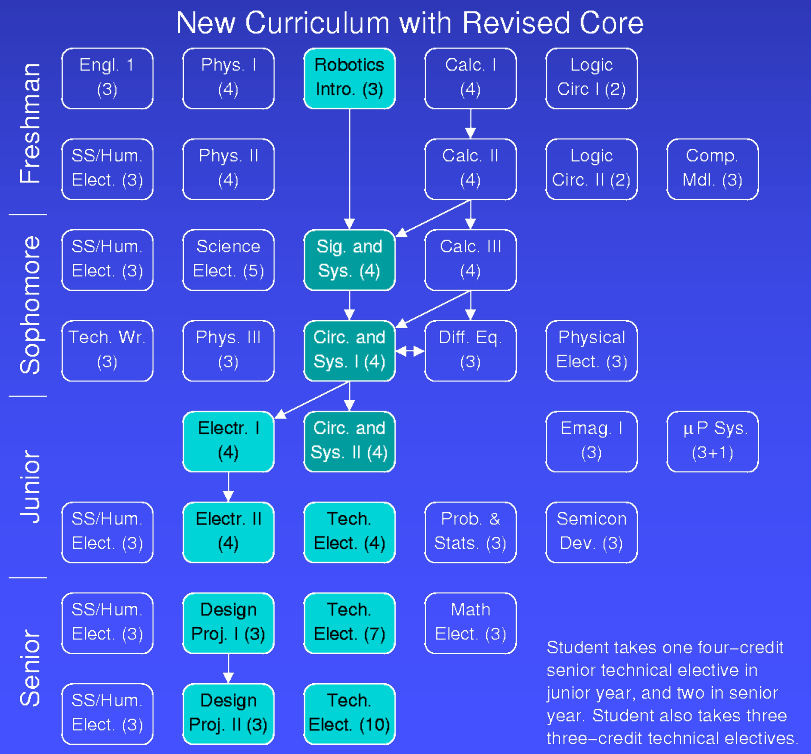
Curricular Threads

- Improve coherence of BSEE (systems) by "weaving" specific concrete engineering applications or "threads" through the curriculum
  - We have identified: ROBO^{T}, SWIR^{T}, CEL^{T}
- Robotics thread (ROBO^{T}) example:
  - Early exposure at concept level in *Intro. to Robotics*
  - Build resistive sensors, op-amp motor drivers, A2D, D2A, PWM, and PID control in Circ. and Systems I, II
  - Build H-bridge motor drivers and active sensors in Electronics I, II
  - Introduce advanced concepts in new course "Embedded Mobile Robotics"

Proposed Curriculum Changes

- **NSF Curriculum Implementation proposal**
  - **Kolb/4MAT and structure changes to systems core**
  - **Implementation of ROBO^T, SWIR^T, CEL^T**





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Summary

- The UCCS ECE Department is revising its BSEE curriculum to "reach, reinforce, and challenge" all students
- The Kolb/4MAT system is central to the change
  - Our pilot course has been very successful
- NSF curriculum planning grant to continue work
  - Reordering of systems core with signal processing first
  - Kolb/4MAT introduced into the three new courses
  - Design of "curricular threads" ROBO^{T}, SWIR^{T}, CEL^{T}
- NSF curriculum implementation proposal to complete this phase of work

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Acknowledgement

- ECE Dept. grant to purchase LEGO kits ($4,500)
- UCCS Teaching and Learning Center grant to develop *Introduction to Robotics* course ($4,000)
- UCCS *Instructional Fee* grant to purchase additional LEGO components to allow campus-wide elective ($9,000)
- NSF Curriculum Planning grant to design new curricular changes ($100,000)