

New England Center for Analog and Mixed Signal IC Design

`http://ece.wpi.edu/~mcneill/center.html`

John A. McNeill
Electrical and Computer Engineering Dept.
Worcester Polytechnic Institute

July 9, 1998

Presentation Overview

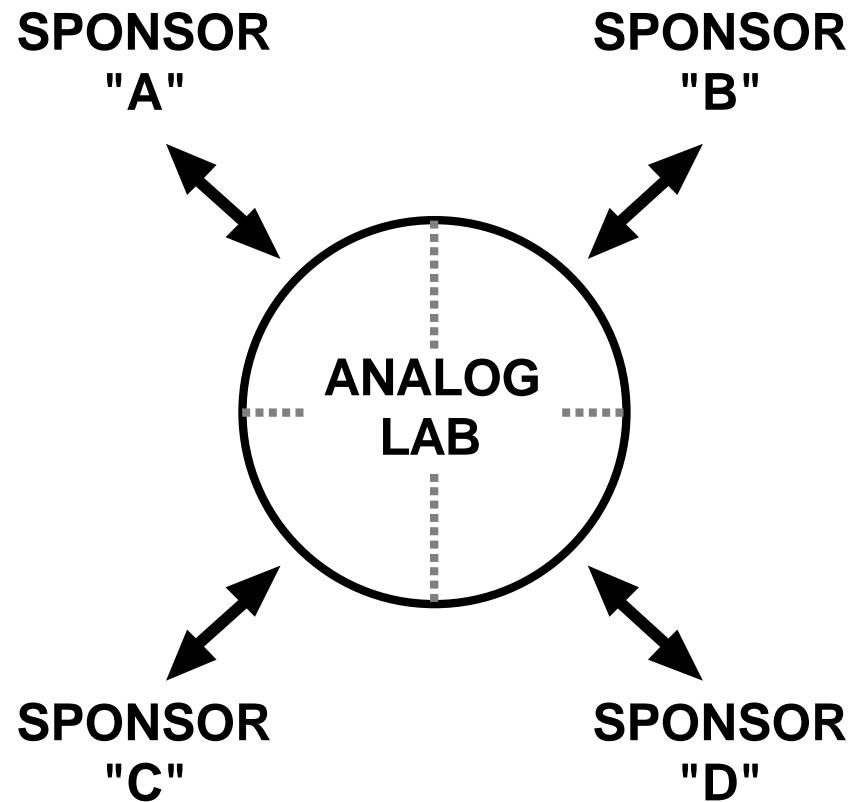
- **Industry-University Collaboration**
 - Traditional Research Model
 - Collaborative Design Center
- **New England Center for Analog and Mixed Signal IC Design**
 - Goals
 - Benefits
 - Organization and Operation
 - Example Projects
 - Faculty / Research Areas

Industry / University Partnership: Goals

- **Industry**
 - **Technical**
 - Stay current with "cutting edge" research
 - Explore / develop "back burner" ideas
 - **Human Resources**
 - Identify good engineers to hire!
- **University**
 - **Intellectual Mission**
 - "Create knowledge"
 - **Customer Service**
 - Instruction, research relevant to industry needs

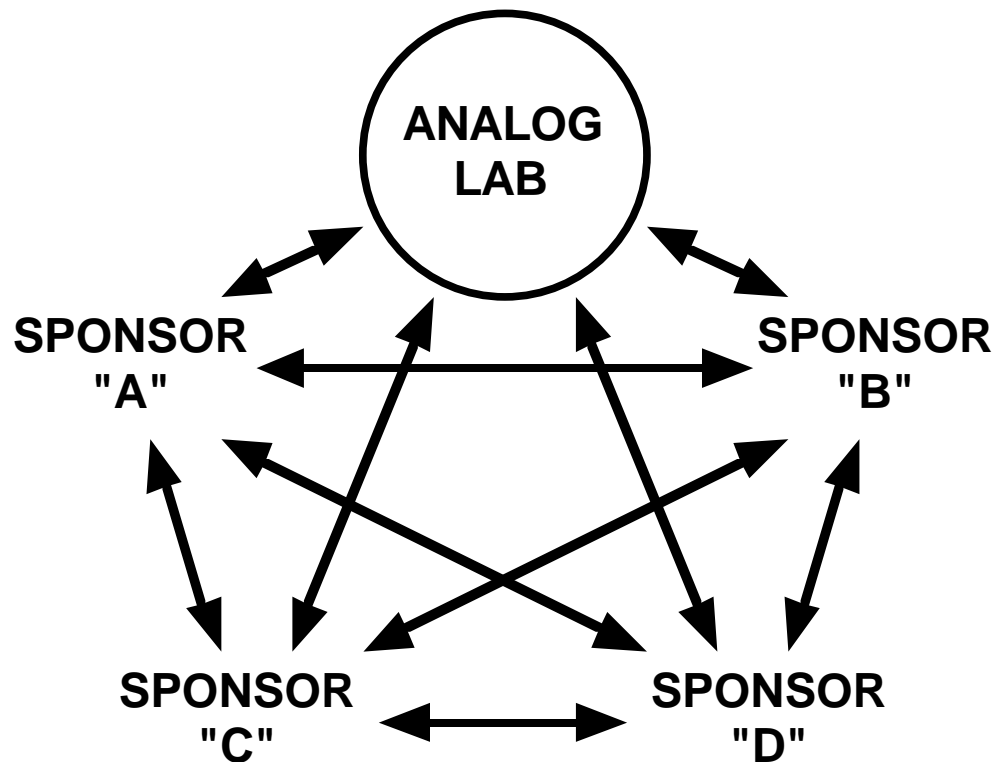
Traditional research model

- **Targeted:**
 - Support 1 graduate student for 1-2 years
 - Single project
- **Disadvantages:**
 - High cost: \approx \$60K
 - Lost opportunity



Collaborative Design Center / Consortium

- Take advantage of common interests
- Free flow of information, contact among members
- Reduced entry cost



Goals

- **The New England Center for Analog and Mixed Signal IC Design at WPI will conduct research into all aspects of mixed signal IC design.**
- **This research will be conducted in an environment that supports the complete "real world" integrated circuit design process.**
- **The Center will be supported by contributions from member companies, who will determine the direction of Center research.**

Benefits

- **Access to graduating seniors, M.S. students**
- **Increase pool of students with mixed signal IC design experience**
- **More awareness of sponsor's company among all students in ECE**
- **Influence direction of research**
- **Awareness of and access to new technologies**
- **Influence curriculum development**
- **Networking**

Organization

- **Advisory Board**
 - Representatives from member companies
 - One-day meetings in fall, spring
 - Review progress, choose future projects
 - Direct interaction with students
- **Membership**
 - \$30,000 annual fee
 - No indirect costs charged
- **Research Projects**
 - Proposed by companies, faculty
 - Selected by companies (Advisory board vote)

"Real World" Design Flow

- **Design with full CAD support:**
 - schematic capture
 - simulation
 - layout, verification
 - process simulation when necessary
- **Fabrication:**
 - MOSIS
 - Member companies, if desired
- **Test and characterization**
 - Full speed time / frequency domain testing
 - Device characterization and modeling

Graduate Research

MSEE; project duration of 1-1/2 years

<u>Time Period</u>	<u>Activity</u>
October	Fall Meeting: Propose Projects
January -March	Recruit grad students
April	Spring Meeting Choose projects to be supported
May - Sept	Complete background research, preliminary design, simulation, critical design review activity in preparation for October meeting
October	Fall Meeting Present project status to Advisory Board
Nov -January	IC Fabrication Design and fabrication of test fixturing
February -March	Test fabricated ICs Complete thesis, documentation
April	Spring Meeting

Undergraduate Project Work

Typically design/fab/test of IC application circuitry

<u>Time Period</u>	<u>Activity</u>
October	Fall Meeting: Propose Projects
January -March	Recruit three-student project team
April	Spring Meeting Choose projects to be supported
August -September	Complete background research, preliminary design specifications for October meeting
October	Fall Meeting Present project status to Advisory Board
Nov -December	Complete design and fabrication of prototype hardware
January -March	Test system Complete project report documentation
April	Spring Meeting Presentation of results to Advisory Board

Fall Meeting

- **Status of Work in Progress**
 - Graduate projects
 - Progress: 6 months
 - "Critical design review"
 - Undergraduate projects
 - Progress: 1 month
 - Feedback / "course correction"
- **Determining General Research Priorities**
 - Input from members, faculty
 - General research direction
 - Specific project proposals (members, faculty)

Spring Meeting

- **Presentation of Completed Work**
 - **Poster Session**
 - **Open to undergraduates and graduate students**
 - **Direct interaction with students:**
 - Assess technical, communication skills**
- **Choosing Research/Projects for Upcoming Year**
 - **Faculty**
 - Present proposed projects for coming year**
 - **Advisory Board**
 - Vote on which projects will be carried out**

Project Voting Procedure

- **Each membership allowed number of votes equal to total number of projects**

Example:

4 undergraduate projects, 4 graduate projects

- **Each membership would have 8 votes to cast among the proposed projects**
- **Votes can be “bunched” to prioritize projects**
- **Top 4 projects in each category would proceed**
- **Insures that projects selected are responsive to needs of industry sponsors**

Scope of Center Activity

- **Start: Fall 1998**
- **Projects**
 - 3 Graduate Research Projects
 - 4 Undergraduate Projects (3 students each)
- **Students**
 - \approx 15 students per year
- **Faculty**
 - John A. McNeill
 - Yusuf Leblebici
 - H. Peter Lanyon

Dr. John A. McNeill

- **Background: Faculty**
 - WPI: 1994 - present
- **Background: Industry/Consulting Experience**
 - Analog Devices (155MHz PLL Synthesizer)
 - EG&G Reticon (CMOS ASIC Design)
 - M.I.T. Center for Space Research (20-bit, 100-nA FSR current-input ADC)
 - Adaptive Optics Associates (Low Noise Detector Readout; Group Leader, Electronics Section)
 - Analogic Corp. (High Resolution A/D Converters)
- **Research Interests**
 - Telecommunications IC design
 - High Speed Imaging
 - Mixed Signal Characterization

Dr. Yusuf Leblebici

- **Background: Faculty Positions**
 - WPI: 1998 - present
 - Swiss Federal Institute of Technology, Lausanne
 - University of Illinois, Urbana-Champaign
 - Istanbul Technical University
- **Background: Industry Experience**
 - Senior designer and project manager, ETA ASIC Design Center, Istanbul.
- **Research interests**
 - Capacitive Threshold Logic (CTL) Circuits
 - Hot-Carrier Reliability of MOS Circuits
 - Semiconductor Device Simulation
 - High-Speed Signal Processing Architectures

Dr. H. Peter Lanyon

- **Background**
 - WPI: 1966 - present
 - Advised many projects (graduate and undergraduate) sponsored by New England semiconductor companies
- **Research Interests**
 - Solid-state electronics
 - Device modeling
 - Heavy doping effects in semiconductors
 - Instrumentation

Summary

- **Cost-effective, collaborative model for industry-university partnership**
- **Improved access to graduating seniors, M.S. students with IC design experience**
- **Influence direction of research, access to new technologies**
- **WPI: Faculty, facilities for complete "real world" design flow**

High Speed Time / Frequency Domain

- **Tektronix 11801C Digital Scope / Communications Signal Analyzer**
 - Waveform acquisition to 25 GHz
 - Time domain resolution of 1 picosecond.
- **Tektronix TDS784C Digital Oscilloscope**
 - Real time sampling at 1GHz bandwidth.
- **HP8648D Low Phase Noise RF Signal Source**
 - Frequencies up to 4 GHz.
- **HP8560E Spectrum Analyzer**
 - Frequency domain measurements over 30Hz to 2.9GHz
- **Wavetek Model 395 Arbitrary Signal Generator**
- **HP54645A Mixed Signal Oscilloscope**
 - Simultaneous acquisition of two 100MHz analog waveforms, 16 bits of digital data

Low Frequency / Precision DC

- **Hewlett Packard HP3458A Multimeter**
 - Measures voltage, current, resistance to 8-1/2 digits
- **Data Precision DP3200 DC Calibrator**
 - Output from -10V to +10V; 10uV increments
- **HP33120 Arbitrary Waveform Generator**
 - sine, square, triangle; arbitrary waveforms to 15MHz.
- **HP54601A Oscilloscope**
 - 4 channels, bandwidth 100 MHz.
- **HP53181A RF Counter**
- **Tektronix PS2520G Power Supplies**
 - digital output voltage and current limit control
- **All instrumentation controlled over IEEE-488 bus.**

WPI Analog Lab: Research Support

- **Corporate Support**
 - **EG&G Reticon**
 - **High Speed Digital Camera-on-a-Chip** \$ 62,816
 - **Analog ASIC for High Speed Imaging** \$ 42,489
 - **Analog Devices**
 - **Graduate Fellowships** \$ 55,000
 - **Unitrode Integrated Circuits Corp.**
 - **Undergraduate Projects** \$ 10,000
- **Government/Academic Support**
 - **National Science Foundation (NSF)**
 - **CAREER Program** \$254,443
 - **CISE Research Instrumentation** \$108,000
 - **Worcester Polytechnic Institute**
 - **J. S. Satin Fellowship** \$ 18,000
 - **Instrumentation Matching Grant** \$ 66,434

WPI Student Job Placement (1997)

Unitrode [NH]
Analog Devices [MA]
Quantum [MA] 4
Teradyne [MA] 3
Sun Microsystems [MA] 2
Nokia Telecommunications [MA]
Lockheed Sanders [NH] 2
Lockheed Martin [NY, VA]
DEC [MA] 4
Raytheon [MA] 9
United Technologies [CT]
Mitre [MA] 2
Clariion [MA] 2
Bay Networks [MA] 2
Stratus [MA] 3

Previous MS Students/Research

- **Jennifer Stander**
 - Analog IC Design, EG&G Reticon
 - IC now used in development of CCD camera systems
 - Jennifer now in Quantum's ADC/DAC design group
- **David Ricketts**
 - 622 MHz synthesizer IC design for Analog Devices
 - General technique used in several VCOs
 - David now Group Leader of APC's ASIC design group

Members

Confirmed Members for 1998-99

- Analog Devices
- EG&G Reticon
- Unitrode

Possible Members for 1998-99

- Allegro
- Teradyne

Intellectual Property

Proposed Intellectual Property Policies

- **Research results equally available to all members**
- **Members may request delay in publication of results**
- **Ownership of discoveries, inventions, etc. remain with WPI**
- **All members entitled to non-exclusive, royalty-free license**