

Computing Research Association

Conference at Snowbird 2000



Slides from a workshop
on the topic of

“Reshaping Doctoral Education”

presented by

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Reshaping Doctoral Education

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A Broad Vision for CS&E Education

- Computers/computing is a tool
 - Computer Scientists as toolsmiths (Brooks)
- Our research and education should blend
 - Computer Science and Engineering
 - Application knowledge
- Including deep CS&E research
- *People perform Tasks with Computers*
 - Therefore we need some understandings of tasks and people

Fundamental propositions

- Breadth is Good \Rightarrow minors outside of CS&E are good
 - Enhance impact/leverage to our work
 - Challenging research problems
 - Applications motivate the research; research supports the application
- Expansive view of CS&E \Rightarrow One house, many rooms



Corporate Labs want Breadth

- CRA Snowbird '98 opening plenary session
 - Diversity of computer usage is driving the need for a diverse workforce, particularly in the computing research communities - Fran Allen, IBM Fellow
 - Business strategy courses would be very useful - Richard Wirt, Intel Fellow



Corporate Labs want Breadth

- National Academy Workshop on Corporate Research Assessment (1998)
 - The need for broad multidisciplinary work is at odds with narrow training – Melvin Cohen, Bell Labs VP for Research Effectiveness
- CS Labs - PARC, Interval, FXPAL, MERL, Philips
- Automotive labs - Daimler-Benz, Nissan, GM



The CS&E Community Calls for Breadth

- Computing the Future (CSTB/NRC 1992)
- Priorities
 1. Sustain the core research effort in CS&E
 2. Broaden the field
 3. Improve undergraduate education in CS&E
- Recommendations (selected)

Broaden research horizons (with) research in domains with non-routine computer applications

CS&E Ph.D. should require a non-CS&E minor or a non-CS&E undergraduate degree



The CS&E Community Calls for Breadth

- PITAC Report
- Enabling Technology Centers
 - Each focused on one application of computers
 - Up to 15; multi-year, multi-institutional, up to \$10M per year



But the CS&E Academic Community Responds Slowly

- Let us look to Engineering for an example of how a different academic community responded to its increasing breadth and depth and importance



Intellectual Structure of Engineering

- Engineering is about the creation of *Physical Artifacts*
- Engineering foundations are the sciences of the physical world (Biology and Chemistry and Physics) plus Math; they lead to –



Many forms of Engineering

- Aeronautical Engineering
- Bioengineering
- Chemical Engineering
- Civil Engineering
- Electrical Engineering
- Environmental Engineering
- Mechanical Engineering
- Nuclear Engineering
- Industrial Engineering, Human Factors Engineering, and Engineering Management – at the intersection of Engineering and People

Intellectual Structure of Computing

- Computing is about
 - Creation and manipulation of *Information Artifacts* (CS)
 - Creation of *Physical Artifacts* for this purpose (CE)
- Computing foundations (a subset of CS) are the sciences of the information world
- Fundamental computer science and math and psychology and engineering lead to –



Many Forms of Computing

- Applied Computer Science - Graphics, DBMS, AI, Telecomm
- Computational Science
- Computational Linguistics
- Computer engineering
- Educational technology
- Information/library science
- Management information systems
- Computers applied to X , for all X
- HCI and Software Engineering - at the intersection of Computing and People



Why is this Structure Not so Neat as Engineering?

- *People perform Tasks with Computers*
 - The scope of human intellectual activity is greater and more diverse than the scope of engineering
 - Therefore computing is broader and more diffuse than engineering
- So we have more opportunities!



But there is Still a Parallel

- Architecture and Industrial Design and Human Factors Engineering are to Engineering

As

- Information Design and Graphic Design and Web Design and HCI Design are to Computing



And of Course, We're Just Starting As a Discipline

- About 30 years since first CS Ph.D.
- Engineering has about 100 years of history
 - For instance, Lehigh University founded 1865



The Status Quo is not Viable

- Change depends on each of us
- What will YOU do to broaden / redefine computing?