

# Computer & Information Science & Engineering – What's All This?

Marc Snir



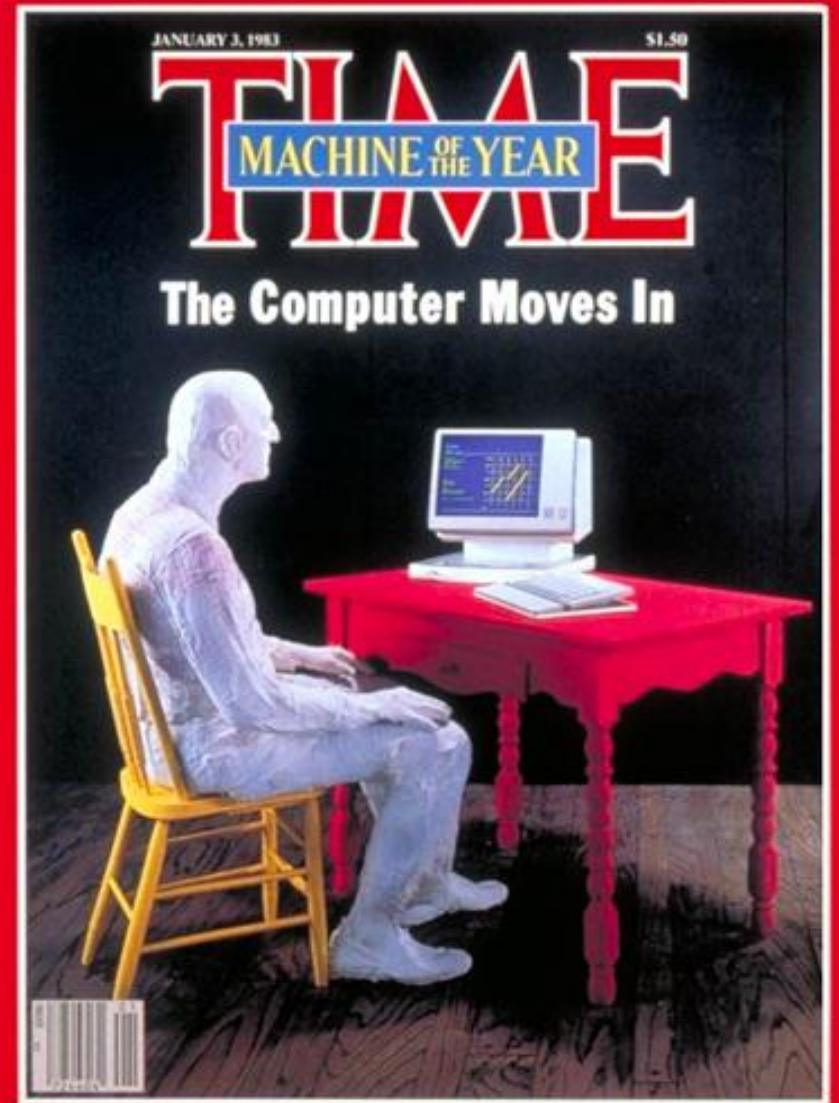
Department of Computer Science

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# Time's "man of the year", 1982

## "A New World Dawns"

- Steven Jobs was 27
- The IBM PC was a few months away
- ARPANET had 113 nodes
- **We have come a long way**
- **We have just started**



# Computers are Becoming a Necessary Extension of our Brain

- **Extend our cognitive capabilities:** Captures, stores, communicates and analyzes massive amounts of information
- **Extend our senses:** Increasingly mediates our interactions with the physical world and with other people
- **Change our perception of the world:** create new virtual worlds (simulation; games) that enhance or replace reality; abolish distances in time and space.
- **Create a new economy of intangibles:** most investment is in intangibles; IP has become main “means of production”; World is increasingly less dependent on physical resources



# The Information Revolution

- It is more significant (and more frightening) than the industrial revolution that merely extended our physical capabilities
- And it has just started: it will have run its course when “brain-thought” becomes as valuable as “hand-made”



# The World of Computing has Changed – How About the Discipline?

Engineering

CE

SE

Science

CS

IS

IT

Professional

MIS

LIS

X-Informatics

X= astro, bio, business, chem, community, eco, geo, health, medical, social...

X= art, media, games





# Some Views

- “Computer Science is no more about computers than astronomy is about telescopes” (Dijkstra)
- “Computer Science meets every criterion for being a science, but has a self-inflicted credibility problem.” (Denning)
- “Any discipline with 'science' in the name isn't.”



# Closer to (Hyper)reality

- **Engineering:** The Science of Building Useful Stuff Using Science (i.e., applying Applied Science to applied technology)
- **Mathematics:** Physics of Hyperreality
- **Computer Science:** Engineering of Hyperreality
- **Computer Engineering:** Combination of the Engineering of Hyperreality (architecture, software, architecture-level hardware) with the Engineering of Reality (physical-level hardware).
- **Computer Programming:** Construction work to implement Computer Engineering.



# Engineering: Building a Better Mousetrap

Mousetrap Engineering

- Catches more mice
- Cheaper to manufacture
- More robust
- Safer
- ...

How

applied

Why

pure

Mousetrap Science

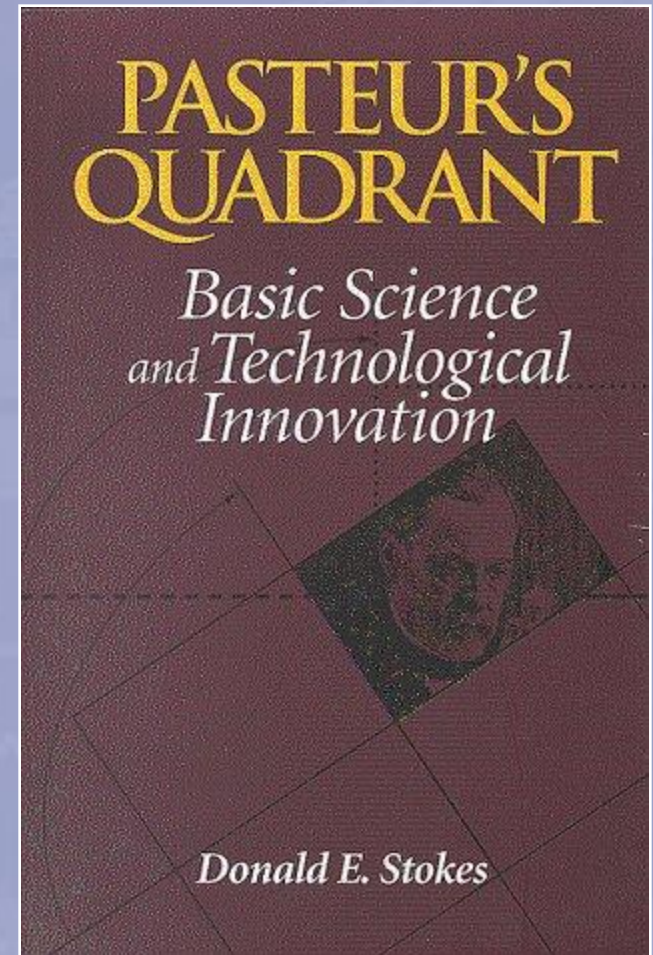
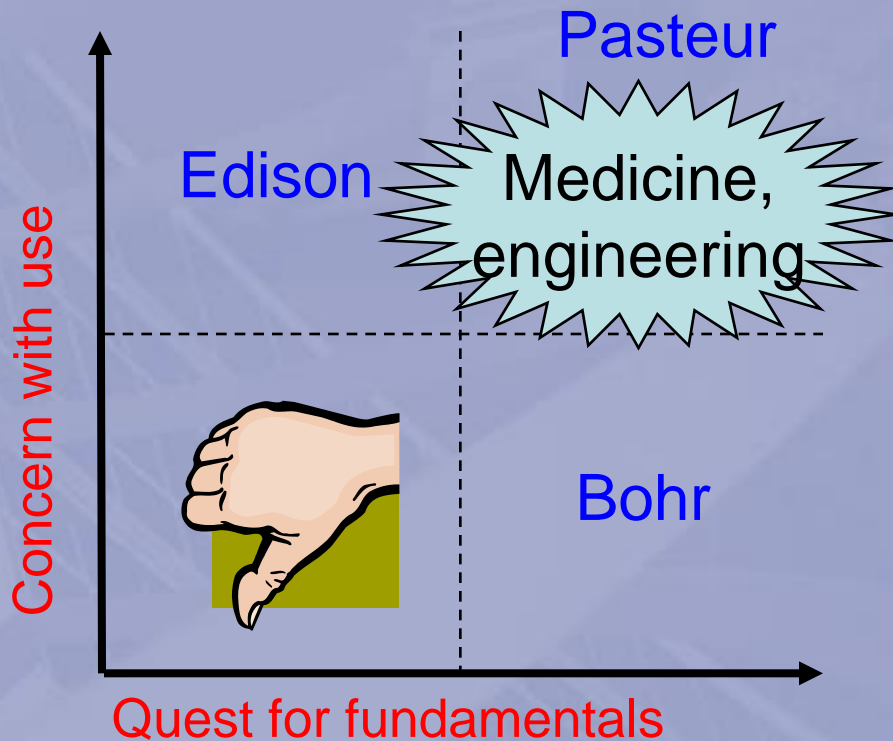
- Physics
- Biology





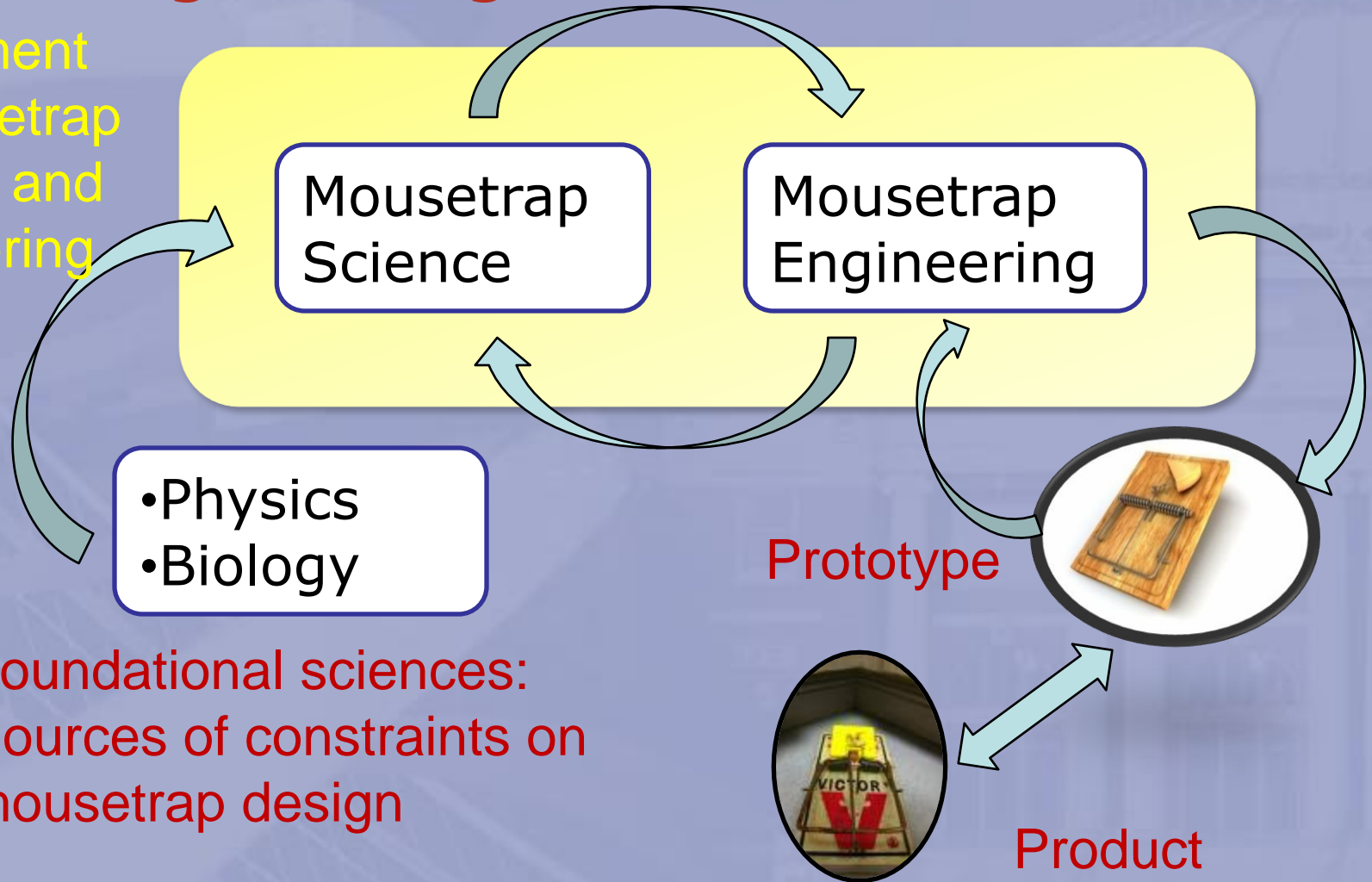
# What is Engineering Research?

Alternative View



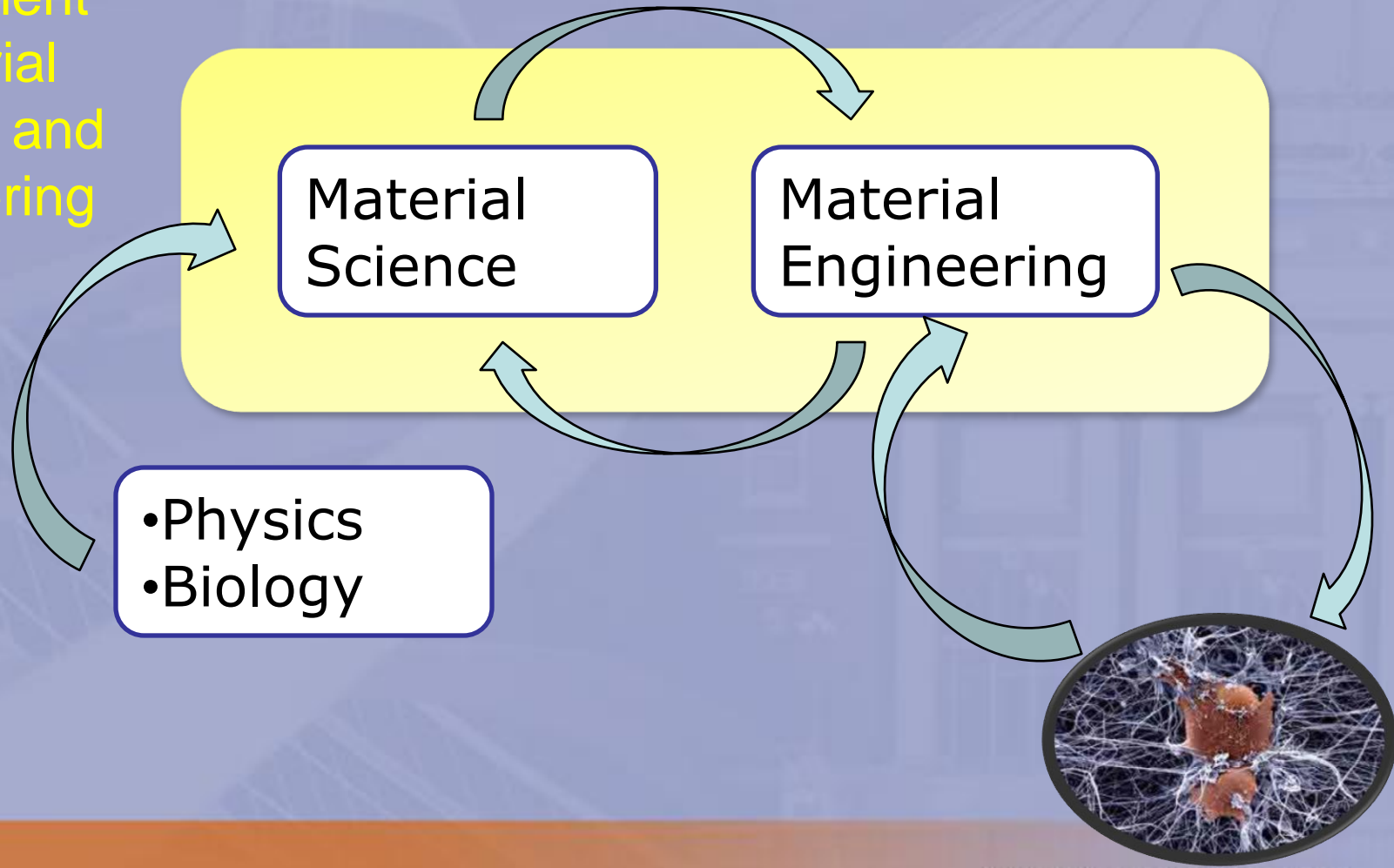
# Engineering: A Modern View

Department  
of Mousetrap  
Science and  
Engineering  
(MSE)



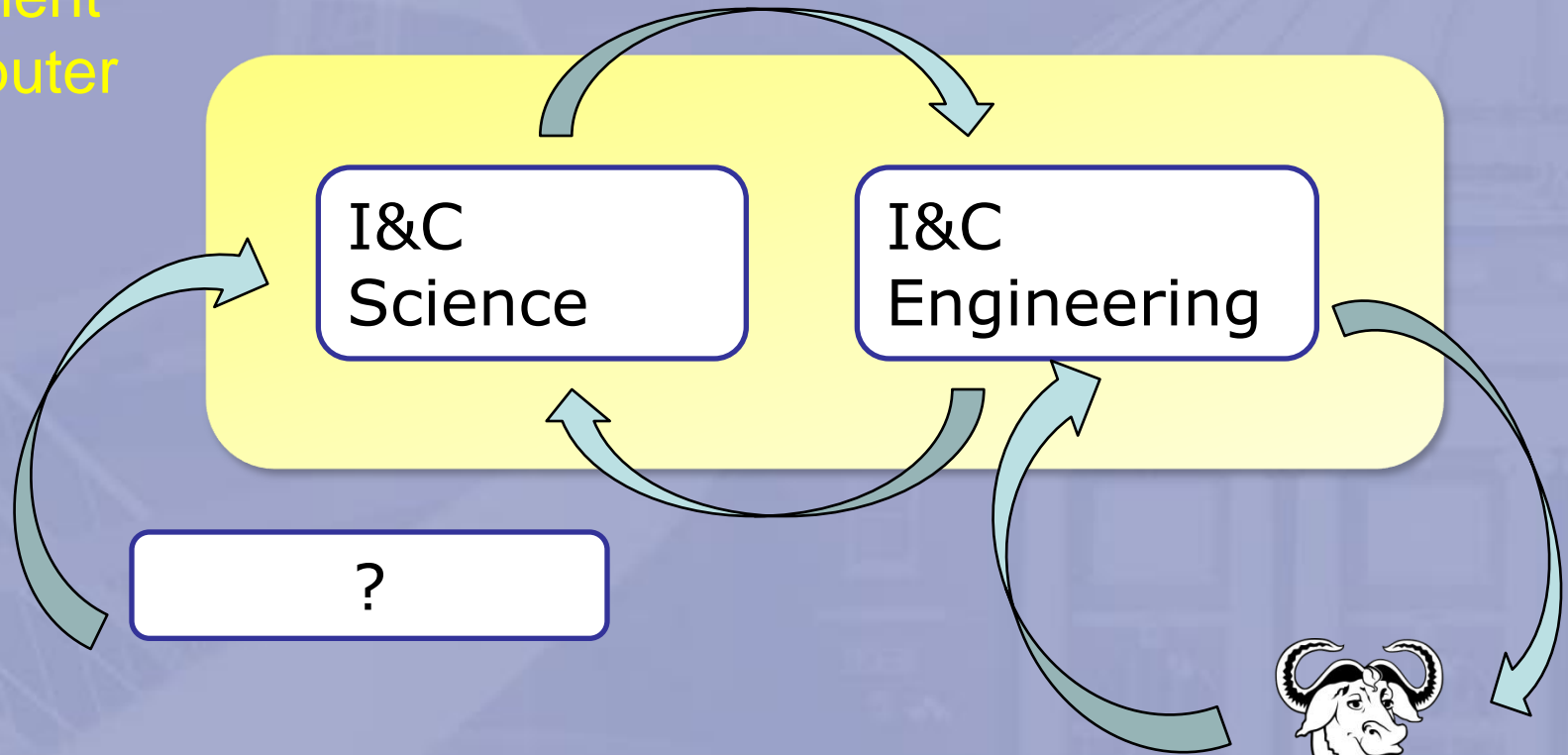
# Engineering: A Modern View

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of Material  
Science and  
Engineering  
(MSE)



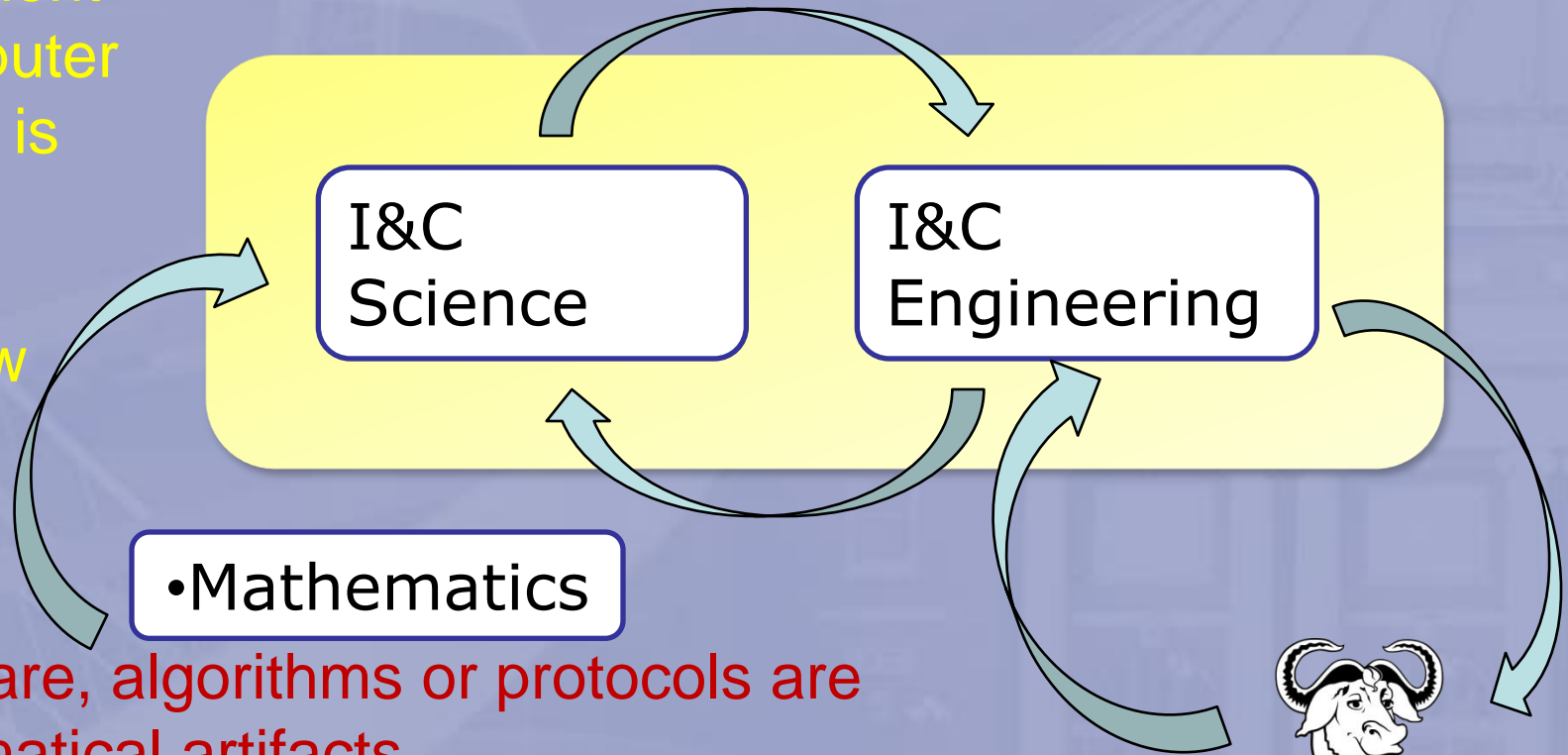
# Information and Computation Engineering

Department  
of Computer  
Science



# Information and Computation Engineering

Department of Computer Science is about building better sw widgets



- Software, algorithms or protocols are mathematical artifacts
- Time/space complexity are mathematical abstractions



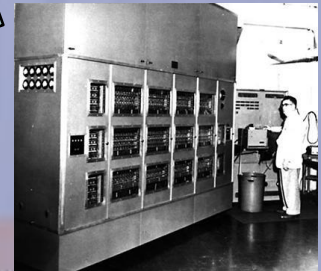
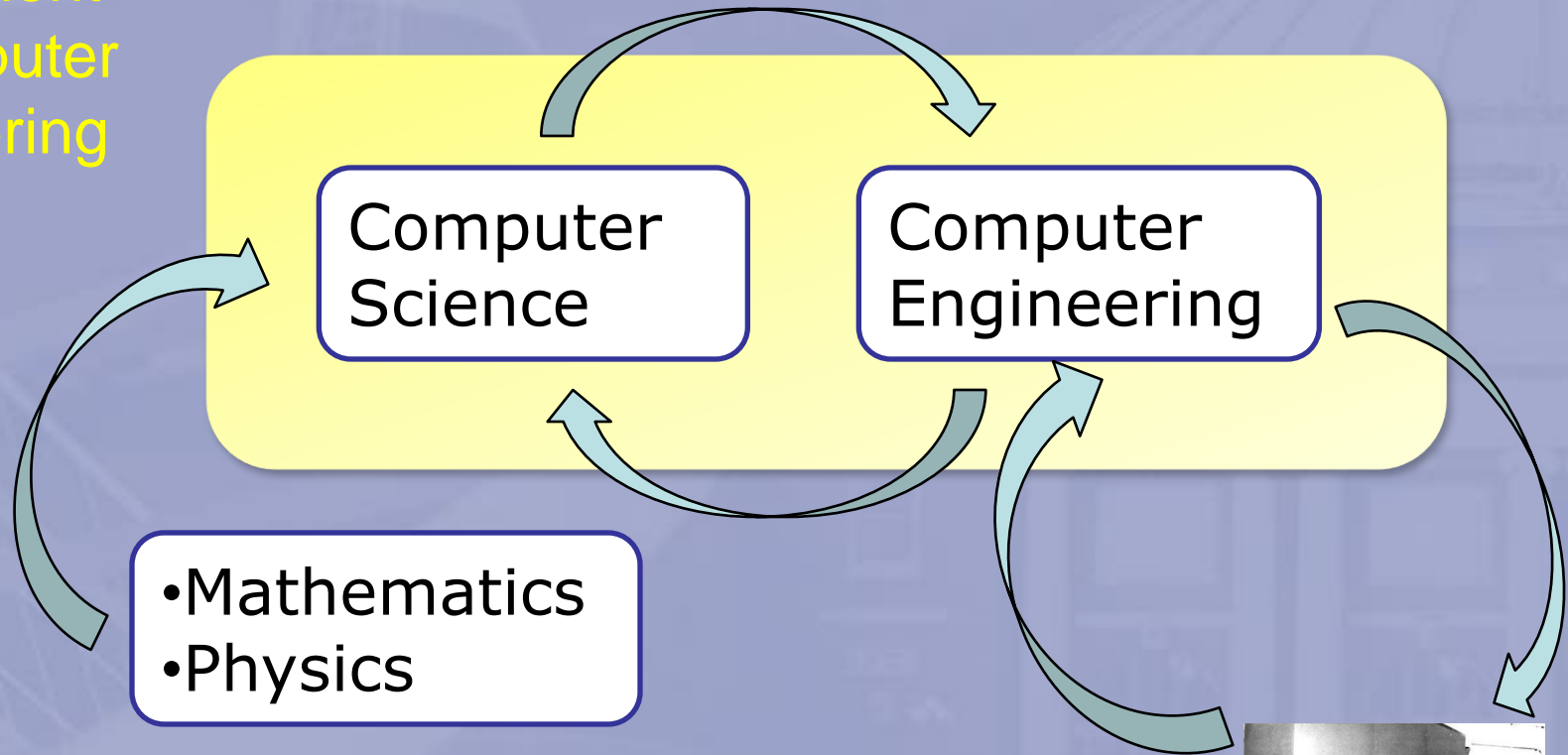
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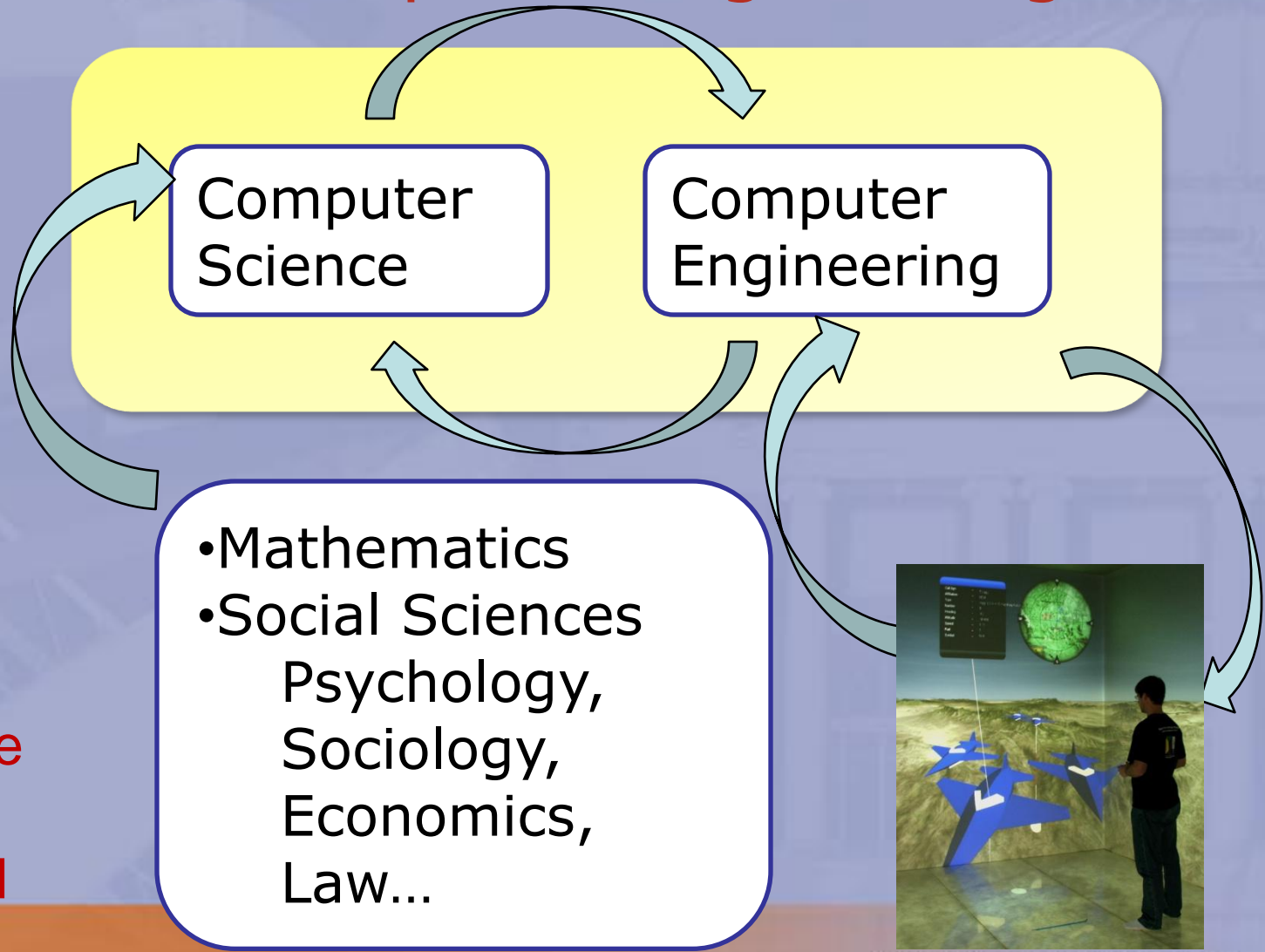
# “Classical” Computer Engineering

Department  
of Computer  
Engineering



# "Modern" Computer Engineering

Department  
of ??



- Constraints come from human in the loop (user, programmer)
- Many constraints are not mathematized



# “Modern” Computer Engineering

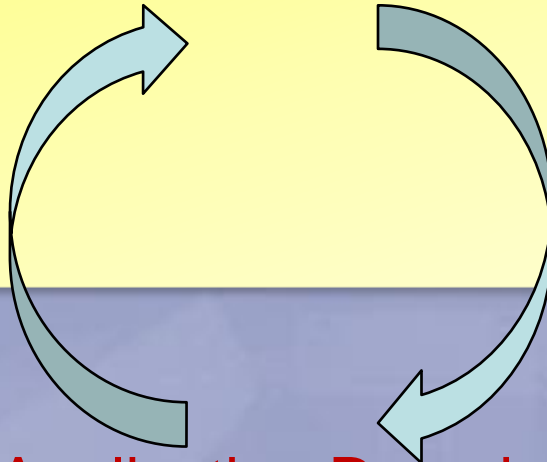
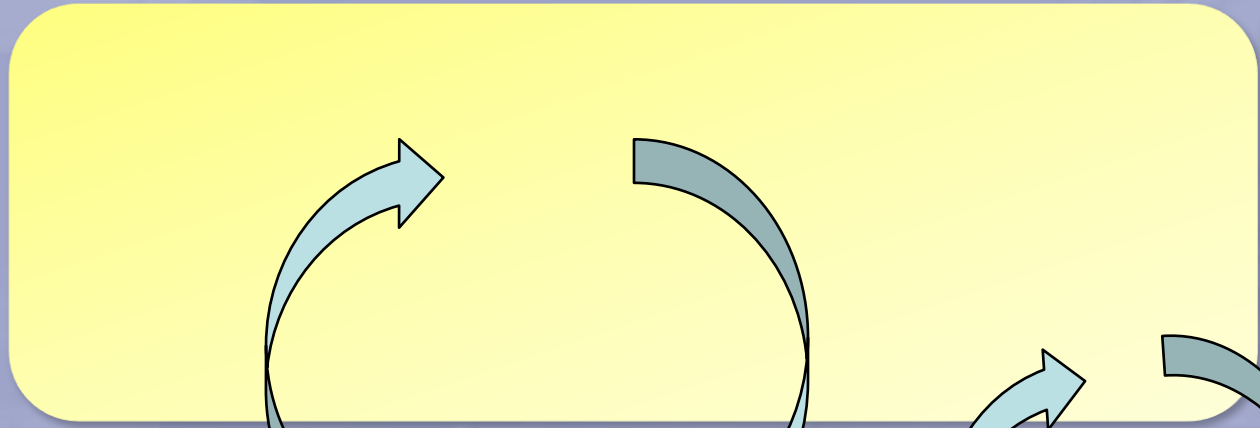
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of ??



**Constraints**

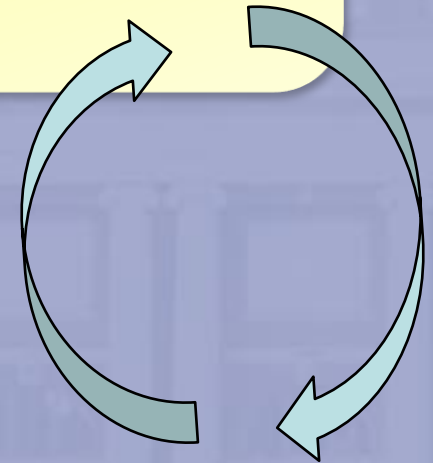
- Mathematics
- Social Sciences

CS is malleable –  
Affected by apps



**Application Domains**

- Sciences
- Humanities
- Arts
- Business



**•Products**



# Computer and Information Science and Engineering

- Engineering of mathematical artifacts that enhance our cognitive capabilities
- Constrained by
  - Mathematics
  - Human in the loop
  - Needs of applications
- Quite different from “physics driven engineering”
  - Strong background in social sciences needed for HCI, social computing, software engineering...
  - Background in application area needed for applied informatics



# How is CISE Organized, Academically?

- CS, ECE, LIS
- CS+ECE – focus of “old” CSE Department
- “New” Computer & Information School:
  - “Hard CS” – mathematized systems (CSE)
  - “Soft CS” – human in the loop (CS+Social Sciences)
    - *May require qualitative science*
- IS – data organization and retrieval
- Applied informatics – impact of applications





# Possible Organization Principles:

- Technology clusters
- Professional Specialization
- Anything goes



**SOCIAL COMPUTING**

**LIFE-SCIENCES  
INFORMATICS**

**COMPUTATIONAL  
INFORMATICS**

**COMPUTER SCIENCE**

**COMPUTER  
ENGINEERING**

**society**

**users**

**interfaces**

**data analysis**

**applications**

**life-sciences  
applications**

**services**

**operating  
systems**

**networks**

**hardware**

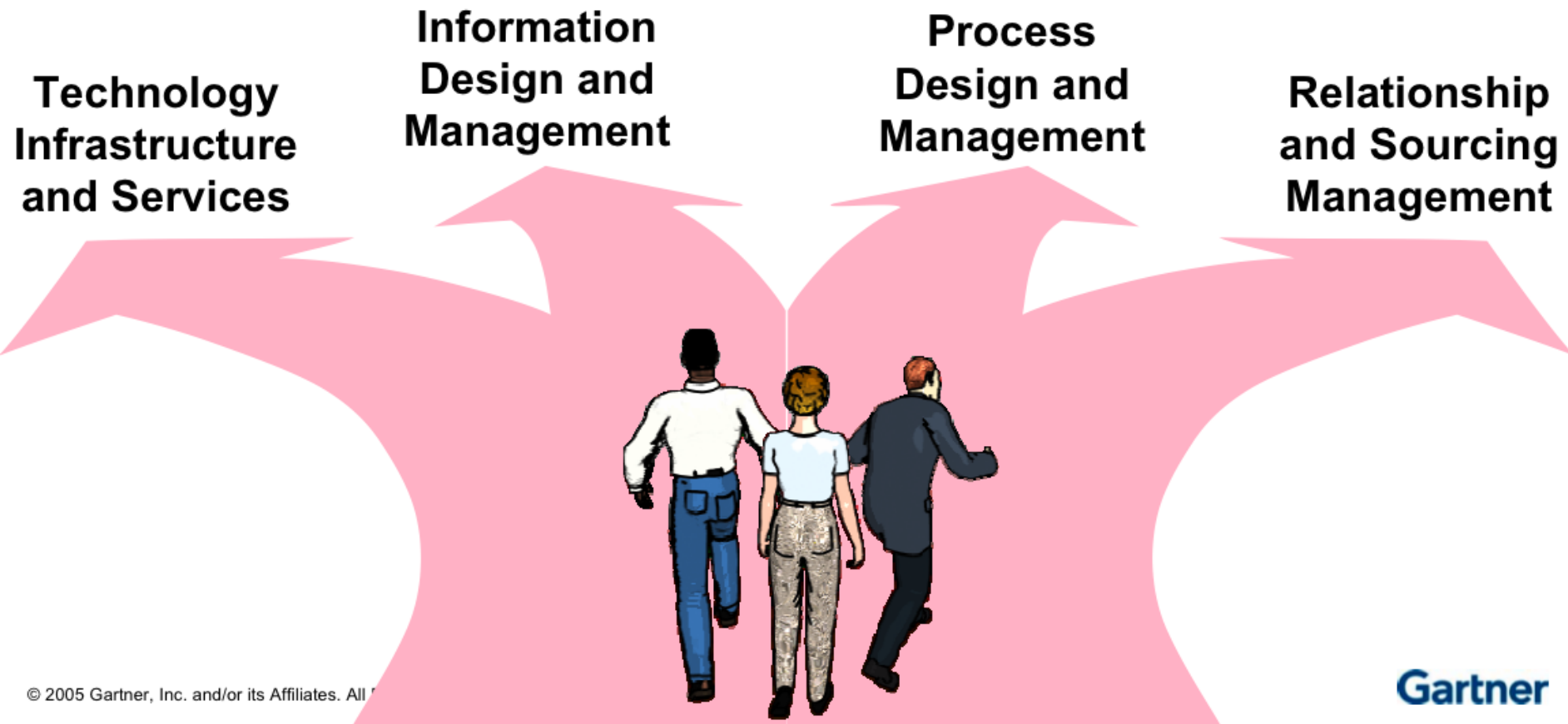
**INFORMATION  
ANALYSIS**

[M. Pollack]



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# Second Approach: Professional Specializations



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[D. Morello]

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# Third Approach: Anything Goes [Against Method]

- Georgia Tech: 2 (out of 8) threads, one role
- Threads:
  - Computational modeling, Embodiments, Foundations, Information Internetworks, Intelligence, Media, People, Platforms
- Roles:
  - Master practitioners, Entrepreneurs, Innovator, Communication



# A Modest Proposal



- Common core – The C&I **education** canon
  - what makes a C&I person think differently
    - *Computation, Information, System, Design*
  - What makes him capable to learn on his own C&I
- Secondary split according to
  - *fundamental sciences needed: physics, discrete math, cognitive science, sociology, economy, biology...*
  - *Professional formation: computer engineer, software engineer...*

**Education is what remains after one has forgotten everything he learned in school (Einstein)**





# Looking Outside: How IT Will Change the University and How We Can Help the Change

- IT combating Baumol's cost disease
- IT encouraging pull model rather than push model
- IT democratizing knowledge



# Baumol's Cost Disease

- There has been no labor productivity increases in classical music performance for hundreds of years: It still takes four musicians to play a Beethoven string quartet
- ▶ The cost of classical music performance increases faster than inflation.
  - As does the cost of medicine or of education
- IT is the usual cure to Baumol's disease in services – how does it play in higher education?
- Time to think again about CAE?



# Push vs. Pull

- Self-service vs. service
  - ✓ When you want, where you want, what you want
  - ✓ Cheaper
  - × No human touch
- Phone dialing, ATM, self-checkin/checkout (airport, hotel, library, retail), internet shopping, administration...
- Service: lecture, reception hours
- Self-service: ?



# Democratized Knowledge

- Wikipedia
- Citizen science projects (e.g., Audubon Bird Survey, Galaxy Zoo.org, Mountain Watch...)
  - Interested amateurs and concerned citizens can make a difference
- Synthesis science (e.g., environmental science)
  - Not about creating unique data but about analyzing and synthesizing publicly available data
- The knowledge monopoly of professional scientists is eroded: How should our profession be redefined?



Thank You!

