

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

Marc Snir

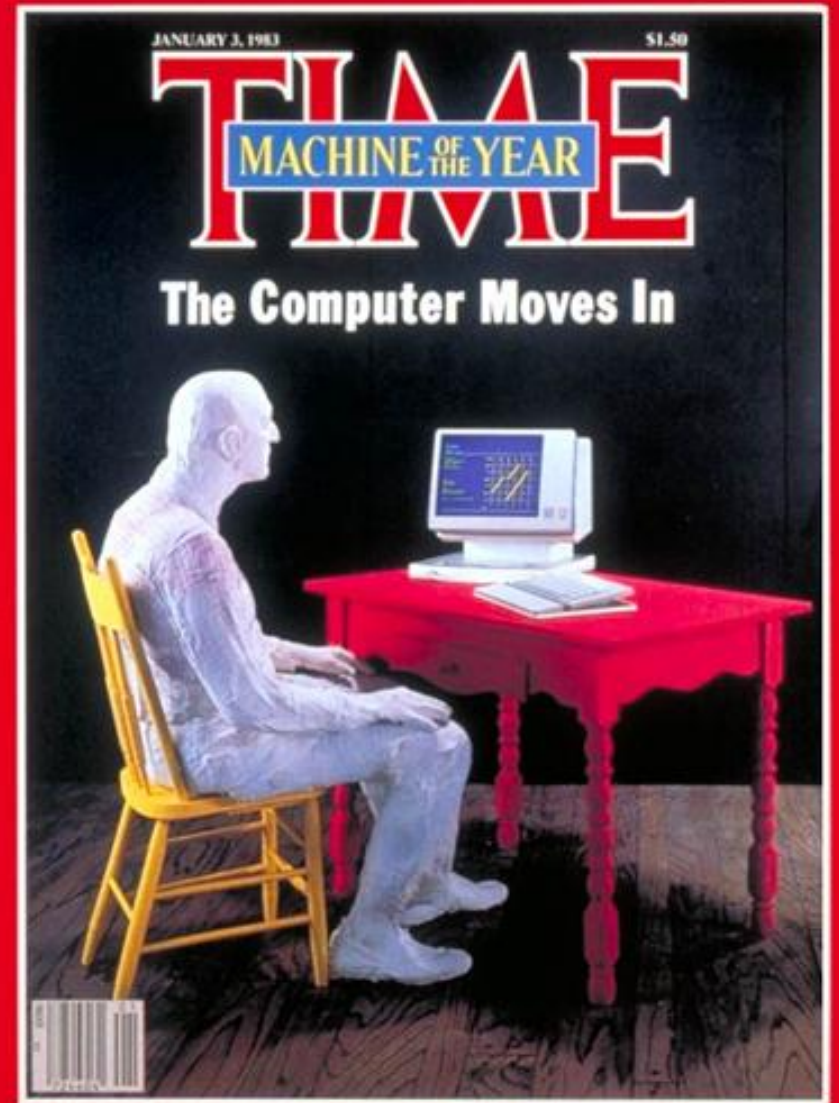


Department of Computer Science



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

Mousetrap Science

Why

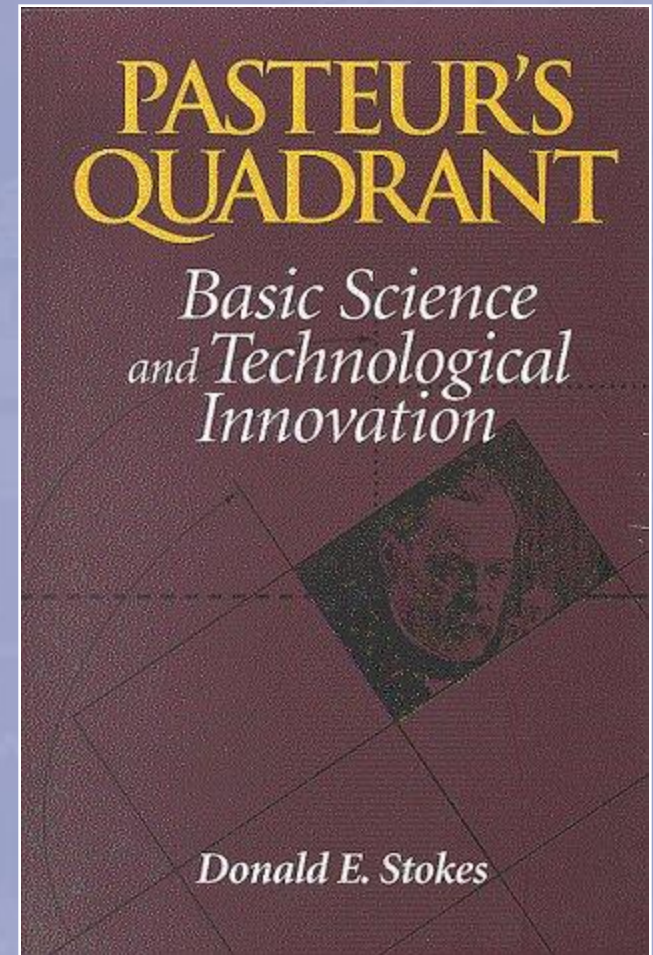
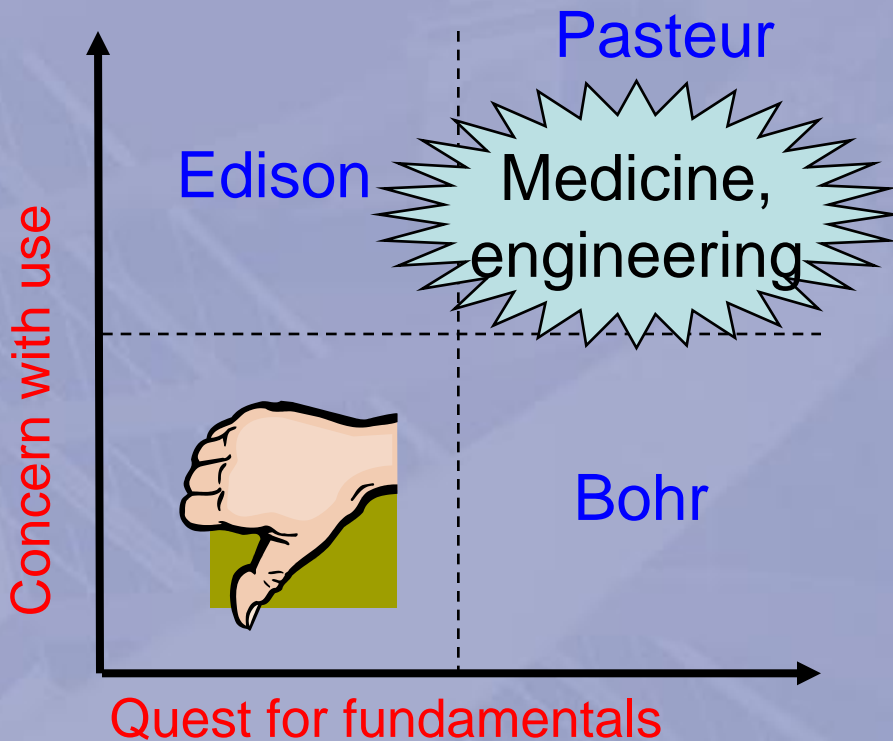
• Physics
• Biology

pure



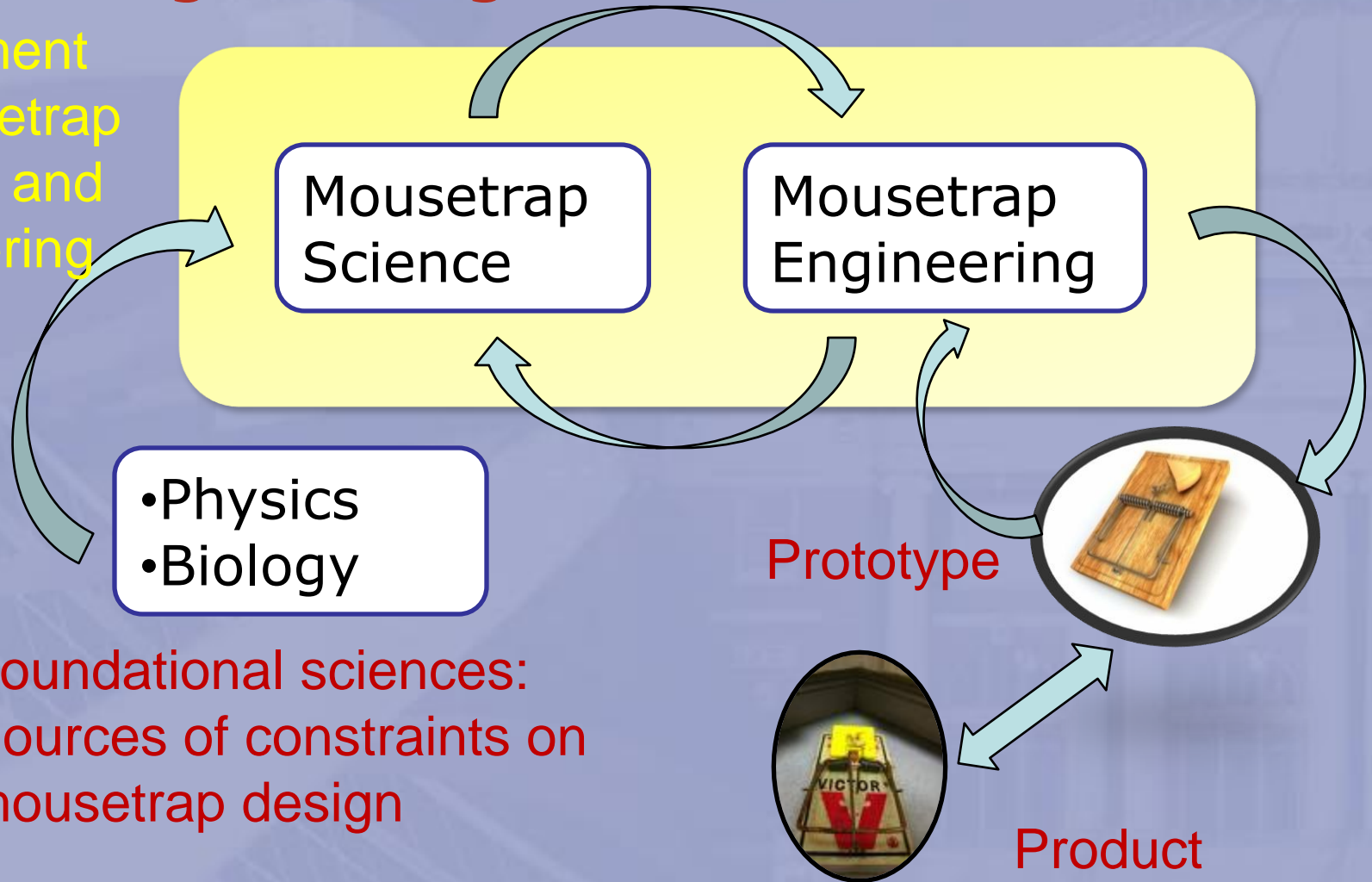
What is Engineering Research?

Alternative View



Engineering: A Modern View

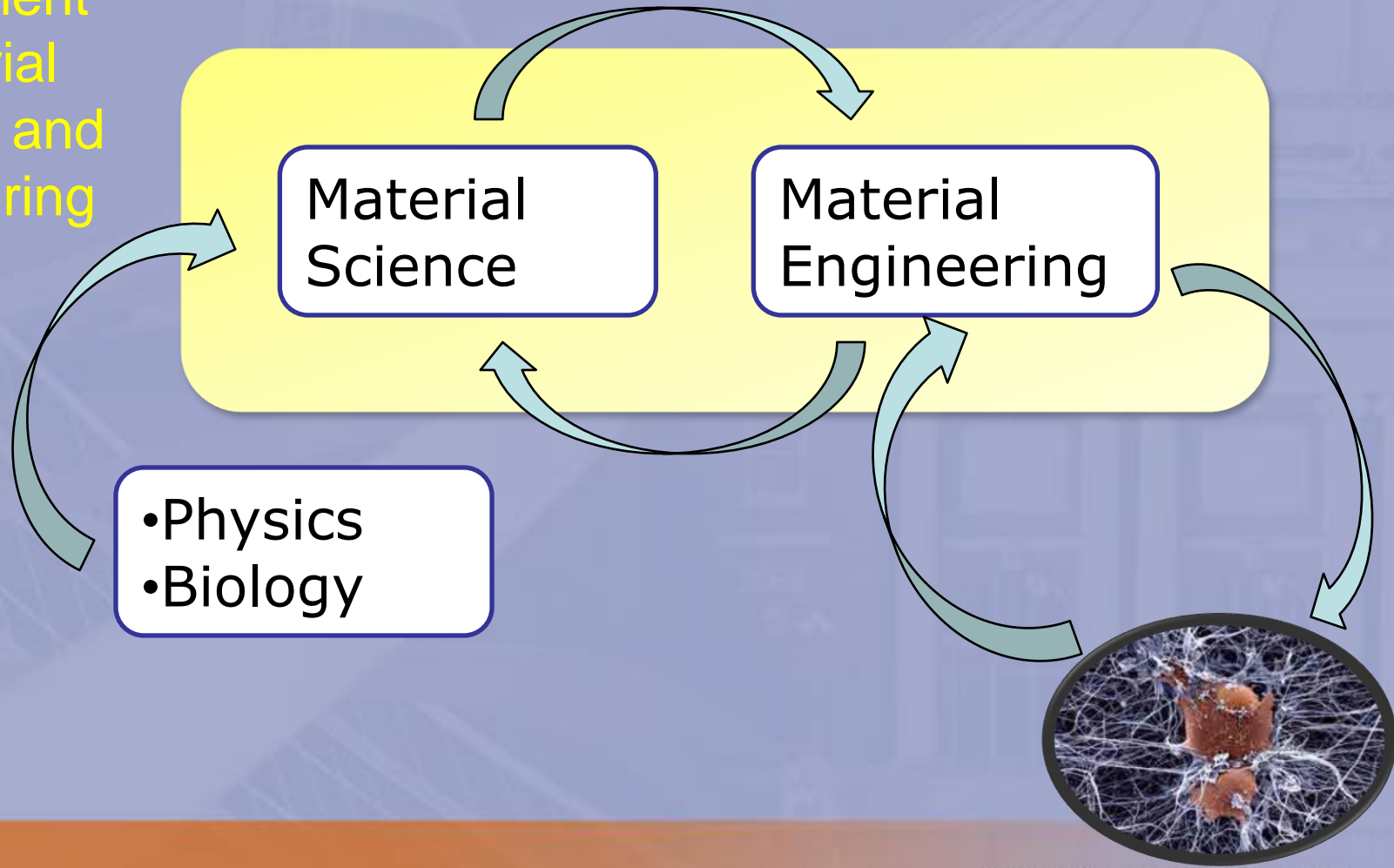
Department
of Mousetrap
Science and
Engineering
(MSE)



Foundational sciences:
Sources of constraints on
mousetrap design

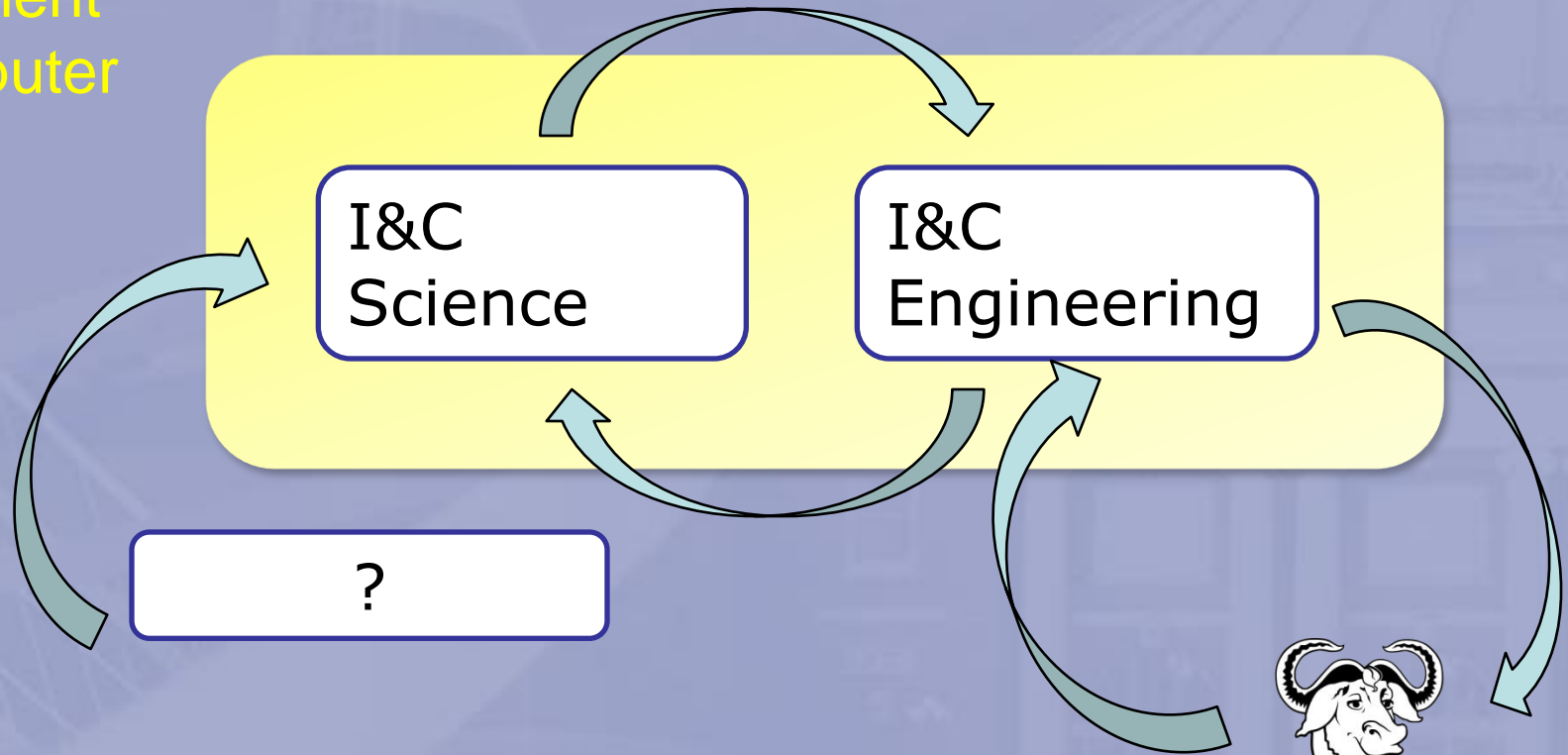
Engineering: A Modern View

Department
of Material
Science and
Engineering
(MSE)



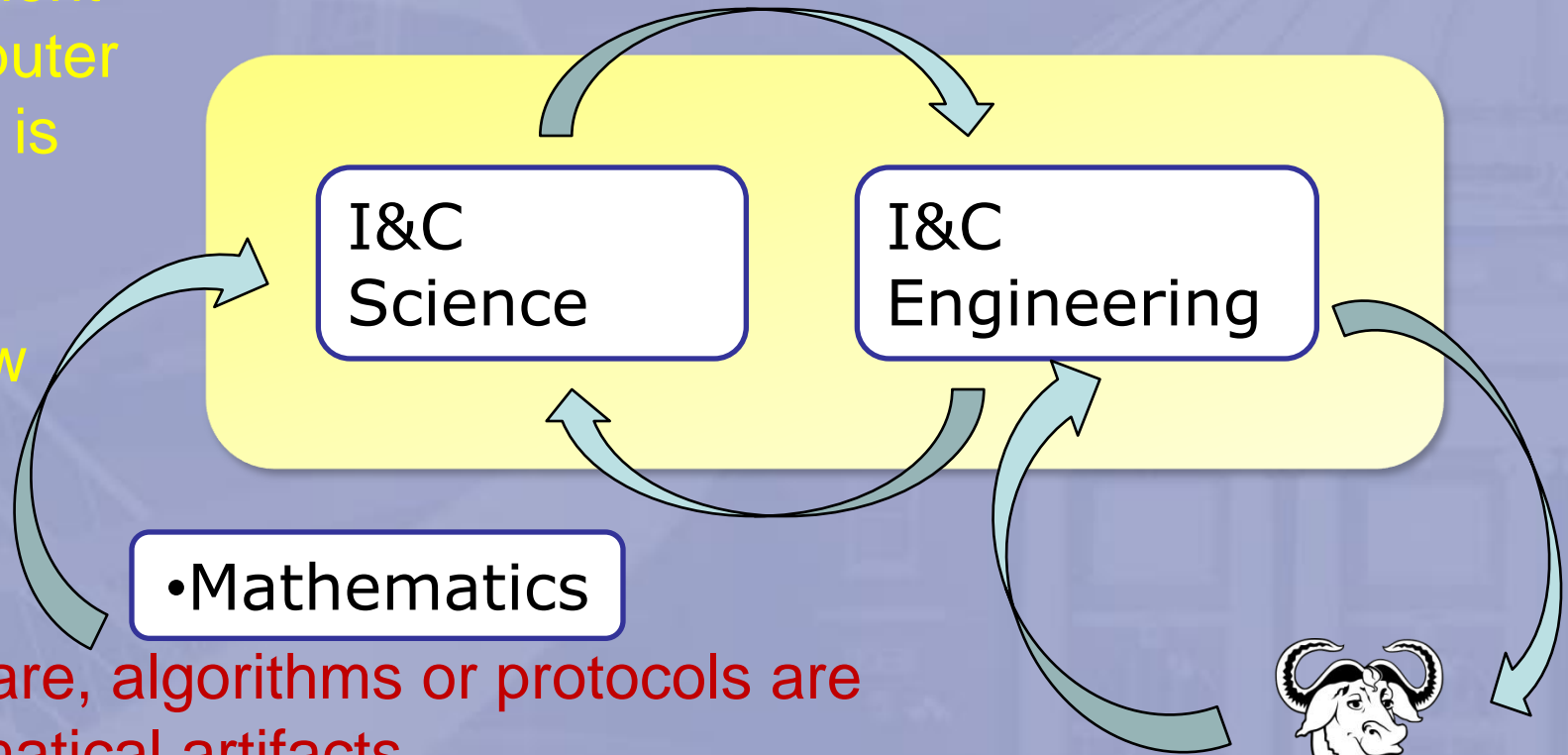
Information and Computation Engineering

Department
of Computer
Science



Information and Computation Engineering

Department of Computer Science is about building better sw widgets



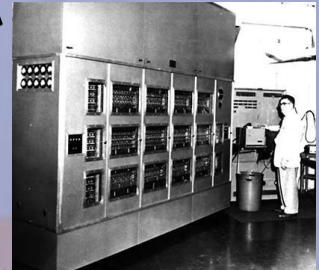
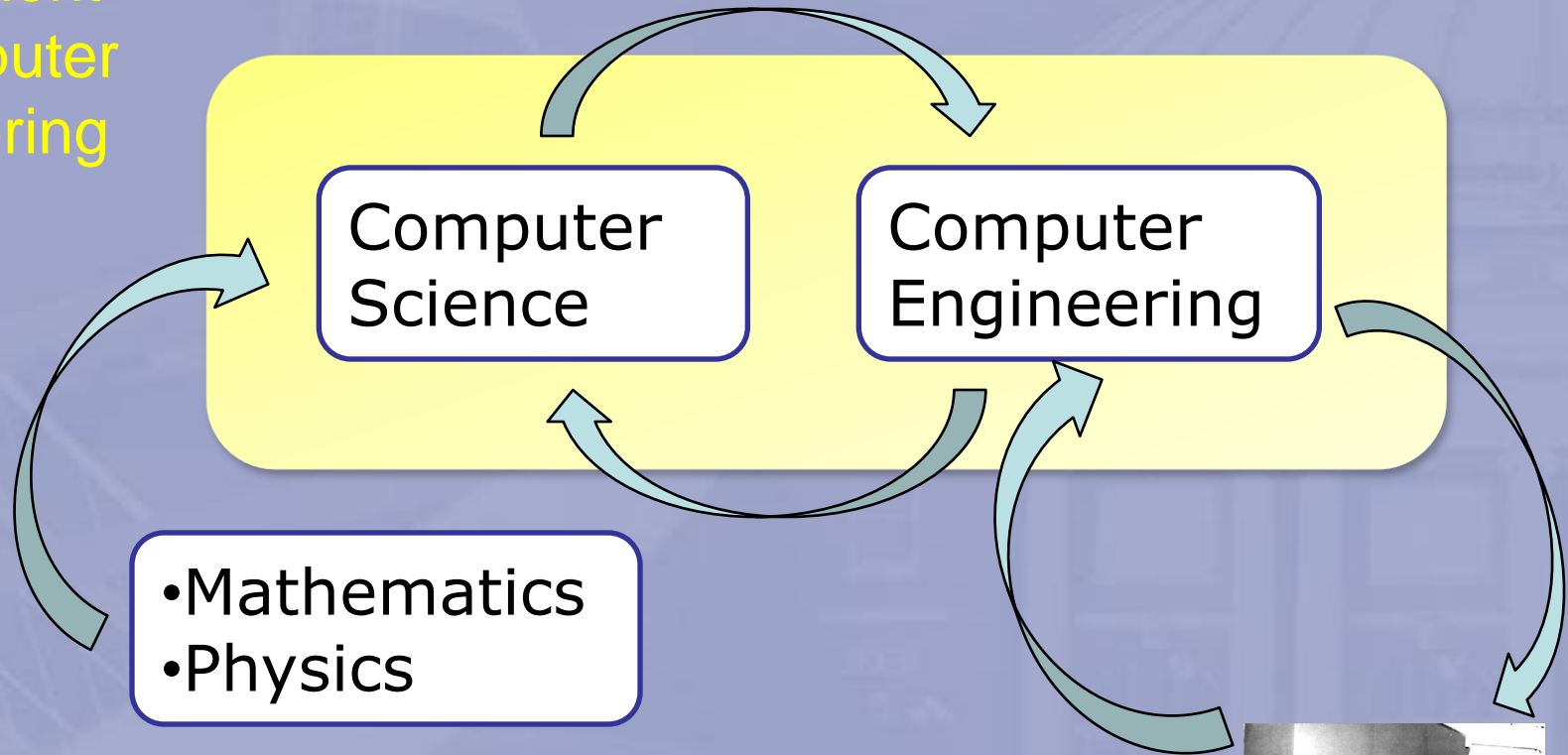
- Software, algorithms or protocols are mathematical artifacts
- Time/space complexity are mathematical abstractions



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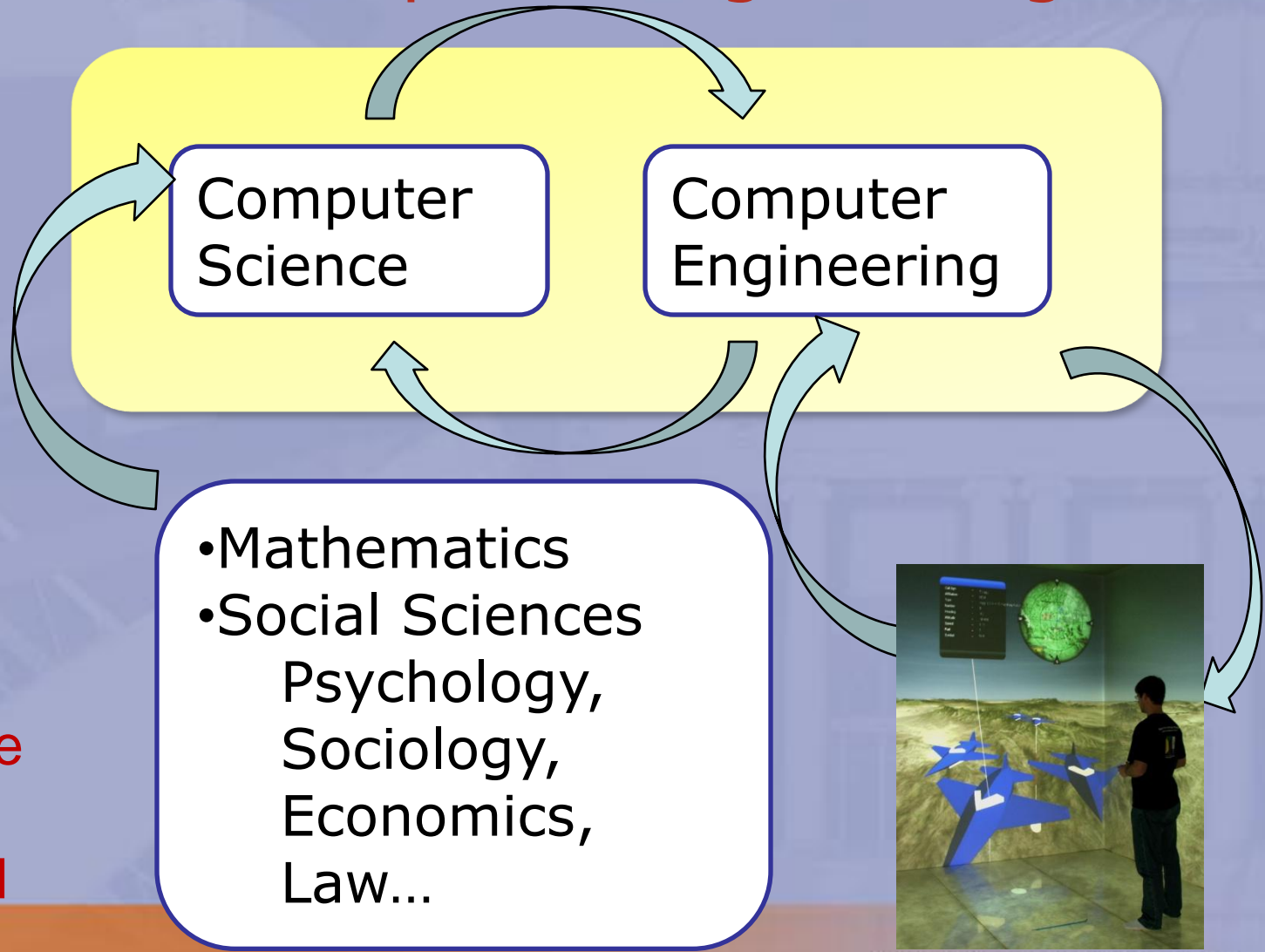
“Classical” Computer Engineering

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

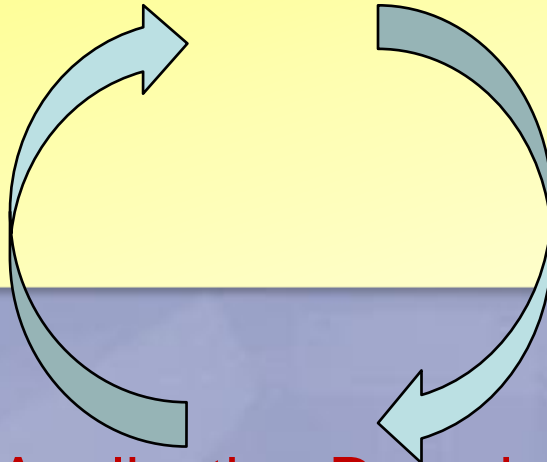
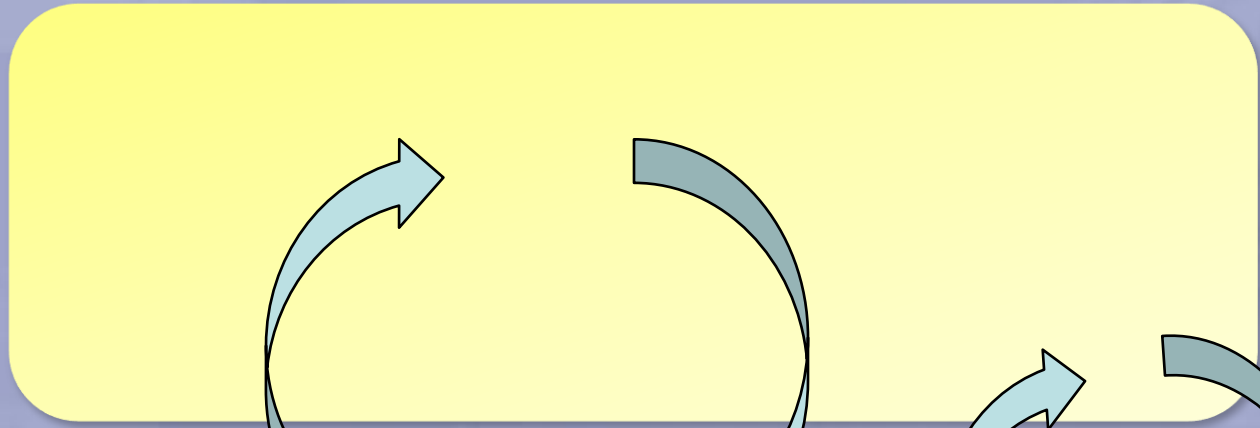
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of ??



Constraints

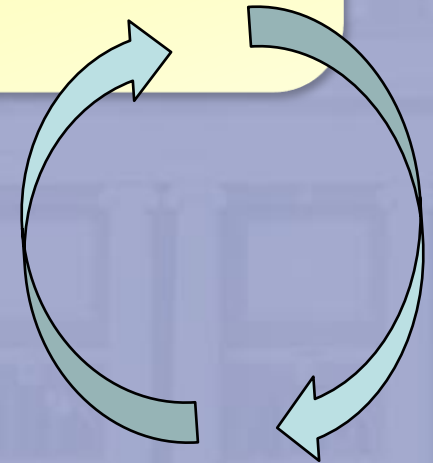
- Mathematics
- Social Sciences

**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

life-sciences

applications

applications

services

**operating
systems**

networks

hardware

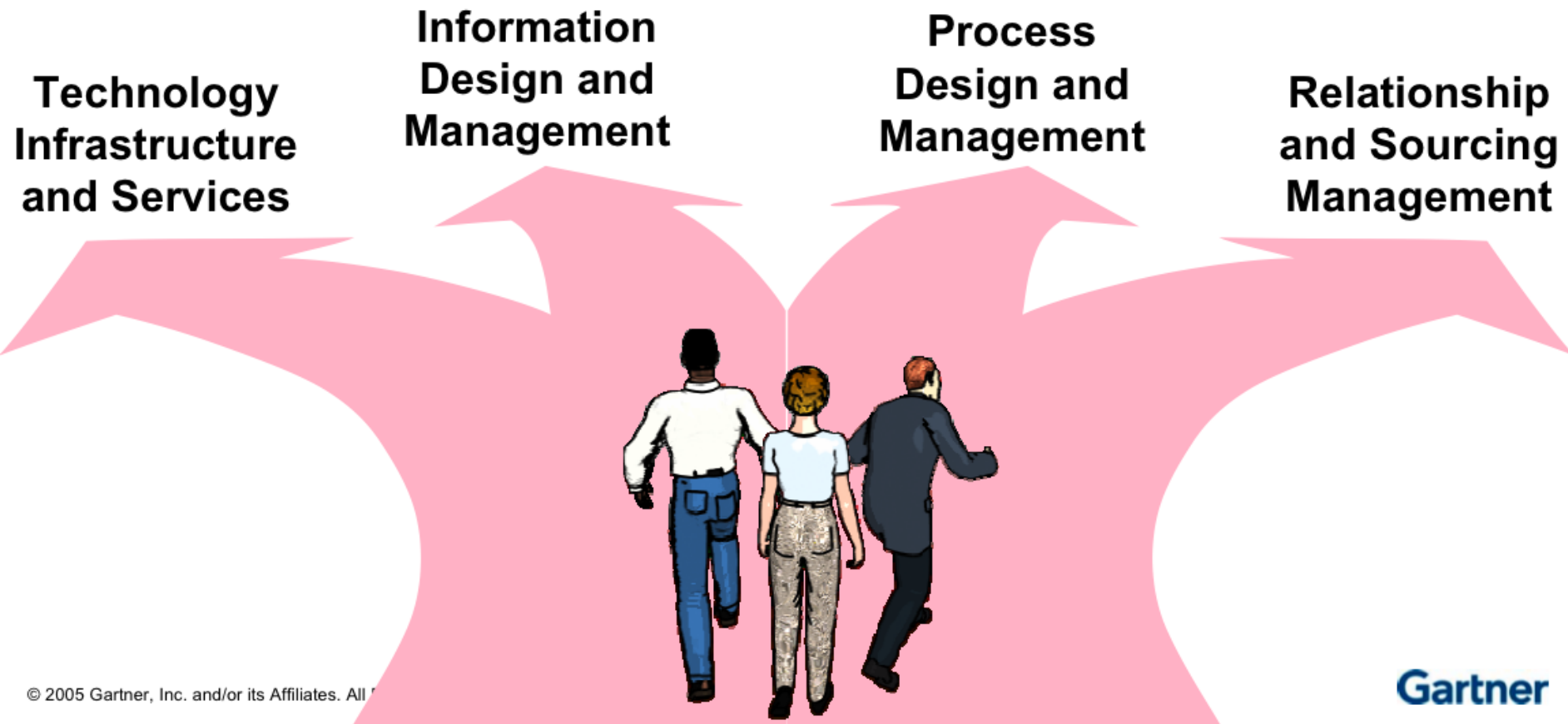
**INFORMATION
ANALYSIS**

[M. Pollack]



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Second Approach: Professional Specializations



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Gartner



[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!

