Creating New Physics Learning Environments for Higher Education

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Acting Provost

Undergraduates Too Often Shortchanged in the Past

- Nevertheless, the research universities have too often failed, and continue to fail, their undergraduate populations. Tuition income from undergraduates is one of the major sources of university income, helping to support research programs and graduate education, but the students paying the tuition get, in all too many cases, less than their moneys worth.
  - The Carnegie Foundation

Are Research Universities Cheating Undergraduates?

- "Untrained teaching assistants groping their way…tenured drones who deliver set lectures from yellowed notes," anybody we know?
- A report released by the Carnegie Foundation for the Advancement of Teaching bluntly accused the nation's research universities of false advertising.
  - What's New @ APS by Robert L. Park

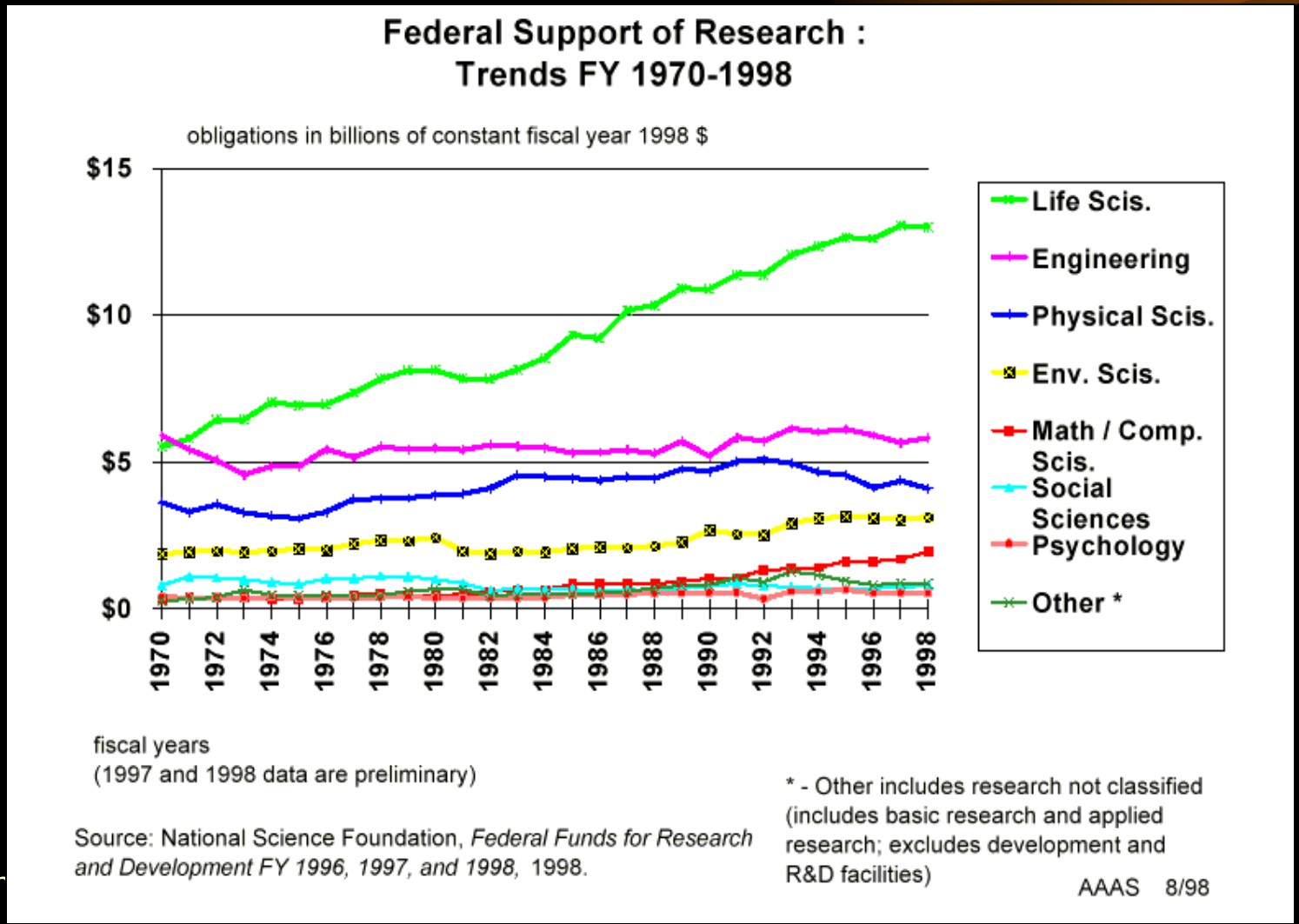
The bad news

- Physics is often one of the worst examples at the research universities
- ABET has removed any requirement for Physics taught by Physics Departments

More bad news

- 1960's: Physics was perceived as "challenging, boring, and vital."
- 1990's: Physics is perceived as "challenging, boring, and irrelevant."

Research has also been a tough road



Some good news

- The Physics Community has been the leader in reforming the undergraduate experience.
- Much of the research on which new programs are based was done in physics.
  - (just not enough deployment)

Bright spots

Physics Education

- **Lecture based models**
  - Active learning physics systems (Ohio State)
  - Peer Instruction/ConcepTests (Harvard)
  - Interactive Demonstrations (Oregon)
- **Studio/Workshop models**
  - Workshop Physics (Dickinson)
  - The Physics Studio (RPI)
  - Physics by inquiry (U. Washington)
- **Lab models**
  - Tools for Scientific Thinking (Tufts-Dickinson)
  - RealTime Physics (Dickinson-Oregon)
- **Recitation models**
  - Cooperative Problem solving (Minnesota)
  - Tutorials in Intro. Physics (U. Washington)
  - Mathematical Tutorials (Maryland)

Restructuring strategy

- Replace Large Lectures with Studios
- Create 4 X 4 Curriculum
- Expand into new markets with Distributed Learning

Features of the Studio Courses

- De-emphasize lecture
- Combine Lecture/Recitation/Lab
- Constructivist approach
- Multimedia courseware
- Theater in the Round Classroom
- Multipoint video/audio/collaborative

The Studio Classroom

- Hesburgh Award 1995
- Boeing Outstanding Educator Award 1995
- Pew Prize 1997

The old model

Faculty working very hard while the students listen (rest?).

Students working very hard while the faculty listen (rest?).

No more lectures

- Mini-lectures
- Cooperative Learning - Teams
- Peer instructions
- Teacher as mentor
- Hands on
- Combine Lecture/Recitation/Lab
- Distributed Educational Systems

No more books?

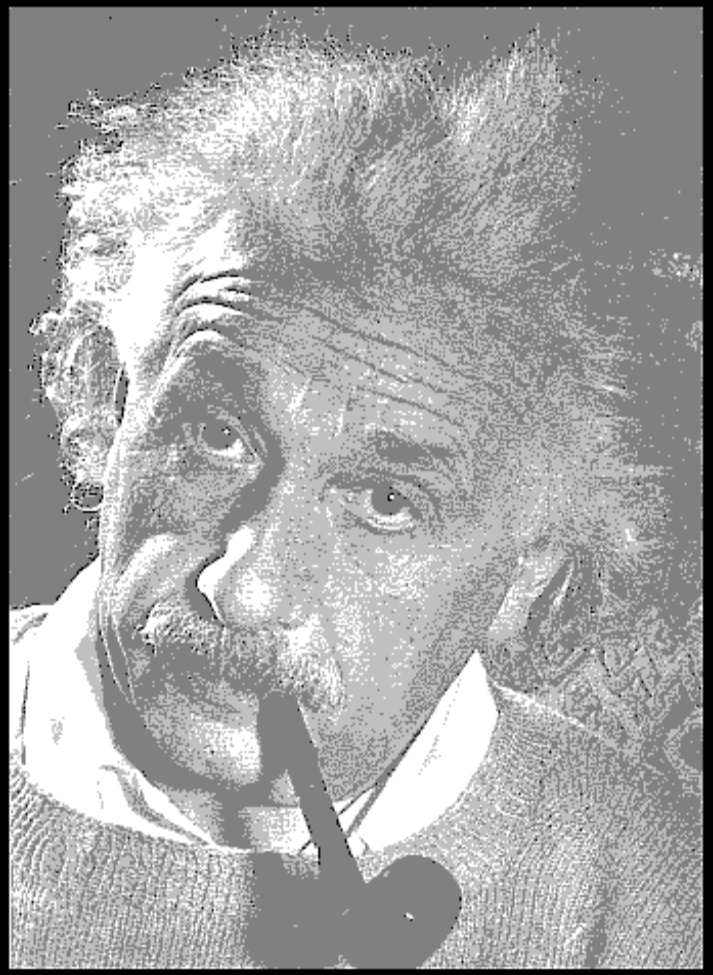
- Of course! Texts
- Interactive Texts
- Web Access to Resources/Databases
- Full Motion Video
- Data Acquisition/Analysis/Visualization
- Live Links to Experts

No more dirty looks

- An improved classroom climate
- Able to address diversity
  - Learning styles
  - Gender/Race/Culture
  - Interests
  - Preparation
- Developing Cooperative and Leadership Skills

What happens to me?

- Will the Web or a CD-ROM Replace your <Blank> Instructor?

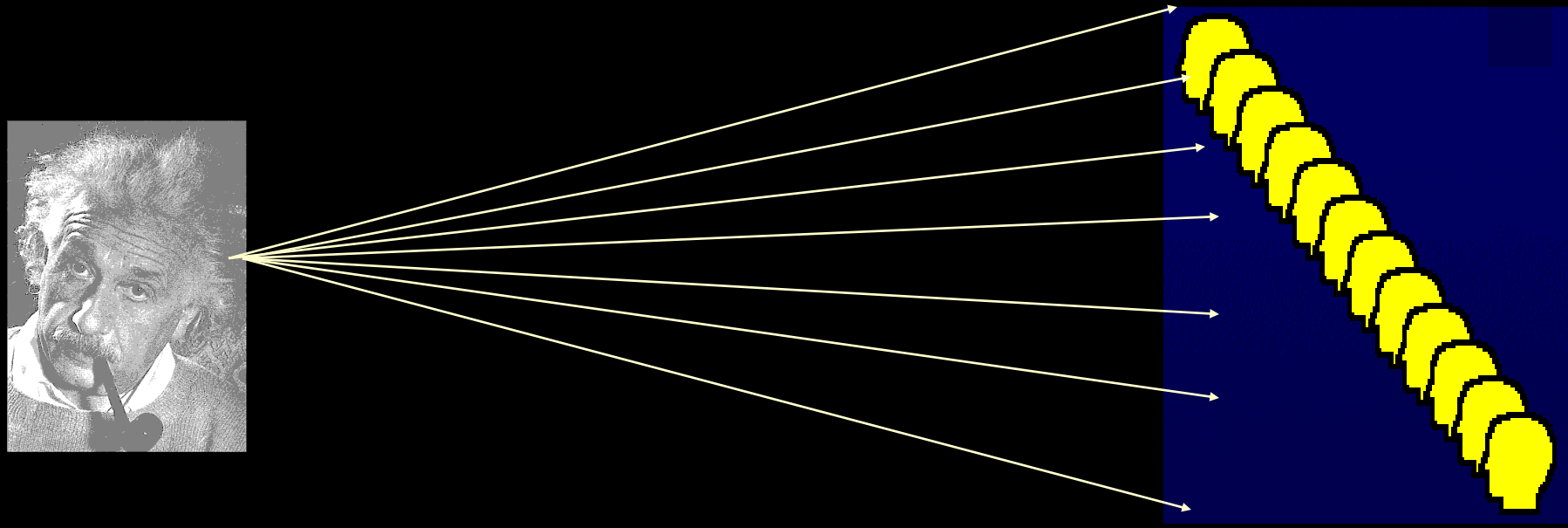


Faculty fears and legislators hopes

- Prism: "If a student can zoom the best professors into his or her living room, then what is to happen to the rest of the countries professors?" (the mainframe model!)
  - In a word: hogwash.
- Presenting is not teaching!

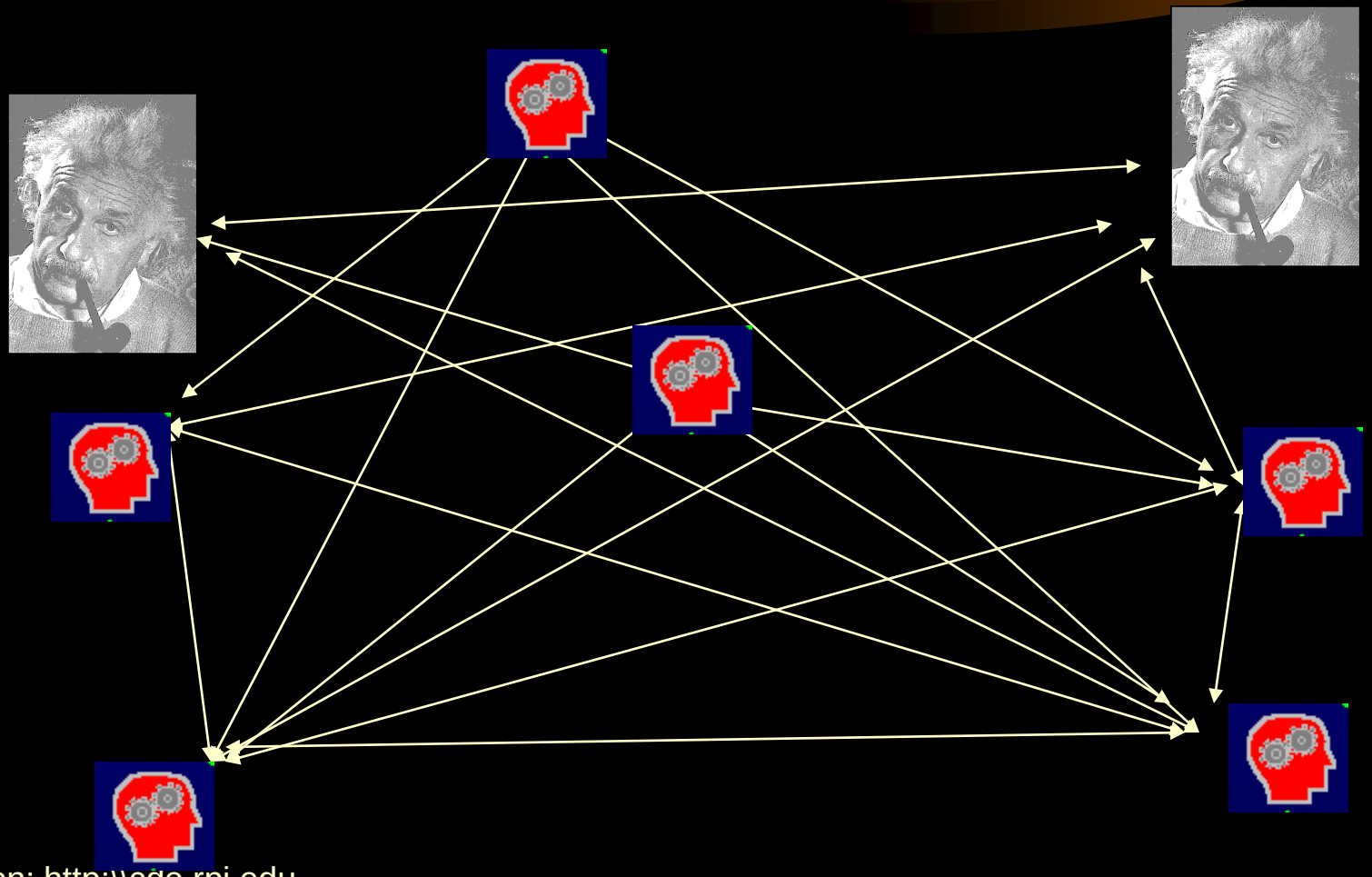
The transmission model

- The mainframe approach



Distributed Collaborative Model

Physics Education



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Distributed Cognition

Physics Education

- The "Client-Server" model.
- Connecting students, instructors, and resources into a rich interacting community of learners.
- Peer Teaching
- Cooperative Learning
- Student-student as well as student-instructor and student-resource interactions
- Synchronous as well as asynchronous
- Video/Audio/ and Multimedia interactions
- The real "World Wide Web"

Learning: The Killer App

- Is Learning the "Killer App" of the next generation of computing?

Evolution of Computing

- First we thought the PC was a calculator
- Then we thought it was a typewriter
- with multimedia we thought that it was a TV
- Now, with the World Wide Web.....

  we've realized it's a (four color sales) brochure.

  ..... Douglas Adams,

  Author Hitchhiker's Guide to the Galaxy

The Fact:

- It is the worlds best communication tool combined with what will be the
- World's Largest Library Creating the First and Only
- Global Continuous Learning Environment

Relentlessly changing the way we

Physics Education

- Labor
- Live
- Love

  and

- Learn

The Forty Year Degree

- Christopher Galvin, President Motorola:

- We are not hiring any more graduates with four year degrees.
- We want employees with forty year degrees

The Introductory Course

750 - 1100 Students

Calculus (1100)

Physics (750)

Chemistry (650)

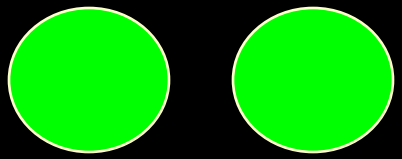
Intro. to Engineering Analysis (650)

Economics (~300)

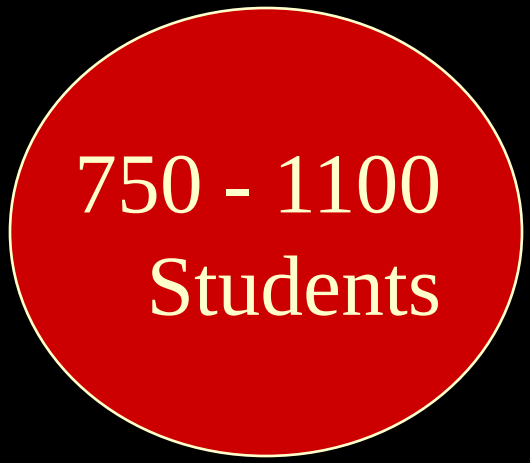
(and now many advanced courses)

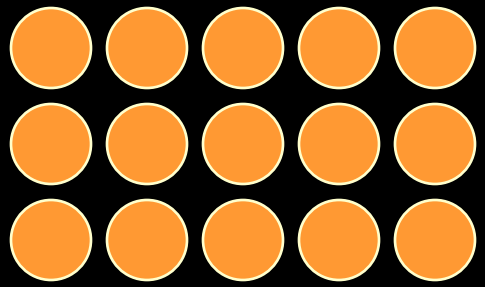
The Introductory Course

Physics Education

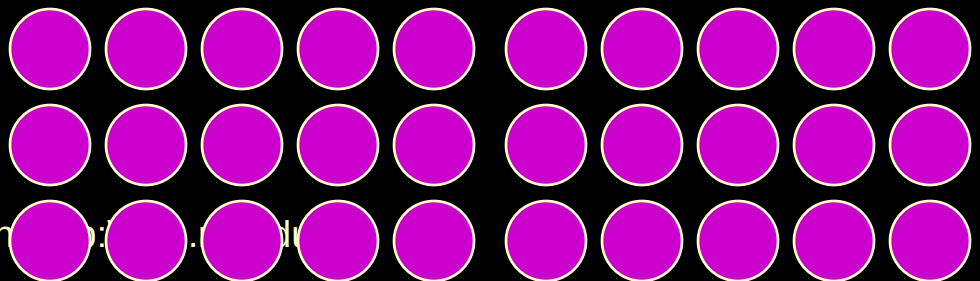


2 Lectures





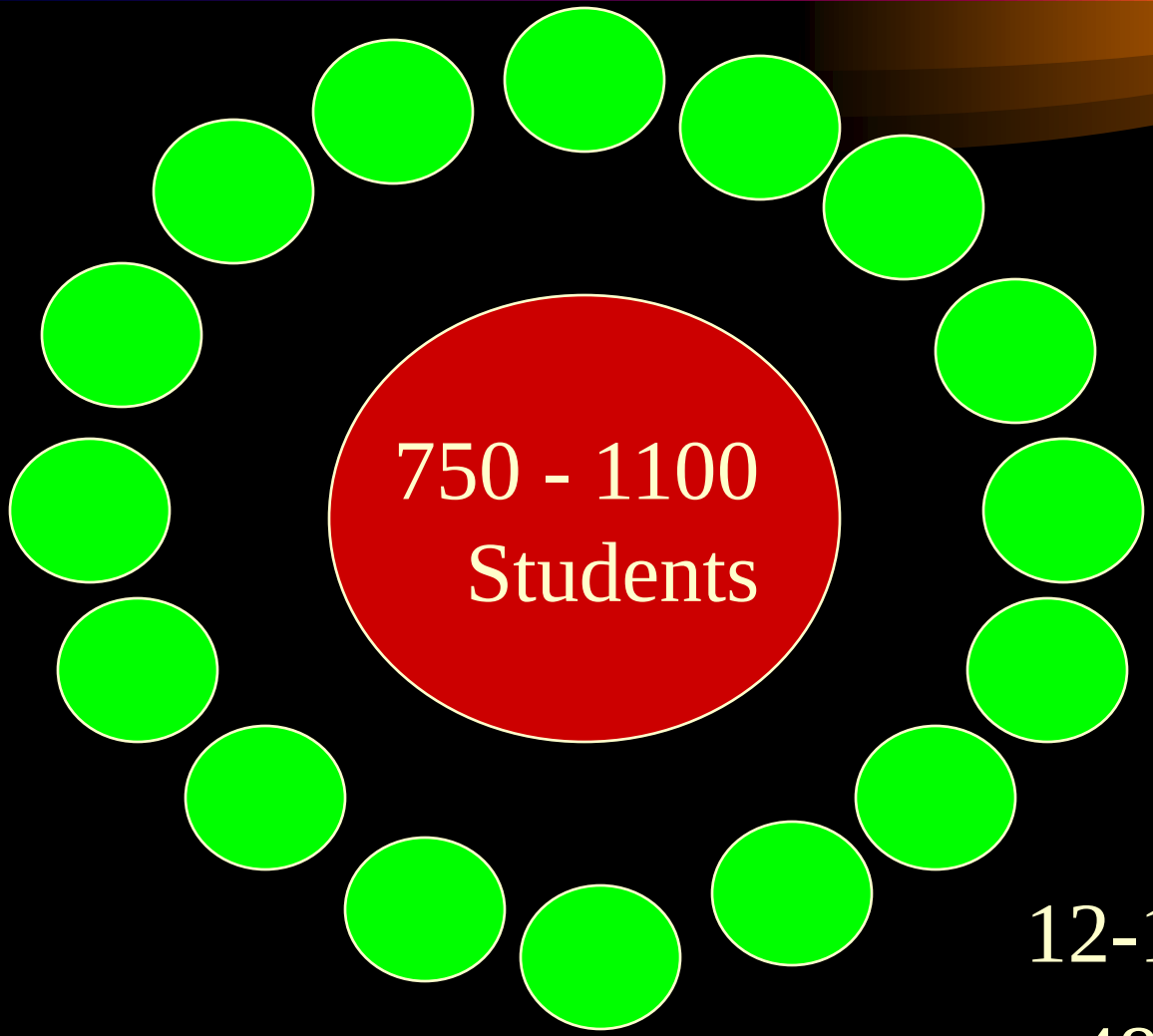
25-30 Recitations



30-40 Labs

The Introductory Course

Physics Education

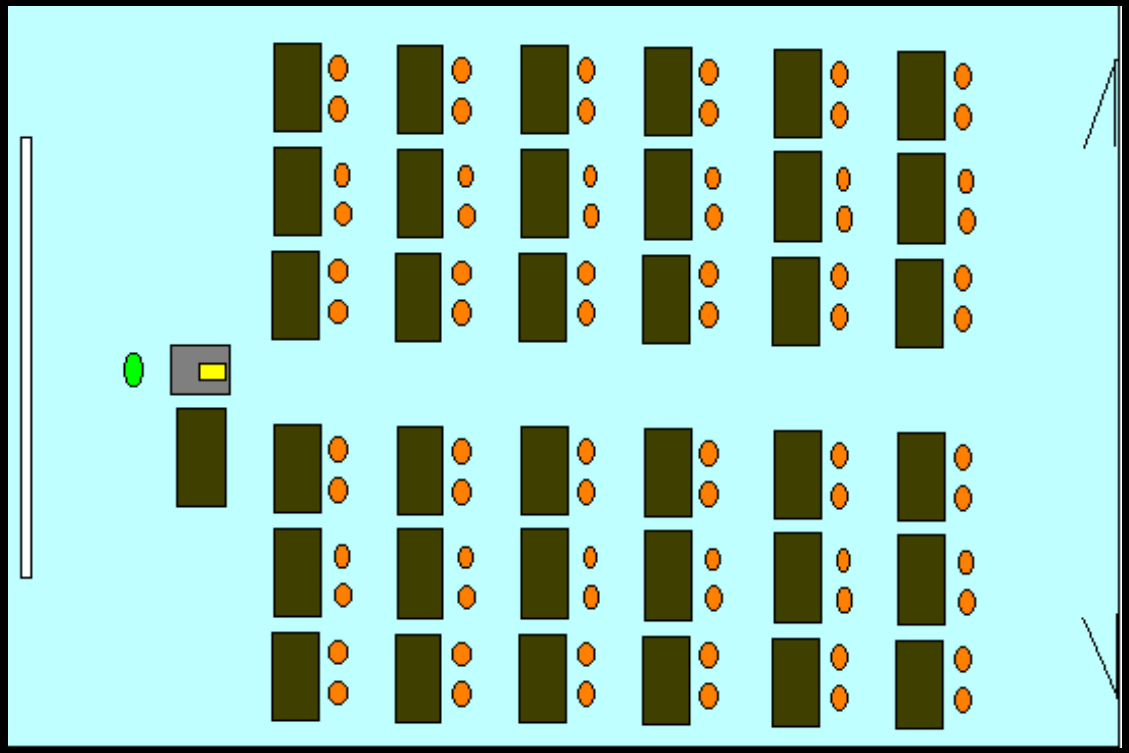


12-15 Studios

48-64 each

The Traditional Classroom

Physics Education



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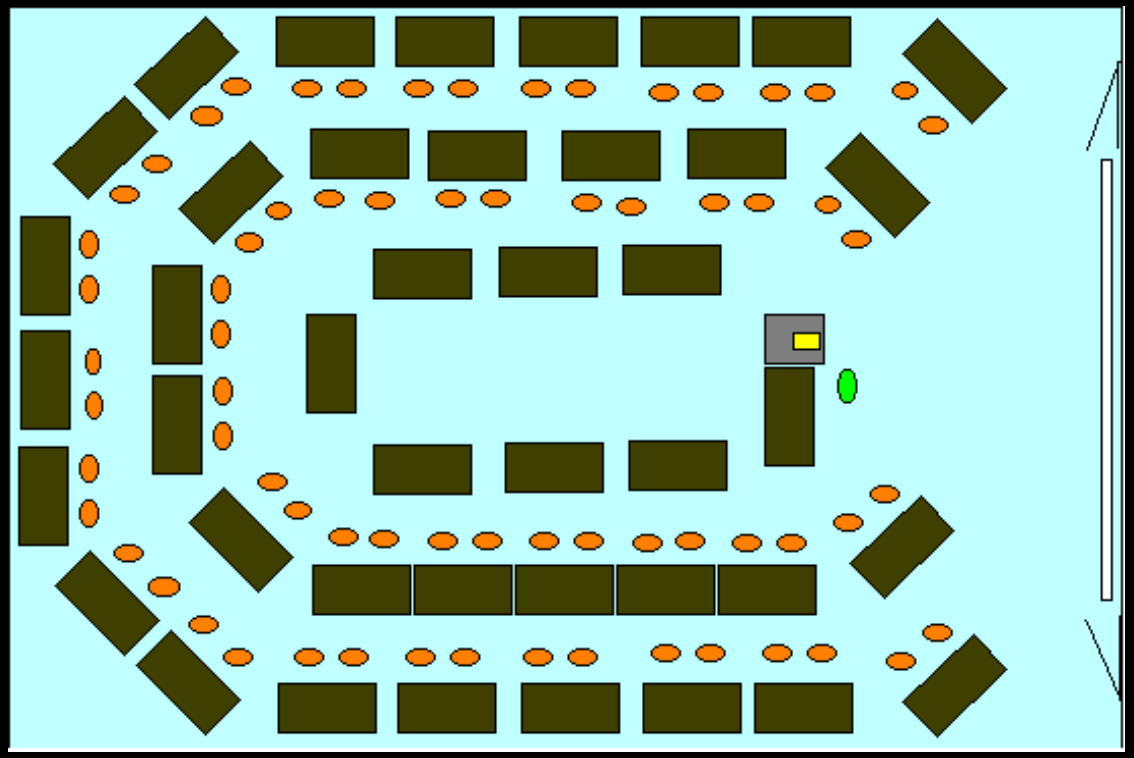
The Studio Classroom

Physics Education



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The CUPLE Physics Studio

Traditional

- Credit Hours: 4
- Contact Hours 6
  - 2 Hours Lecture
  - 2 Hours Recitation
  - 2 Hours Lab

Studio

- Credit Hours: 4
- Contact Hours 4

The CUPLE Physics Studio

Physics Education

- (20 min) Problems Due - Discussion
- (40 min) Hands-on Group Activity
- (10 min) Discussion
- (15 min) Another Group Activity
- (15 min) Mini Lecture: Formalism
- (5 min) Conclusion

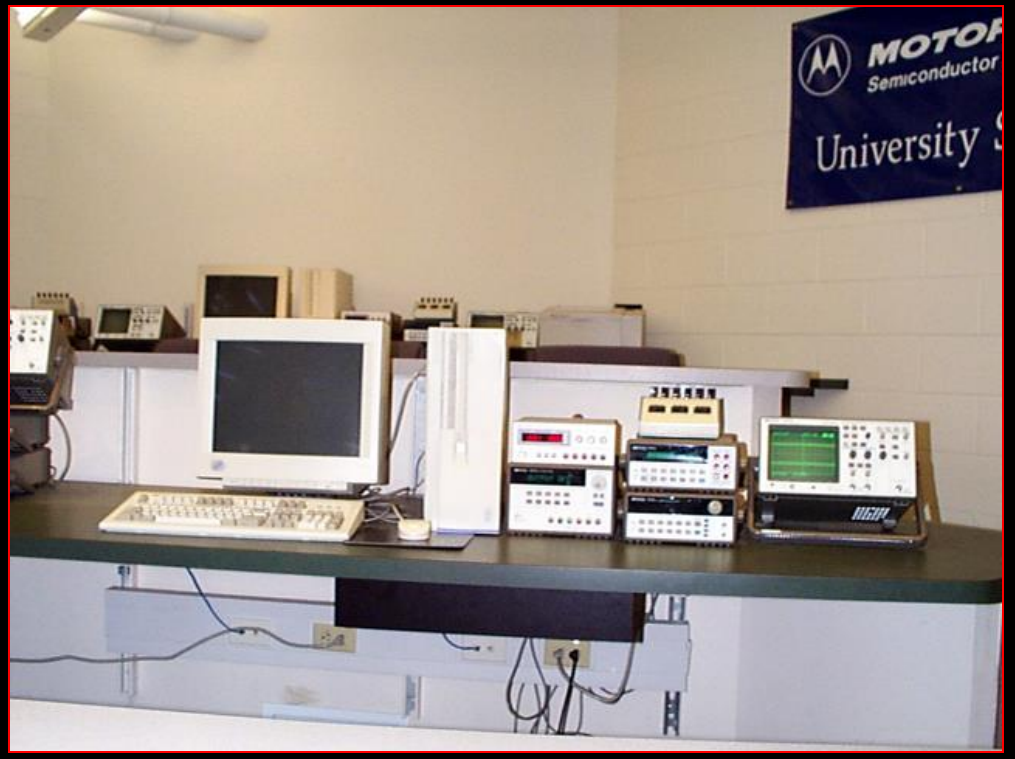
Studios in ECSE

- Circuits Studio - 1500 ft^2- 42 Students
- Instrumentation Studio - 1200 ft^2 - 36
- Computer Studio - 1200 ft^2 - 36
- Control Studio - 1500 ft^2 - 44
- LITEC Studio - 3600 ft^2 - 72
- 12 More Around Campus
  - plans for 10 more

ECSE Studio Courses

Physics Education

- Computer Components and Operation
- Computer Architecture, Networks and Operating Systems
- Laboratory Introduction to Embedded Control
- Electric Circuits
- Analog Electronics
- Microelectronics Technology
- Digital Electronics
- Electronic Instrumentation
- Fields and Waves I
- Signals and Systems
- Discrete Time Systems
- Control Systems Engineering
- Still More to Go



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Other Studio Courses

- Calculus (1100 students / yr)
- Physics (750)
- Chemistry (650)
- Intro. to Engineering Analysis (650)
- Economics (~300)
- Biology

Results

- Significant improvement: Student Satisfaction
- Significant improvement: Faculty Satisfaction
- Equal or better performance on regular exams.
- Year long Rutgers led evaluation
- Significant Attendance increase
- Cost containment
- Ongoing longitudinal study

The Virtual Classroom

- Hand-raising
- Floor passing
- Annotation
- Q and A
- Feedback
- Application sharing

Rensselaer and Hong Kong City U.

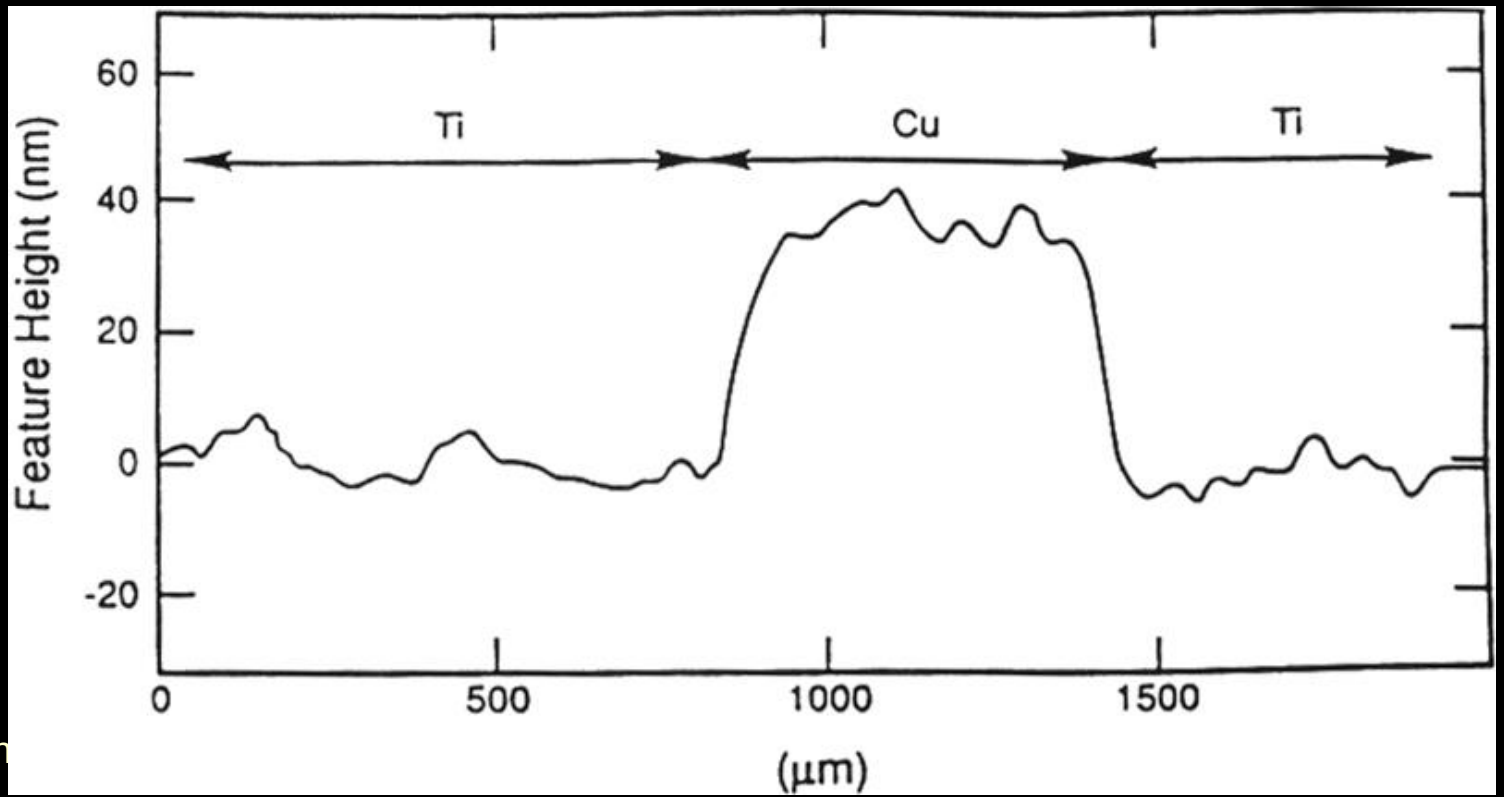
- Survival Skills for Astrophysics
- Professor Chun Ming Leung
  - Graduate Students in Astrophysics
    - Video/Audio/ ILINC Web Data Conf.
    - Both ISDN and Internet connection
    - 7 am Eastern (6 Hong Kong)
    - Student Collaborative Presentations
    - One Semester length

Chemical Mechanical Planarization

- RPI/Intel/Applied Mat./ Matsushita/IBM
- Murarka, Schowalter, Duquette
  - (Introduction to Copper Metalization)
  - (Wall Street Journal article)
- Month long course to engineers and scientists in the workplace.

- Video/Audio/ILINC Web data Conf.
  - ISDN and Internet
  - ProShare, PictureTel, Panasonic multipoint

- Profilimeter trace showing dishing of the titanium liner relative to the adjacent recessed copper metal. An electrochemical interaction between the copper metal and the titanium accelerated the normally low polish rate of titanium to produce the negative dishing.



The End

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Our Strategies

- Follow our corporate partners throughout their own globalization process
  - ex: GM into Mexico, Luxembourg and elsewhere
- Focus on Engineering, Management and Technology, Computer Science, and Information Technology
- Offer old, new, and leading edge technologies.

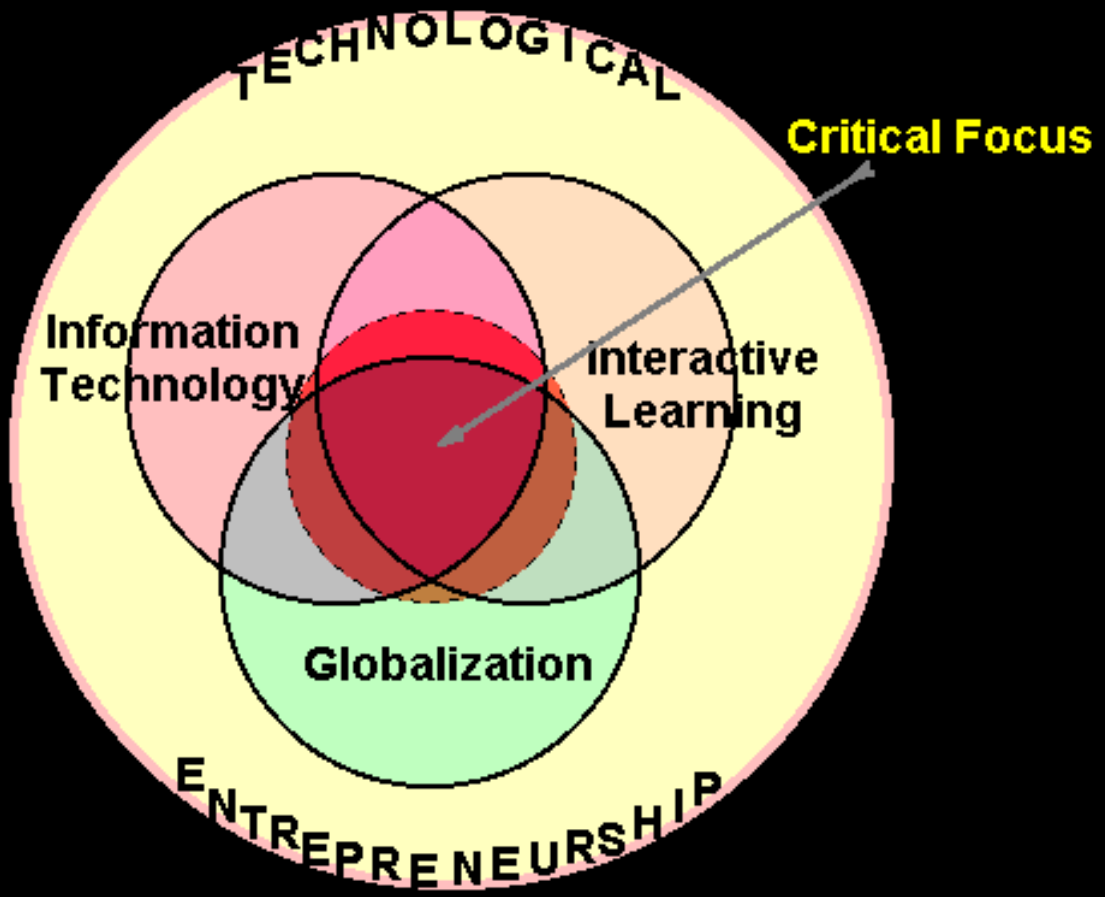
RSVP

- 10 Years +
- '93 Telecon "Best Distance Learning Program"
- '96 USDLA Industry-University Collaboration
- 944 Students in Credit/Degree Courses
- Several hundred more in short courses
- Bringing education to the workplace
  - (GM, IBM, Lockheed Martin, AT&T, Lucent, Con Ed, GE, UTC, Pratt &Whitney, Ford, Intel,Applied Materials, Matsushita, Bugle Boy, Albany International, Key Bank, +++++)

Technologies in Use

- Satellite Video
- ISDN Videoconferencing
- CD-ROM Creation
- Mail out materials
- World Wide Web materials
- ILINC LearnLinc
  - Desktop Video (multicast)
  - Network based materials management
  - Classroom management
- Software Spin Off: ILINC

Our Strategies



“Venture Capital”

- RSVP Reserve Fund
- Strategic Investment Fund
- Our Partners
  - Ex: HCI Certificate and IBM
- Operations

NTU-Rensselaer Course

Physics Education

- Satellite broadcast
- Hands On Exercises
- Synchronous Tutoring
- Asynchronous support

Wilson: http:\\cde.rpi.edu

NTU-Rensselaer Course

Hands-On World Wide Web

- Feb 10 & 17, 1998
- 8000 participants
- 500 sites
- Most successful NTU course ever
- “The future of satellite based education.”
  - Lionel Baldwin, President, NTU

Albany International Paper

- Management and Technology

  Gene Simons

  – North America
  – South America
  – Europe
  – Australia
  – Asia
- Face to Face first then PictureTel and Web

Rensselaer at Hartford

- Formerly Hartford Graduate Center
- Originally founded to provide graduate engineering education to Hartford corporations
- Merged last year
- Now 91% Management and 9% Engineering

Vision of the virtual classroom

- Student Centered
- Web of instructors, students, and resources
- Studio model of instruction
- Peer teaching
- Live video and audio plus canned multimedia
- Synchronous (~20%) & Asynchronous instruction
- Lowered unit cost of instruction

Oregon Graduate Institute

Physics Education

- 155 Faculty members
- 4 Student/Faculty
- Doctoral Students: 116 Full 23 Part
- Masters: 109 Full 168 Part
- Research: $12 million

OGI Fields

- Biochemistry and Molecular Biology
- Computer Science and Engineering
- Electrical and Computer Engineering
- Environmental Science and Engineering
- Management in Science and Technology
- Materials Science and Engineering