

Physics Education



Physics Education

**A focus on the introductory
course**

Undergraduates Too Often Shortchanged in the Past

Physics Education

- 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?

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“ ‘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

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

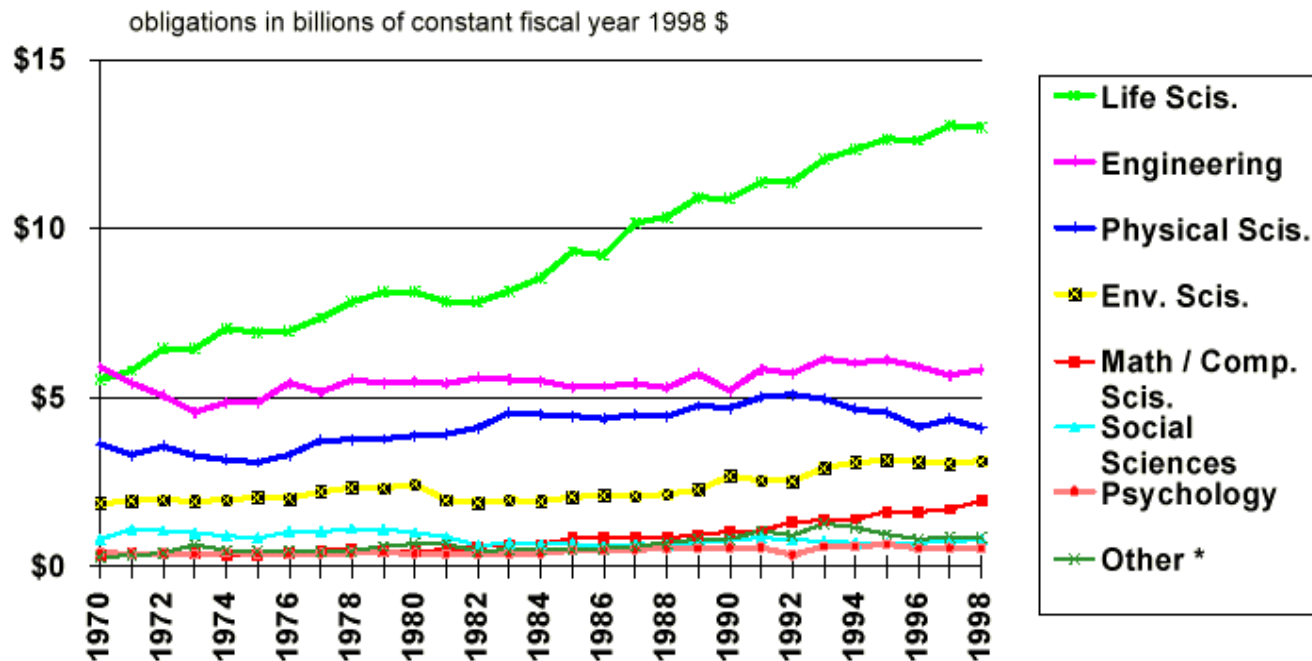
More bad news

Physics Education

- 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

Federal Support of Research : Trends FY 1970-1998



fiscal years
(1997 and 1998 data are preliminary)

Source: National Science Foundation, *Federal Funds for Research and Development FY 1996, 1997, and 1998, 1998.*

* - Other includes research not classified (includes basic research and applied research; excludes development and R&D facilities)

Some good news

Physics Education

- 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

- **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)

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Undergraduate Research

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- Increased use of Undergraduate Research



The Studio Classroom

Physics Education



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

Features of the Studio Courses

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

The old model

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

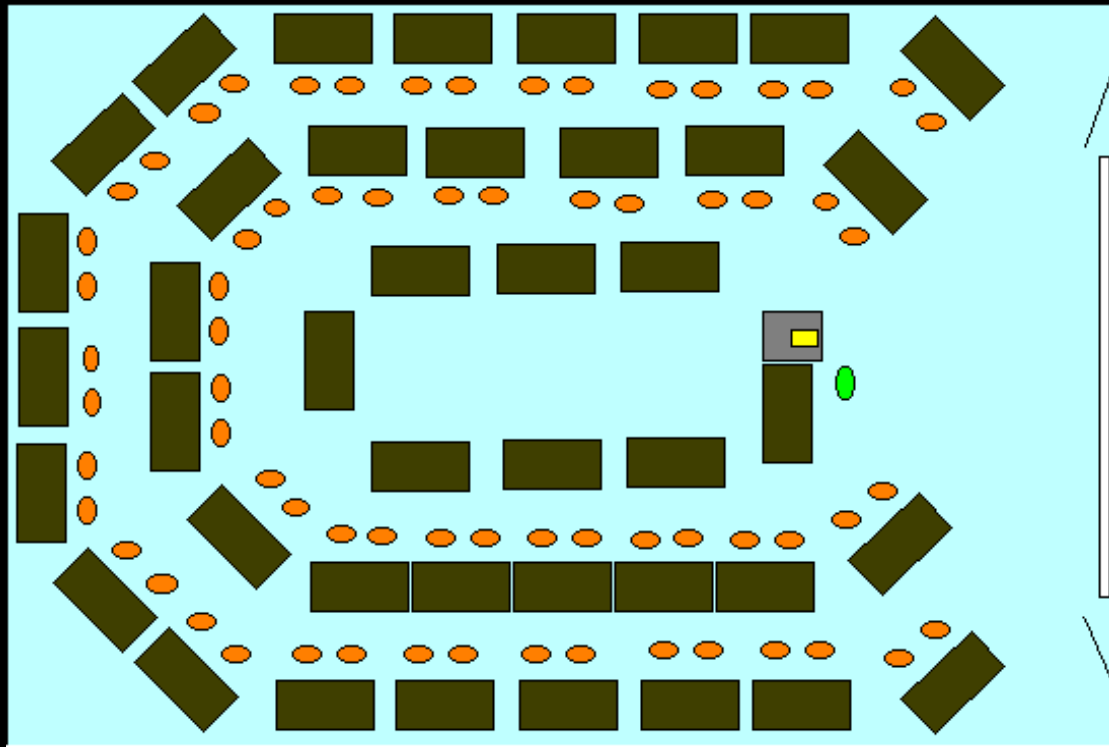
**Students working very hard
while the faculty listen
(rest?).**

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**Faculty working
very hard while
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(rest?).**

The Studio Classroom

Physics Education



The CUPLE Physics Studio

Physics Education

Traditional

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

Studio

- Credit Hours: 4
- Contact Hours 4



No more books?

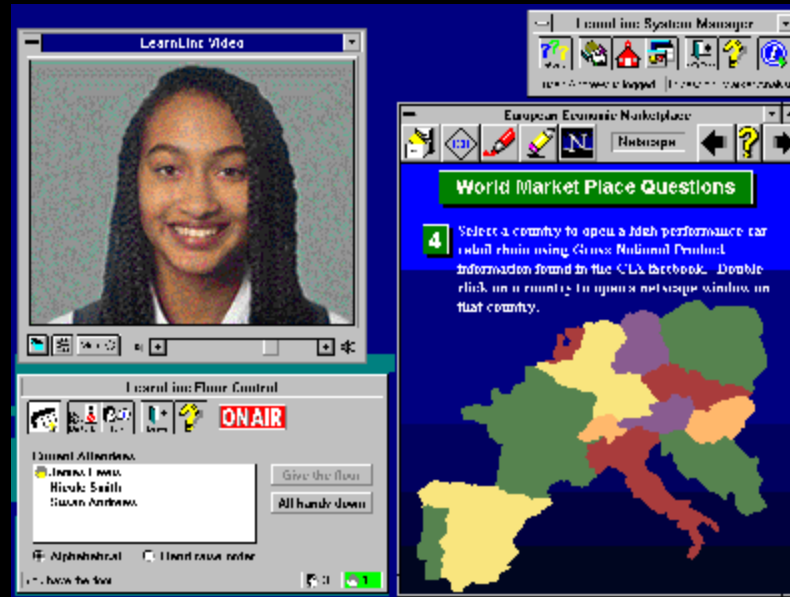
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- Of course! Texts
- Interactive Texts
- Web Access to Resources/Databases
- Full Motion Video
- Data Acquisition/Analysis/Visualization
- Live Links to Experts

Learning: The Killer App

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



Evolution of Computing

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- 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:

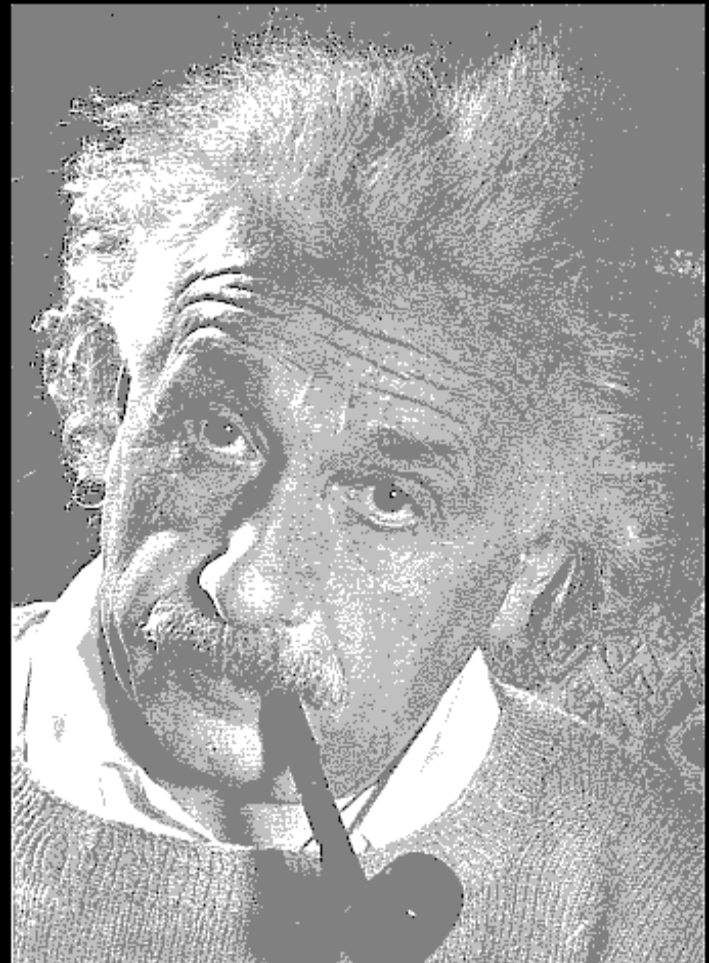
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- It is the worlds best communication tool combined with what will be the
- World's Largest Library
Creating the First and Only
- Global Continuous Learning Environment

What happens to me?

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- Will the Web or a CD-ROM Replace your Physics Professor?



Faculty fears and legislators hopes

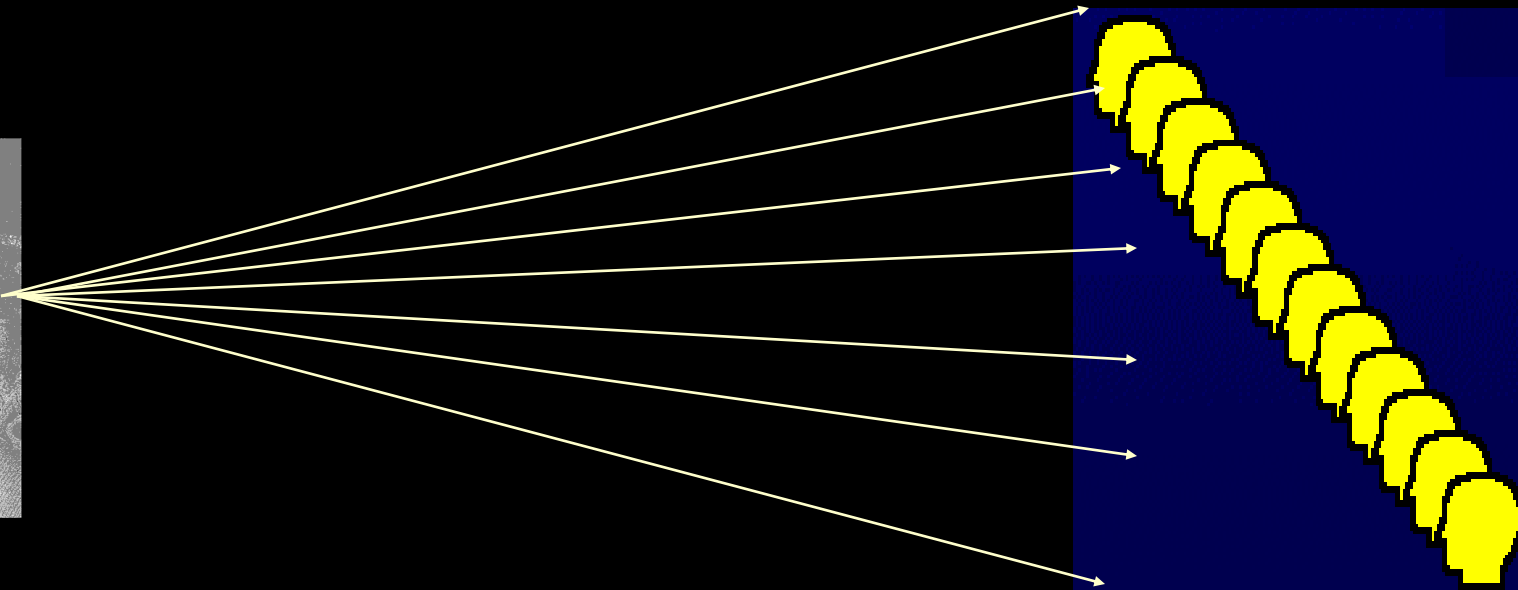
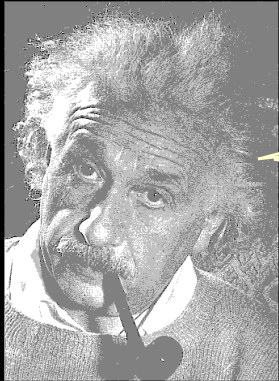
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- Prism: "If a student can zoom the best professors into his or her living room, then what is to happen to the rest of the countries professors?" (the mainframe model!)
 - In a word: hogwash.
- Presenting is not teaching!

The transmission model

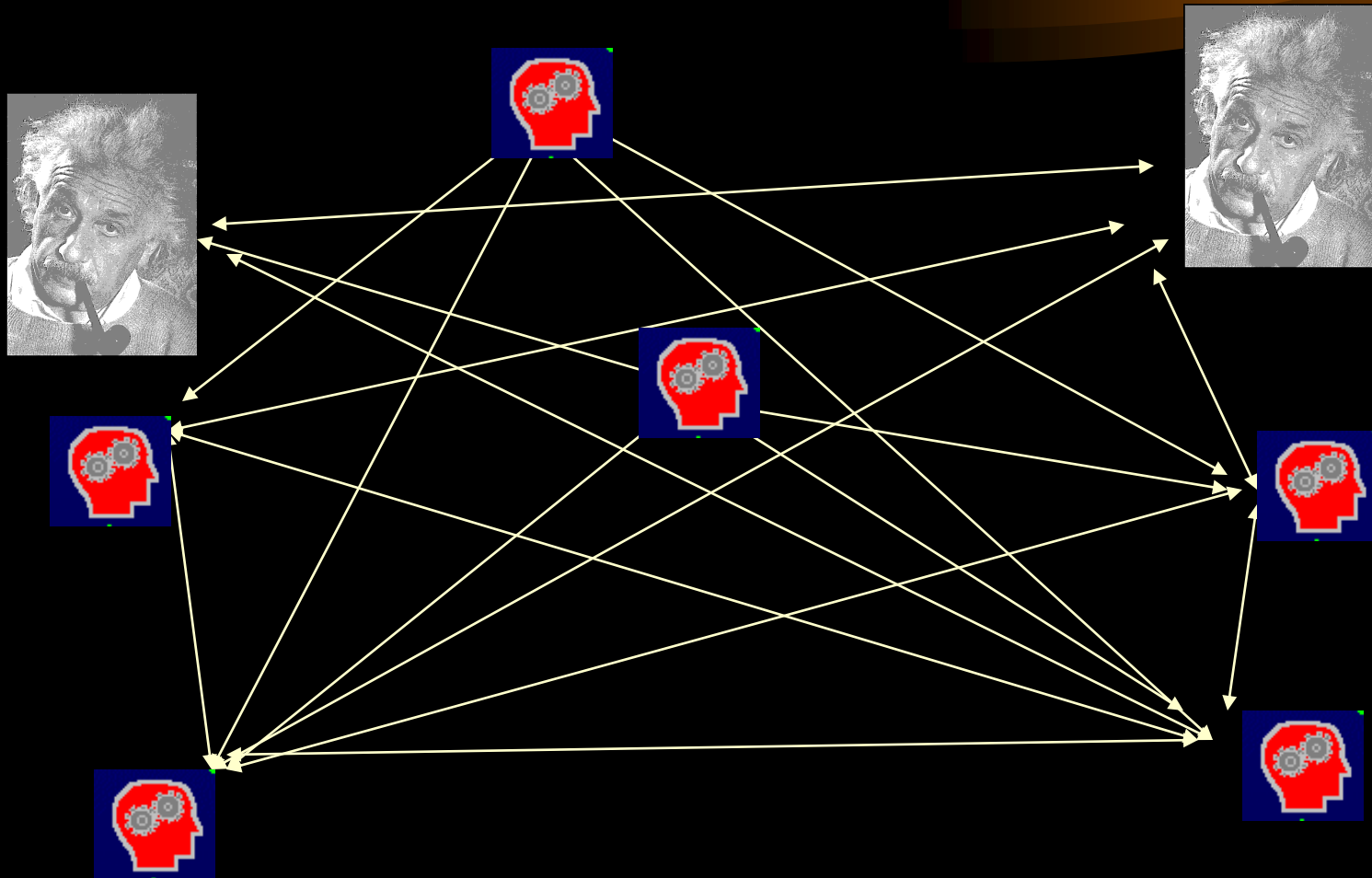
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- The mainframe approach



Distributed Collaborative Model

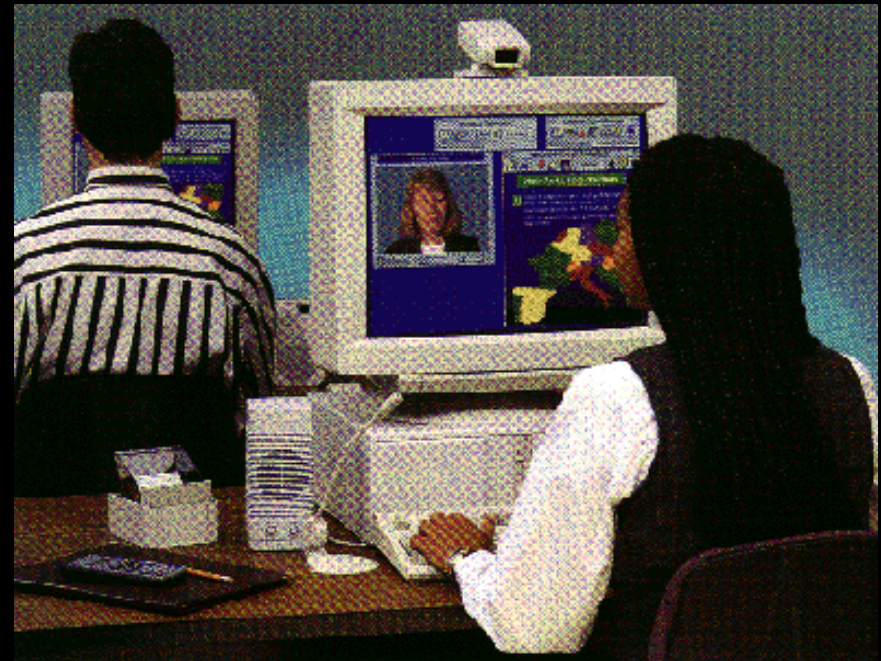
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The Virtual Classroom

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- Integrated Voice & Data
- Synchronized Content Delivery
- Hand-raising
- Floor passing
- Annotation
- Whiteboard
- Text Chat
- Q and A
- Feedback



Distributed Learning

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- Example: Chemical Mechanical Planarization

- RPI/Intel/Applied Mat./ Matsushita/IBM

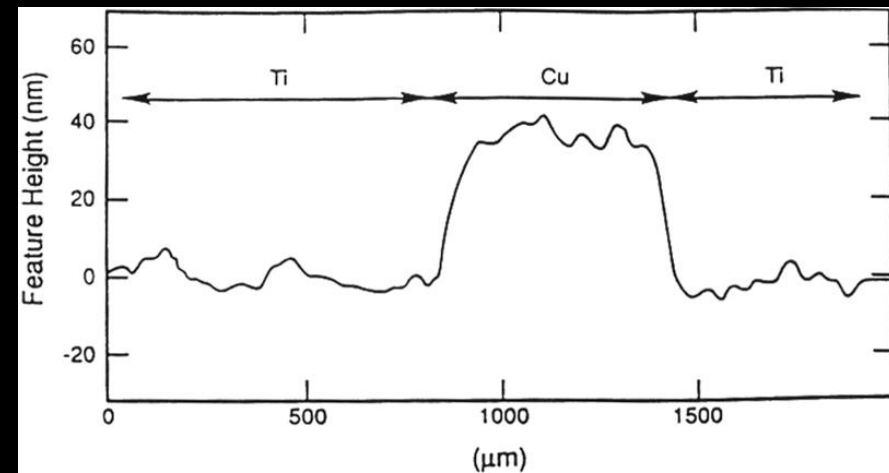
- ☒ (Introduction to Copper Metalization) (Wall Street Journal article)

- Month long course to the workplace.

- Video/Audio/ILINC Web data Conf.

- ☒ ISDN and Internet

- ☒ ProShare, PictureTel, Panasonic multipoint



Proposed Study

- Study initiation 13 May 1997 (Lederman)
- “to prepare a report that will promote improvements in the teaching and learning of physics, with a particular focus on the introductory undergraduate physics courses...”
- Case studies
- Recommendations
- Dissemination
- Phase II Follow progress

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Related work

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- 1991 Conference on the Introductory Physics Course
- APS/AAPT Joint Study (Hilborne)
- APS Forum on Education (Krane, Wilson +)
- Workshop for new faculty (Krane)

Additional Foci



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- Physics in the High Schools
- Advanced Undergraduate Physics
- Undergraduate Research

Deliverables



Physics Education

- NRC Report (~100 pages)
- Web site
- APS, AAPT, other AIP Meeting Sessions
- Participation: Physics Chairs Conference

The End



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