

## eLearning in Engineering:

# “ How Technology is Mandating and Transforming Continuing Education: Past, Present, and Future”

Jack M. Wilson,  
CEO, UMassOnline  
And  
Vice President, Professor  
The University of Massachusetts

# What shapes my views?

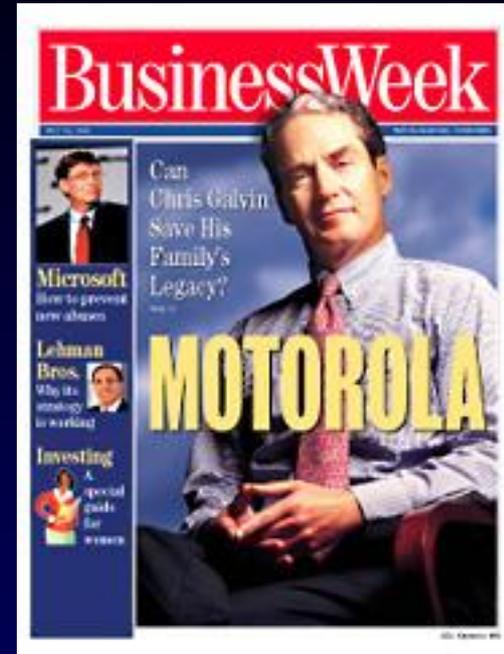
- Service as:
  - Founding Chief Executive Officer (CEO) of UMassOnline
  - 33 years as a professor, department chair, research center director, dean ( 4 times), and provost
  - Recently at RPI: J. Erik Jonsson '22 Distinguished Professor of Physics, Engineering, Information Technology, and Management.
- Founder, CEO, Chairman of LearnLinc
  - a successful eLearning Co
  - Now Mentergy Corporation (NASDAQ: MNTE)
  - Sold in February 2000.

# What else shapes my views?

- Industry Consultant (IBM, AT&T, Lucent, Ford, GM...)
- U.S. Army TRADOC Advisory Committee
- Pew Center for Academic Transformation (\$8.8 M)
- One of founders of the National Learning Infrastructure Init.(NLII)
- Chair, NY State Task Force on Distance Learning
- Former Executive Officer of AAPT (Physics) in Wash. DC: 8 yrs on Science Education: HS. and Univ.
- National Acad. of Science/National Research Council
  - Committees on Information Tech., Physics Decadal Overview Committee, and National Digital Library Committee
- Lots of visits, speeches, writing, reading, and visitors

# 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
- Ernest Smerdon said this yesterday



Robert Jones, who served with me and others on an ASEE/NSF team in China, was asked the question about whether to extend study to contract it.  
 ---Answer: both

# The horrible mismatch

- People change very slowly
- Technology changes very rapidly
- Do you feel like you are herding cats?



# Wilson's Favorite Laws!

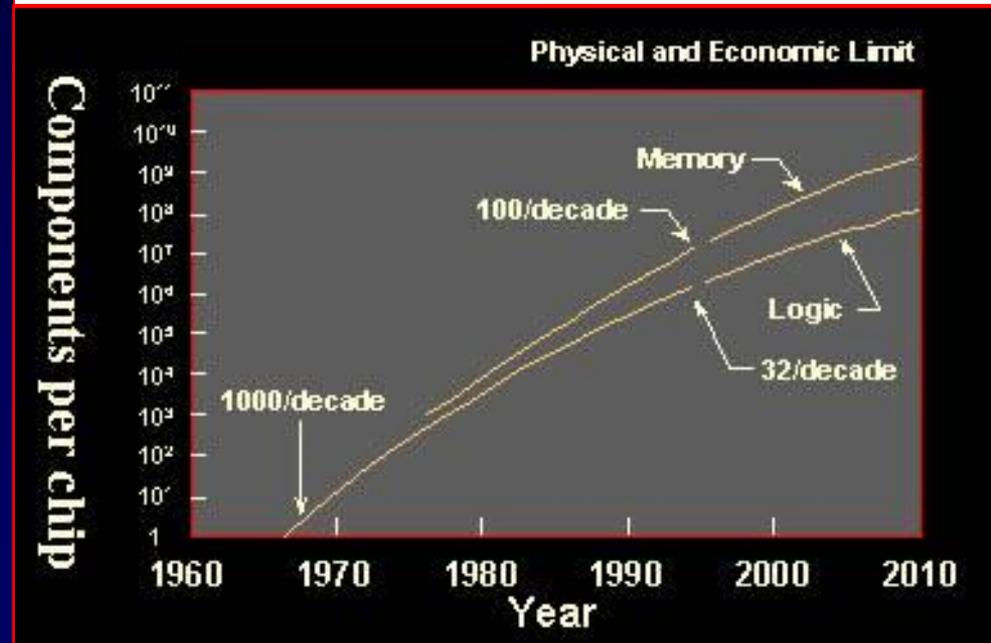
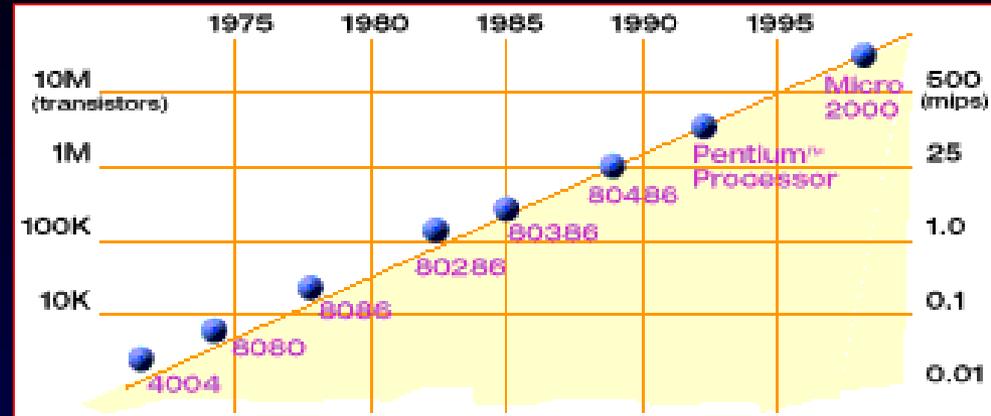


- I. Moore's Law:
- II. Bandwidth Doubling Law:
- III. Metcalf's Law:

# I. Wilson's Favorite Laws!

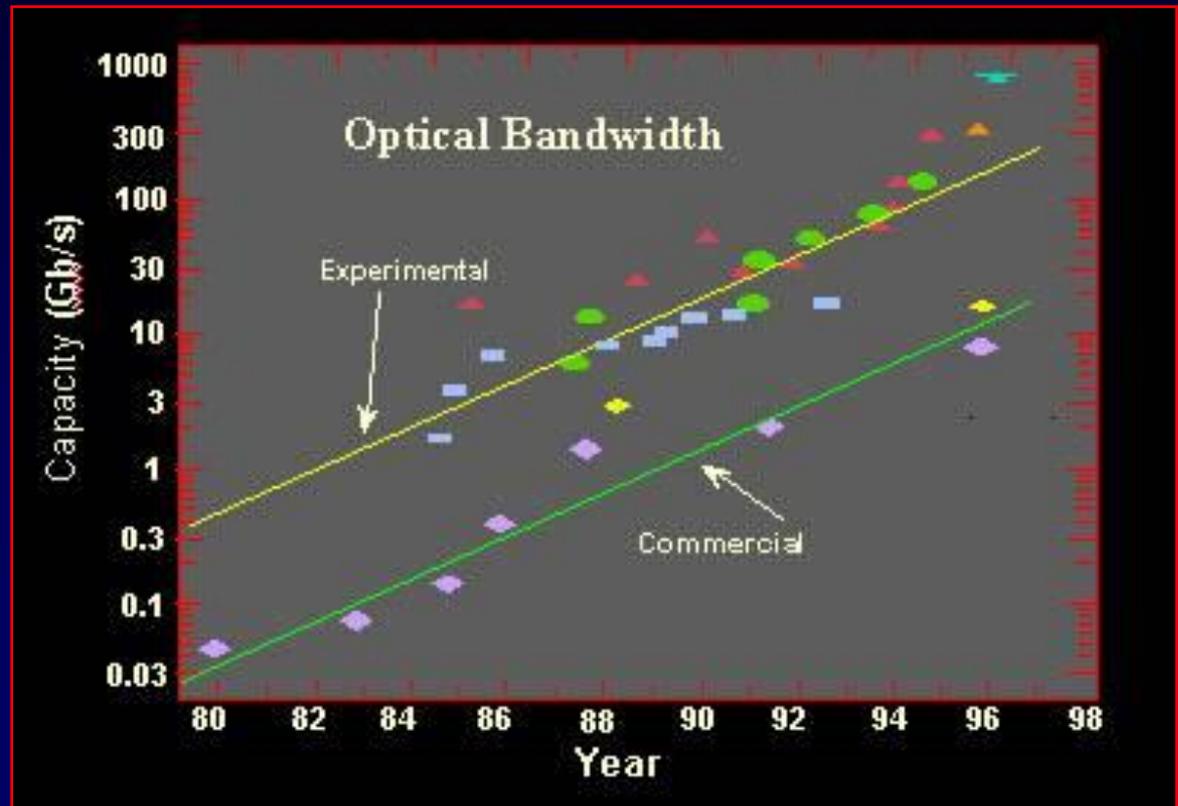
## I. Moore's Law:

- CPU performance doubles every 18 months.
- Cost of equivalent computing power halves
- Basic physics drives this.
  - CMP, etc.



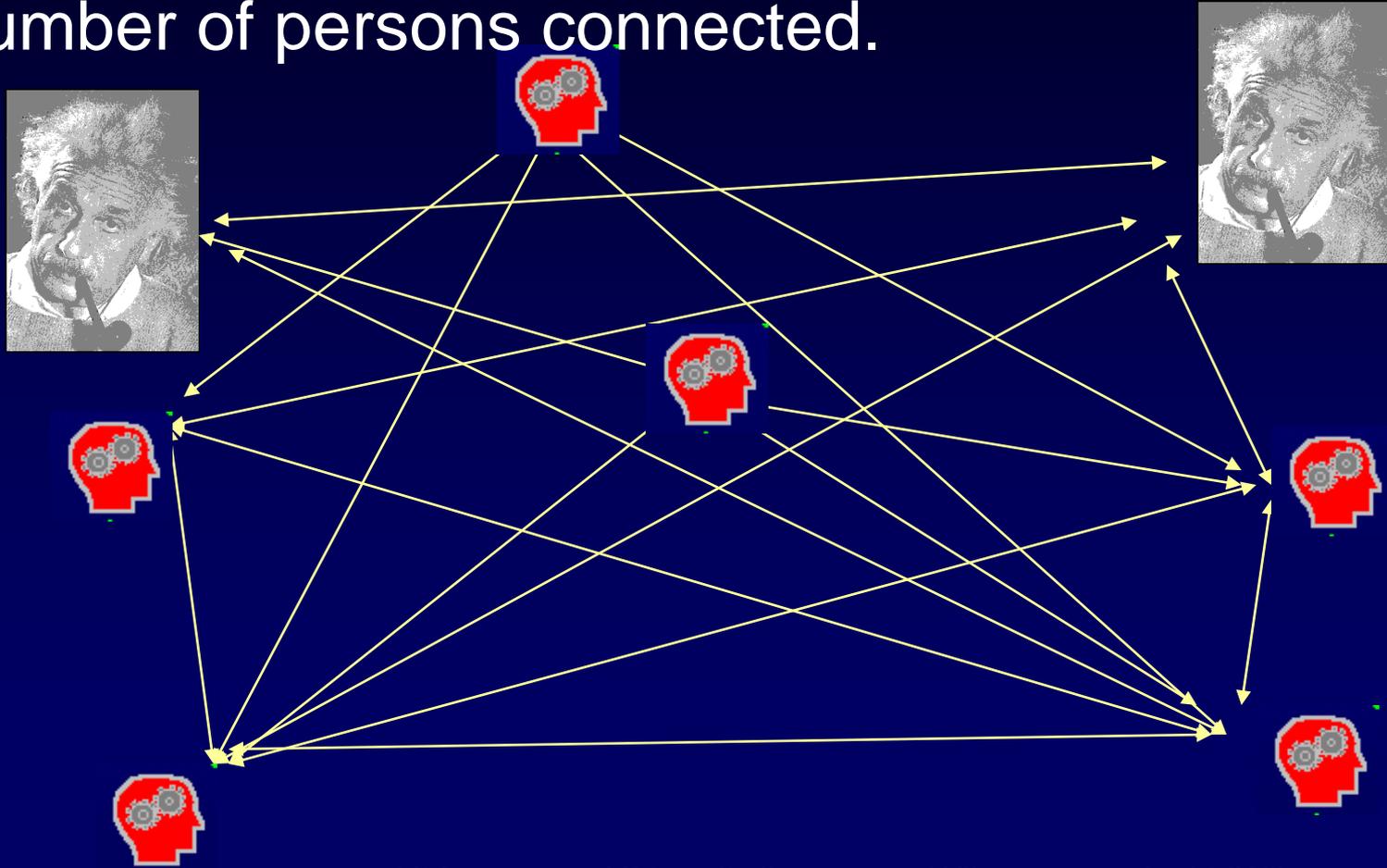
# II. Wilson's Favorite Laws!

- II. Bandwidth law:  
Bandwidth is doubling even faster!



# III. Wilson's Favorite Laws!

- III. Metcalf's Law:  
the value of a network scales as  $n^2$  where  $n$  is the number of persons connected.

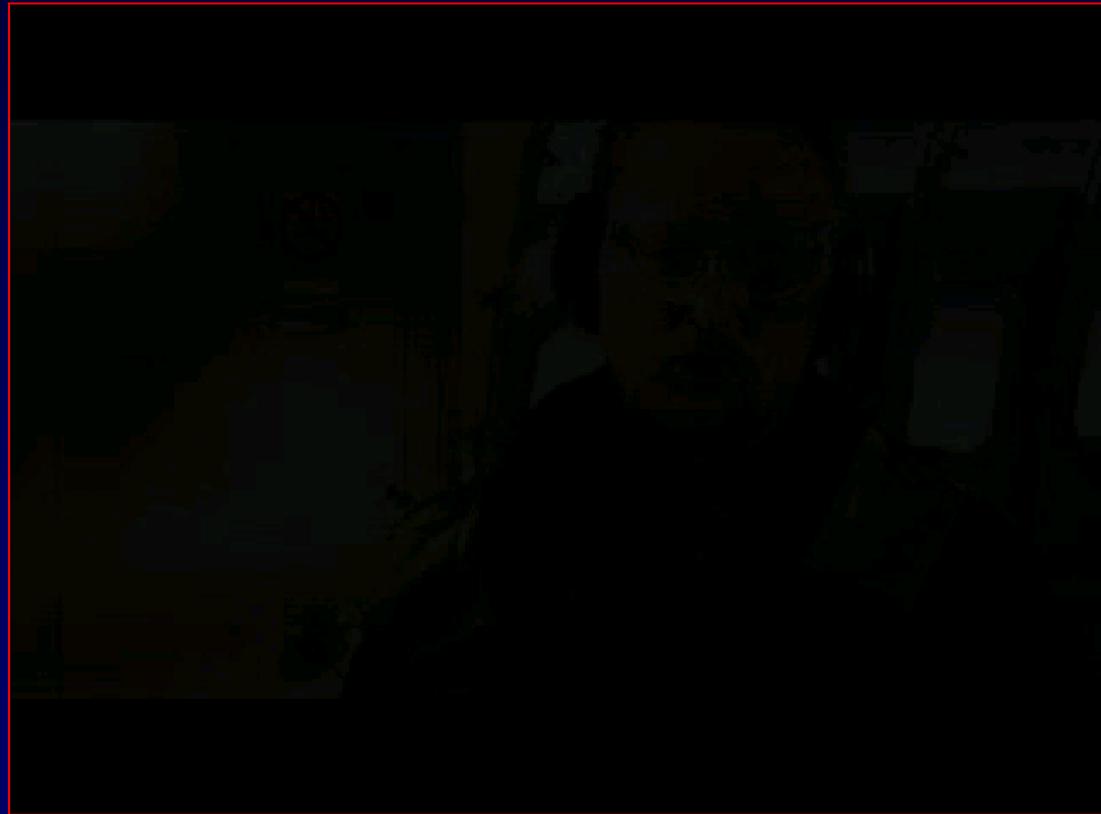


# The paradox of the Internet

- Engineers in the workplace face a difficult challenge.
  - How can they keep up with the pace of technical change and the new economy business environment when they find themselves overwhelmed with work and with little time for traditional educational programs?
- These eExecutives are ideal candidates for high quality and high flexibility learning environments.
- At RPI we designed a certificate for them in eBusiness at the graduate level.
  - The courses could also form part of their program for an MBA degree, an MS in Engineering Science, or an MS in IT.

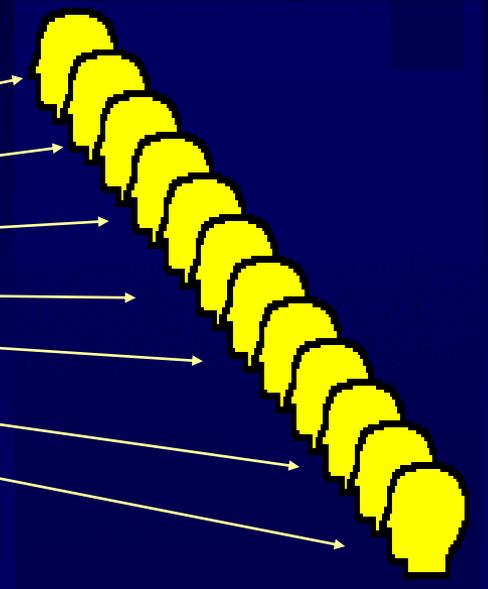
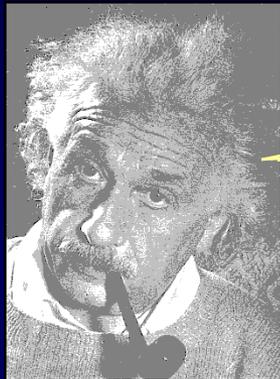
# Are you feeling a bit overwhelmed?

- The restructuring of the curriculum cannot be allowed to disrupt the students' experience
- Ever feel like you are building a plane in flight?

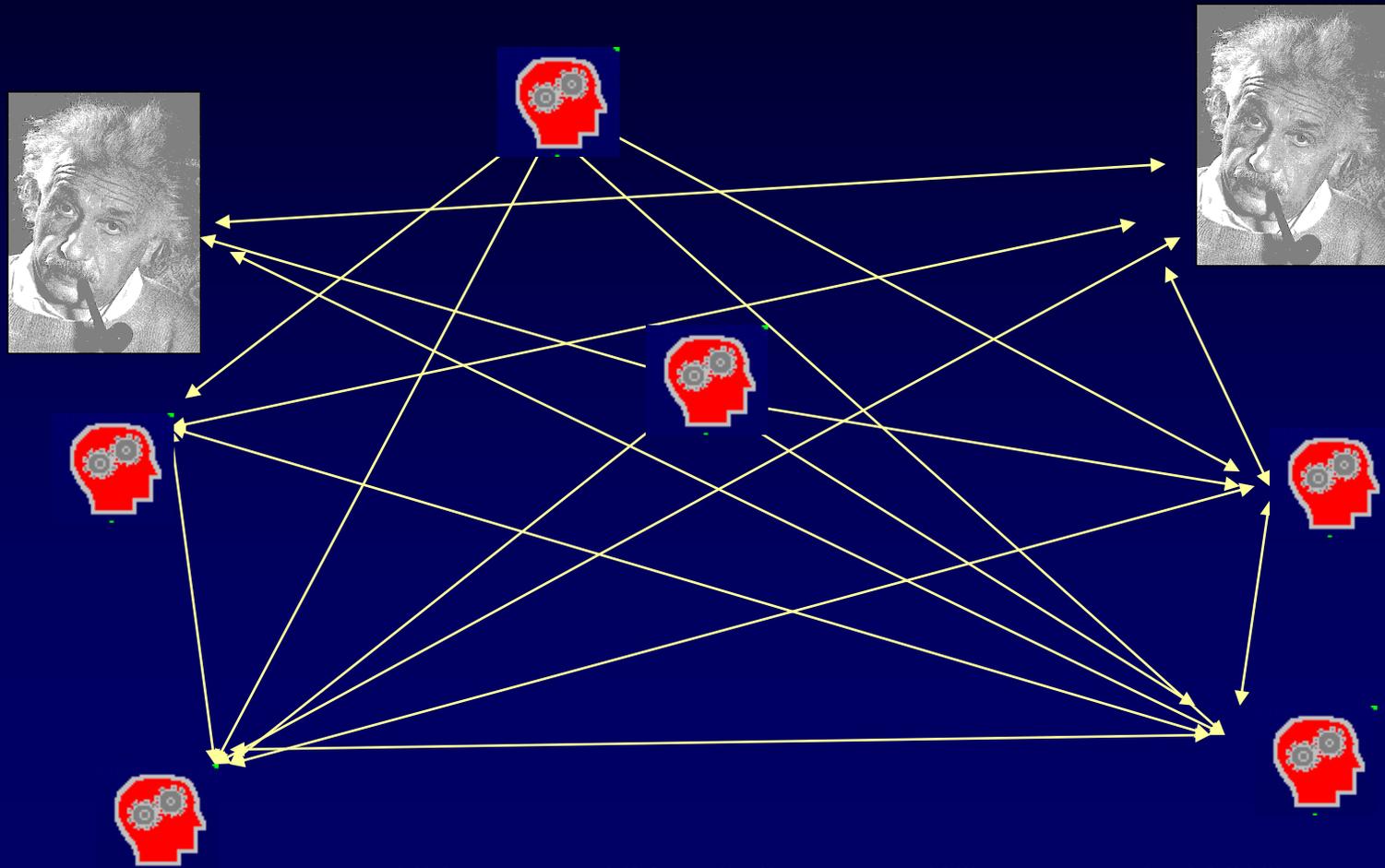


# The transmission model

- The mainframe approach
  - Face to Face: The Lecture
  - Distance: TV (Cable or Satellite)
    - Pushes the back wall out a few thousand miles

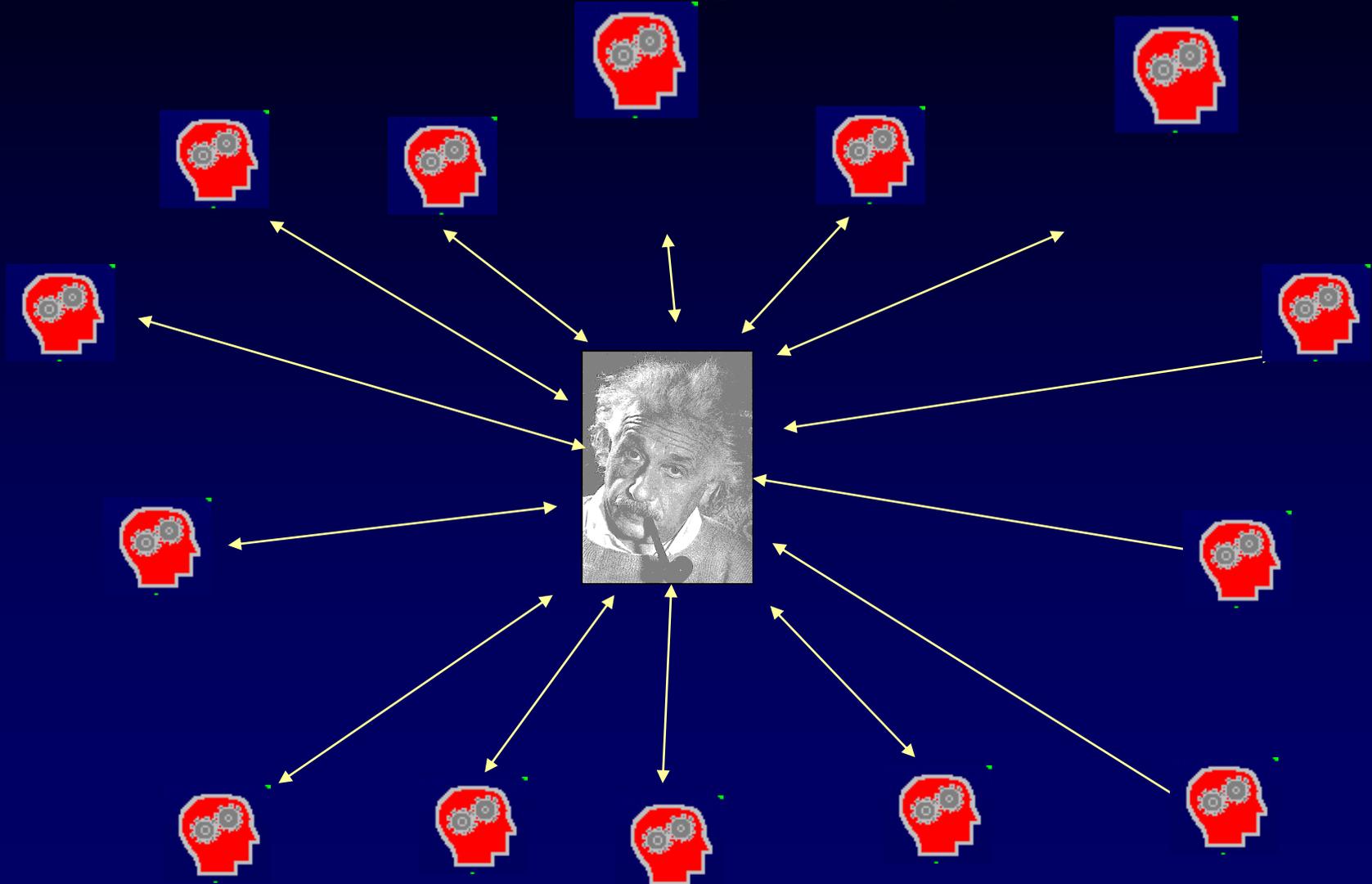


# Distributed Collaborative Model

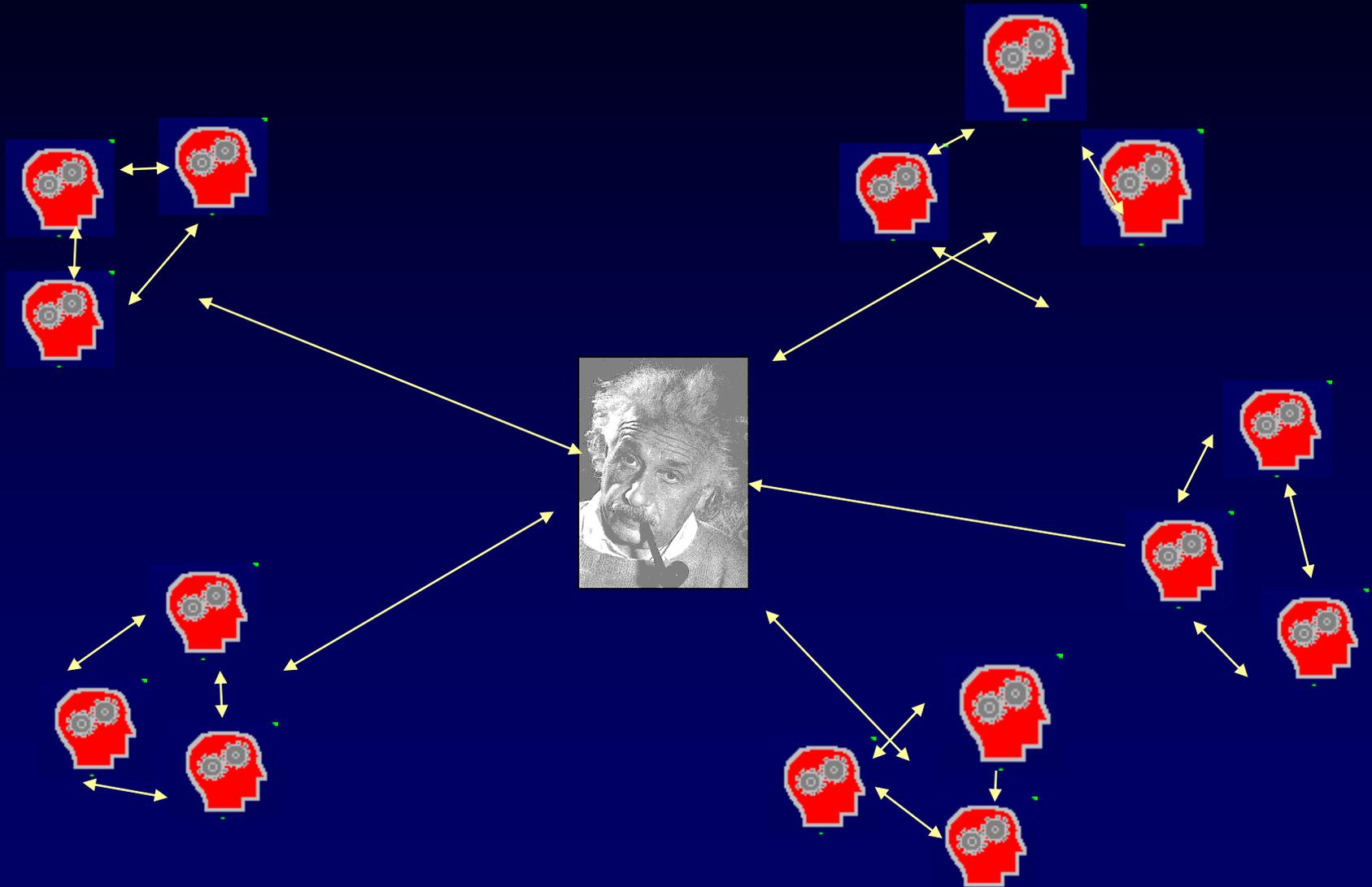


# How not to organize online learning.....

“The 24-Hour Professor;” Chronicle of Higher Ed; May 31, 2002



# Collaborative Learning, Peer Learning.....



# The Studio Classroom



- Hesburgh Award 1995
- Boeing Outstanding Educator Award 1995
- Pew Prize 1997
- Pew CAT \$8.8 million
  
- “The Studio is the future of education.”
  - Randy Hinrichs, Microsoft

# The Introductory Course



750 - 1100  
Students

Calculus (1100)

Physics (750)

Chemistry (650)

Intro. to Engineering Analysis (650)

Economics (~300)

(in the beginning)

# Example: RPI ECSE STRATEGY



- Move All Large Enrollment Courses (>50) to Studio Format
  - Timing Determined by Facilities
- Eliminate Traditional Lab Courses
  - (but **NOT** labs!)
  - Merge Labs with Theory Courses
- Add Hands-On Experiences to Courses That Now Have NO Associated Labs

# Studios in ECSE

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



# ECSE Studio Courses

## Some Examples

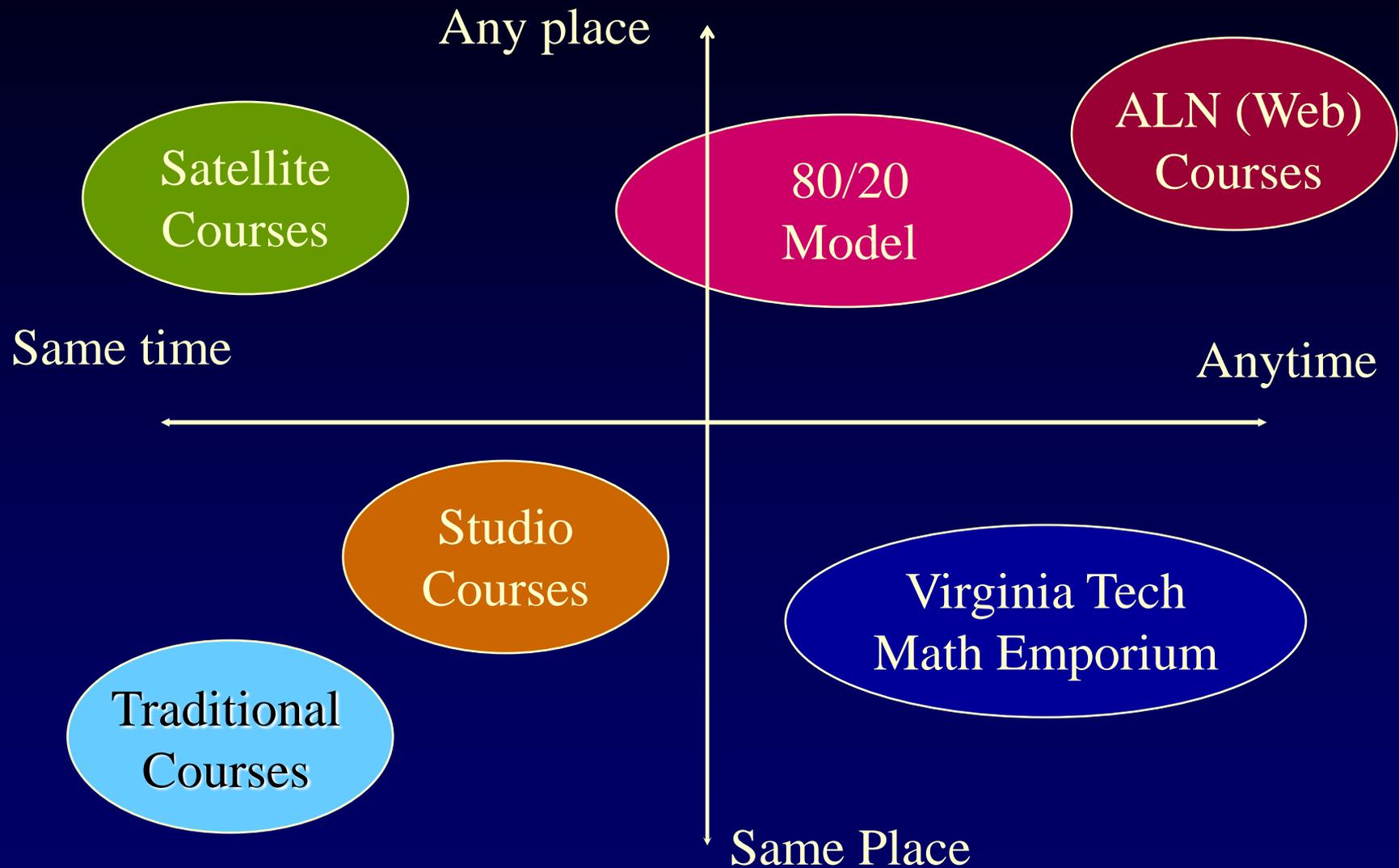
- Computer Components and Operation
- Computer Architecture, Networks and Operating Systems
- Laboratory Introduction to Embedded Control
- Electric Circuits
- Analog Electronics
- Microelectronics Technology
- Digital Electronics
- Electronic Instrumentation
- Fields and Waves I
- Signals and Systems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



# Student Mobile Computing @ RPI

- Laptop requirement
- 4 years of pilot
- cost crossover
- 4 year phase in
- student reaction
- faculty readiness
- key to affordability and pervasiveness

# The Studio at a Distance



# Studio at a Distance

- Delivery on standards based multimedia PC's equipped for live video/audio interactions and connected to a robust ip multi-casting network.
- A mix of synchronous and asynchronous activity.
- Use of Web and/or CD-ROM based multimedia materials.
- Use of professional quality software tools for CAD, symbolic math, spreadsheets, word processing, etc.
- Live audio and/or video interactions among the students and with faculty.
- Email interactions among the students and faculty.
- Small group discussions.
- Collaborative software for application sharing over the network.
- Access to rich resources on the network.
- Ability to “pass the floor” to students to allow them to lead the class through an activity.
- Course administration software to track student progress.
- Classes with a mix of students in traditional and workplace settings.
- Classes with a global perspective and global audience.

- 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, +++++)

# UMassOnline.net in AY 2003

- The Online University for Massachusetts: UMassOnline is a collaborative campus project that
  - involves the faculty, staff, and resources of all University of Massachusetts campuses
  - provides undergraduate and graduate degree programs, special certificate programs, and a few non-credit programs
  - serves working professionals who could not attend a campus.
- Total Enrollments: 11,239
- Tuition Revenue: \$ 9.112 million
- Growth rate: 50 % per yr
- Grants: \$ 2.43 million
- Undergraduate Programs: 17
- Graduate Programs: 20

# UMassOnline.net

- Built upon the successes of the 5 campuses.
- One of the largest in the U.S.
  - 11,239 enrollments in AY 2002-2003
- Portal: [www.UMassOnline.net](http://www.UMassOnline.net)
  - Launched in spring 2001
- Closely coupled to the University mission
- Operates over the M.I.T.I.  
(Massachusetts Information Turnpike Initiative)
- Received \$ 2.25 million IT Bond funding to create statewide platform in partnership with M.I.T.I.
  - Eventually open to all state institutions

- Professional Education for Engineering and Applied Science
  - M.S. & Ph.D. in Electrical and Computer Engineering
  - M.S. in Engineering Management
  - M. S. in Computer Science
  - Ripples and MANIC (<http://manic.cs.umass.edu/>)
  - Founding Member of NTU
    - (National Technological University)
- <http://peeas.ecs.umass.edu/fall2002/degreeinfo/index.html>

# Investing and Developing Programs

- Thirty Eight degree and certificate programs
  - Bachelor's, Master's, and Certificate programs
  - 12 new programs last fall
- Three of our programs have been recognized by US News and World Report as top on-line programs in the October 15, 2001 issue.
  - MBA – UMass Amherst
  - MEA – UMass Lowell – Ed. Administration
  - MPH – UMass Amherst- Public Health

# Serving Community Needs

- BSIT \*
- MSIT
- M.S. Joint Comp. Science Comp. Engineering
- Nursing \*
- MBA \*
- MPH \*
- MS Substance Abuse Professionals
- BLA – Liberal Arts \*
- Degree Completers and many others

# Graduate Programs

- M.S. in Electrical and Computer Engineering (VIP Amherst)
- M.S. in Engineering Management (VIP Amherst)
- M.S. in Computer Science (VIP Amherst)
- M.S. in Information Technology (Boston)
- M.Ed. for Science Teachers Program (Amherst)
- M.S. in Comp. Sci. and Comp. Engineering (Amherst)
- M.Ed. in Counseling: School Guidance (Boston)
- M.Ed. in Counseling: Mental Health Counseling (Boston)
- M.S.(Nursing) Community/School Health (Amherst)
- M.S. in Criminal Justice (Lowell)
- M.Ed.(M.Ed.) (Lowell)
- MBA Professional Program (Amherst)
- MPH in Public Health Practice (Amherst)

# Graduate Certificates

- Certificate in Photonics and Optoelectronics (Lowell)
- Certificate in Foundations of Business (Lowell)
- Certificate: Adapting Curriculum Frameworks for All Learners (Boston)
- Post Master's Nurse Practitioner Certificate (Boston)
- Certificate in Clinical Pathology (Lowell)
- Certificate in Foundations of Business (Lowell)
- Certificate in Instructional Technology Design (Boston)

# Undergraduate Degree Programs

- Bachelor of Business Administration
- Bachelor of Liberal Arts (Lowell)
- Bachelor of Science in Hotel, Restaurant, and Travel Administration (Amherst)
- Bachelor of Science in Information Technology (Lowell)
- Bachelor's Degree in Information Technology: Business Minor (Lowell)
- RN to Bachelor of Science (Nursing) (Amherst)

# Other Undergraduate Programs

- Associate of Science in Information Technology (Lowell)
- Certificate in Communication Studies (Boston)
- Certificate in Contemporary Communications (Lowell)
- Certificate in Data/Telecommunications (Lowell)
- Certificate in Fundamentals of Information Technology (Lowell)
- Certificate in Intranet Development (Lowell)
- Online Communications Skills Certificate (Dartmouth)
- Certificate in Multimedia Applications (Lowell)
- Certificate in Community Media and Technology (Boston)
- Criminal Justice Series (Amherst)
- Certificate in UNIX (Lowell)
- Fundamentals of Arts Management Certificate Program (Amherst)
- Certificate in Plastics Technology (Lowell)
- Certificate in Technical Writing (Boston)

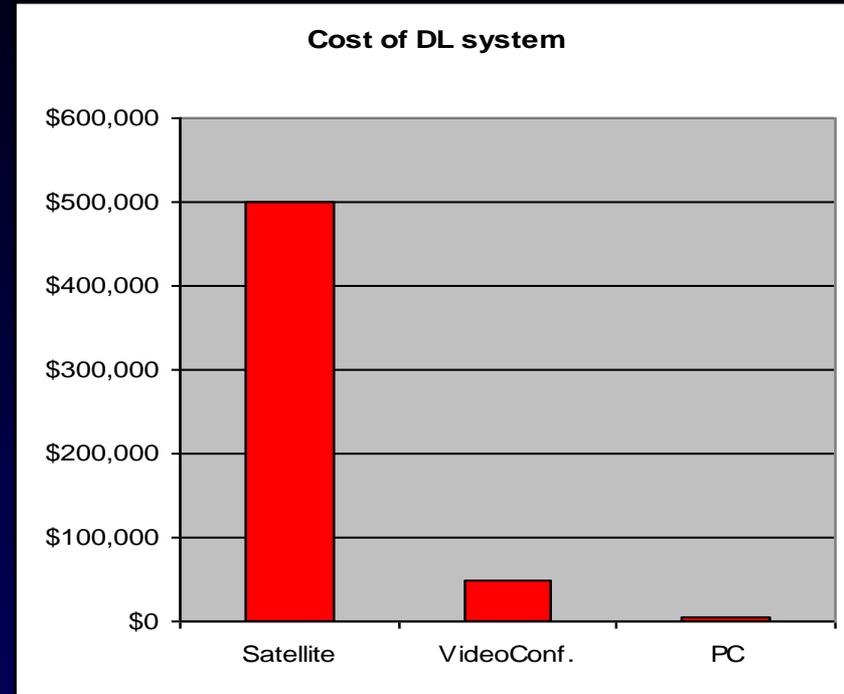
# Technologies in Use

- Satellite Video
- ISDN Videoconferencing
- CD-ROM Creation
- Mail out materials (including videotapes and/or CD's)
- World Wide Web materials
- Asynchronous Tools: Prometheus and IntraLearn
- Streaming Video
- Live-Online Learning (LearnLinc or Centra)
  - Desktop Video (multicast)
  - Network based materials management
  - Classroom management

# Cost Deflation

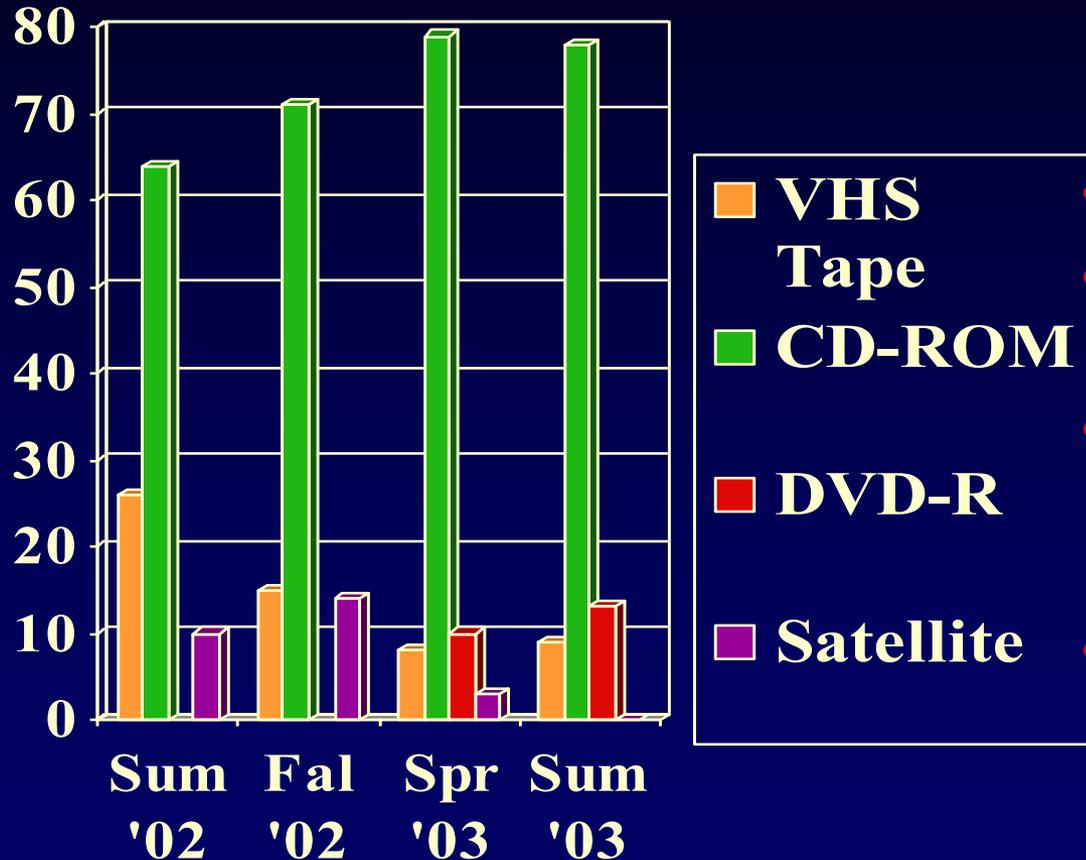
- Satellite Video
  - (\$500,000)
- ISDN Videoconferencing
  - (\$50,000)
- PC Collaborative
  - (\$2,000)
- CD, DVD or Web Based Asynchronous
  - (\$2,000)
- Live Online Learning (LearnLinc, Centra, etc)
  - (\$2,000)

(Cost is being radically reduced)



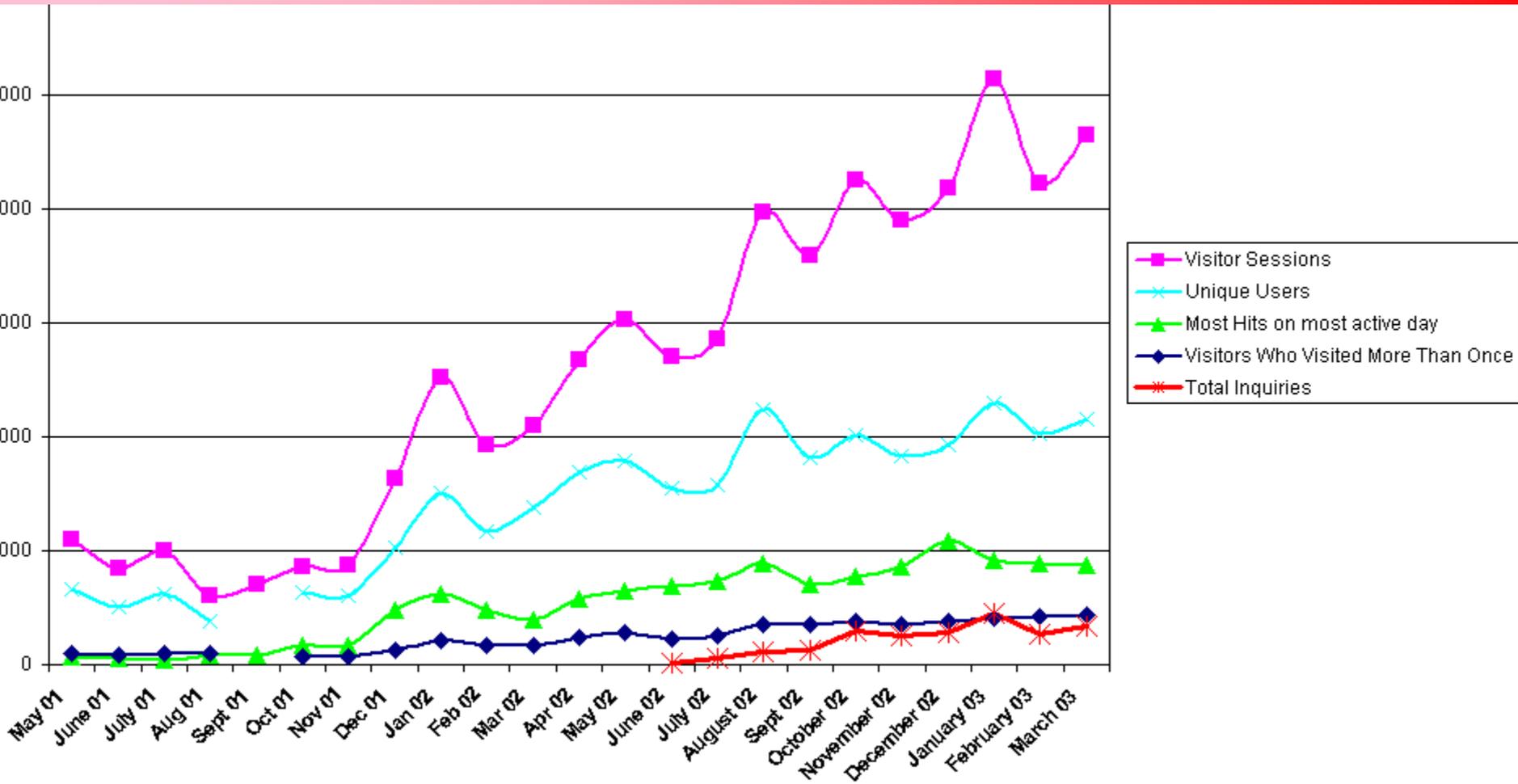
# VIP – UMass Amherst

## PROFESSIONAL EDUCATION FOR ENGINEERING AND APPLIED SCIENCE



- Prior to Fall 2001 primary delivery via VHS tape and satellite
- NTU Co-founder
- 2002 delivery shifts to CD-ROM
- 2003 includes delivery via DVD-R
- Summer 2003 discontinue Satellite

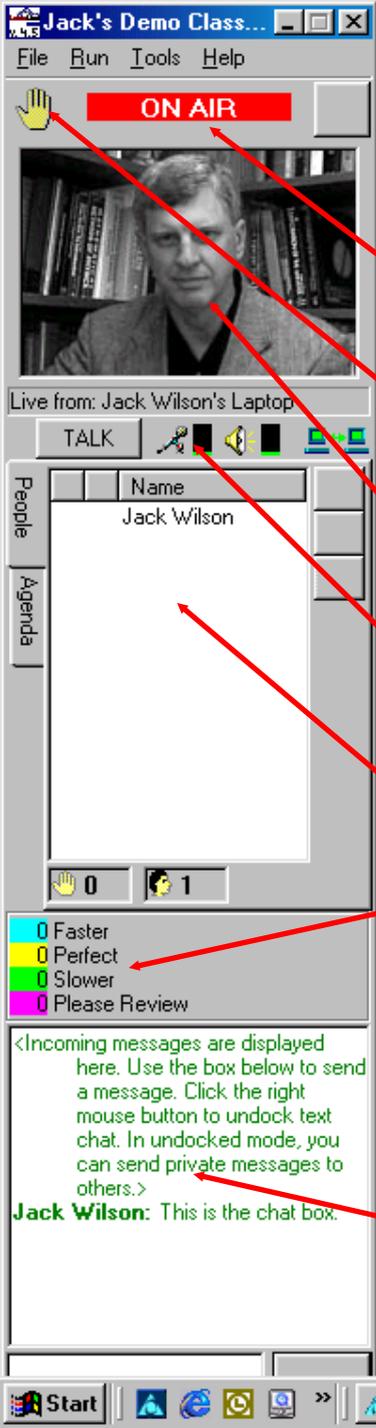
# Portal Traffic



# Introduction to eBusiness



- One night per week from 6:30-8:30 pm
  - Fall 2000: 50 On Campus & 75 Off Campus Students
  - Spring 2001: 75 overflow students (25 on and 50 off)
    - IBM, Ford, GE, Lockheed Martin, Pratt and Whitney, Ford, Consolidated Edison, NY Power, J. P. Morgan, Carrier, Otis, etc.
  - Extensive Website:
    - <http://www.jackmwilson.com/eBusiness/Syllabus-Spring2001/>
  - MBA, MSIT, MS in Engineering Science
  - miniLectures, Discussion, Student presented cases, & asynchronous interactions



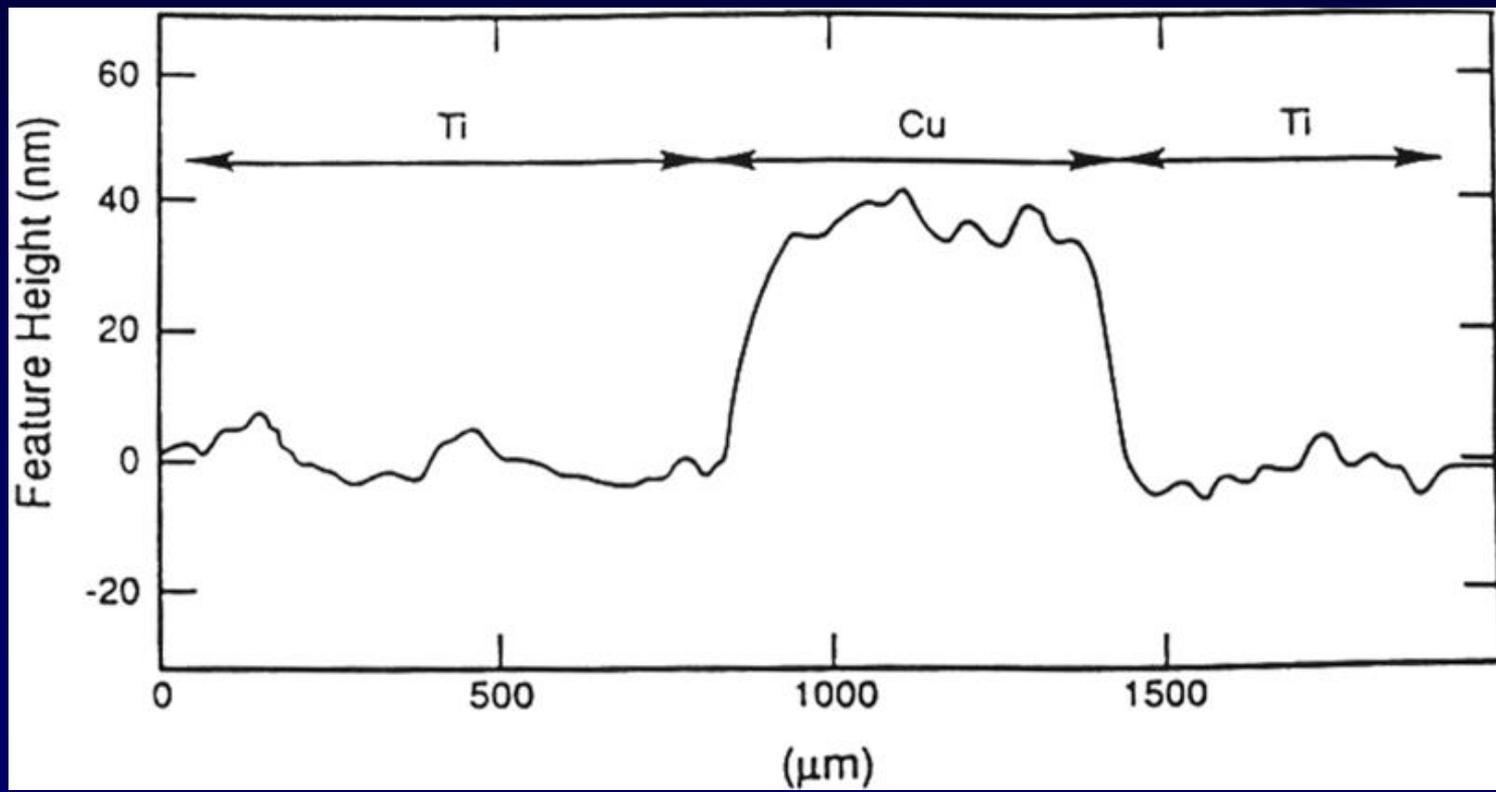
- On- Air indicator
- Raise your hand
- Picture or video of speaker
- Audio and Network controls
- Agenda or class roll
- Feedback section (also Q n A)
  - (can be pace, agreement, T/F, Yes/No, etc.)
- Chat Window (also Whiteboard etc.)

# 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

# Chemical Mechanical Planarization

- Profilometer 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.



# NTU-Rensselaer Course

## Hands-On World Wide Web

- 1998
- 8000 participants at 500 sites
- Satellite broadcast
- Hands On Exercises
- Synchronous Tutoring
- Asynchronous support
- “Most successful NTU course ever”
- “The future of satellite based education.”
  - Lionel Baldwin, President, NTU



# 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

# Remote Physics Course

- Introductory Calculus Physics
- Live On-line
  - Delivered via ILINC **LearnLinc**
- Cobleskill High School in rural upstate NY
- Collaborative between the physics teacher at Cobleskill and faculty and graduate students at Rensselaer



**LearnLine Client**

File Run Tools Help

**Nichole**



Live from: San Francisco, CA

Mute

**People**

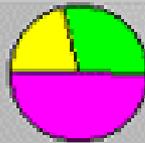
Name

- Isaiah Beres
- Owen Carter
- Tom Elliot
- Wally Emerson
- Ben Frank
- Geoff Gamache
- Alicia Hoffman

**Agenda**

2 25

- 0 Not much progress
- 5 Still working
- 7 Almost finished
- 13 Completed



**Note:** Yes. Could you please review the chapter on formating graphs in Excel?

Raise your hand when you see the AppShare window.

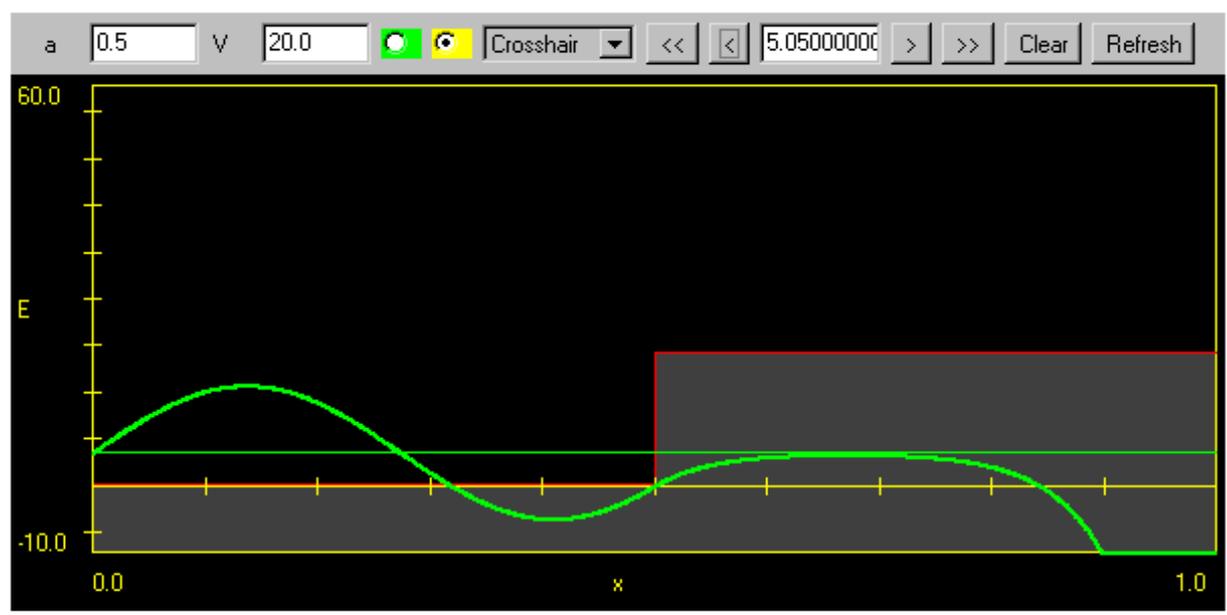
**SquareWell - Microsoft Internet Explorer**

File Edit View Favorites Tools Help

Back Forward Stop Refresh Home Search Favorites History Mail Print Edit Discuss

Address <D:\JavaPrograms\cde\SquareWell.html> Go Links

**This illustrates the solution of a quantum well with an infinite wall at  $x=0$  and a finite potential of 20 V at  $x=0.5$  nm. - Jack Wilson**



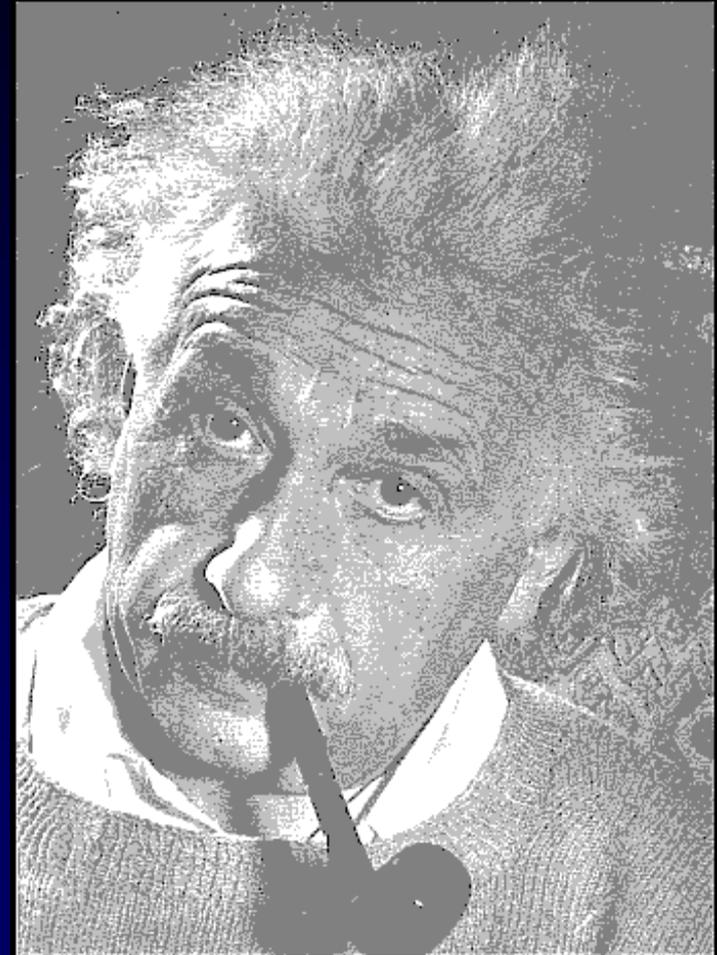
**Author: Jack Wilson**

Using the buttons to each side of the Energy window, you can adjust the energy of the particle in the well to see if the energy leads to a bound state. In a bound state the wavefunction will satisfy the boundry condition at infinity (on the right). It must go to zero to do that. You should find several bound states of the particle for the energy selected here.

Notice that you can select various annotation possibilities, including "Crosshair," "Derivative," "Integral," and "Chalk." You can use each one in combinations with the mouse and mouse button.

# 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!

# TE<sup>3</sup> Ten Commandments

1. Restructure around the learner. Neither over-emphasize nor under-emphasize technology.
2. Build upon research results, which inform design; don't try to reinvent the wheel.
3. Remember that technology has an intrinsic educational value beyond helping students learn better.
4. Do systematic redesign and not incremental add-ons. There is always a tendency to just add on a few computer experiences to everything else. By definition this costs more, is more work for faculty, and adds to the students' burden.
5. Benchmark your plans and build upon examples of systematic redesign. Do not automate the lecture. Find the best examples and build upon them.

\* TE<sup>3</sup> = TEEE – Technology Enhanced Engineering Education

# TE<sup>3</sup> Ten Commandments

6. Count on Moore's law ("What is hard today is easy tomorrow"). - *For example, CPU power and bandwidth have consistently improved.*
7. Cost is an important aspect of quality. There is no lasting quality if there has been no attention to cost. - *There are more than enough examples of expensive high quality solutions. We need inexpensive high quality solutions!*
8. Avoid pilots that linger. Design for a large scale and pilot projects only as a prelude to scaling up. *It is easy to design innovative educational experiences that work for small groups. It is harder to address the needs of the 1000 students taking calculus I at the large research university.*
9. Develop a balance between synchronous and asynchronous distributed learning.
10. There is no longer any way to do good scholarship without technology, and there is no longer any way to teach good scholarship without technology.

# Helpful links

- UMassOnline: [www.UMassOnline.net](http://www.UMassOnline.net)
- Pew Center for Academic Transformation  
– <http://Center.rpi.edu>
- Pkal; [www.pkal.org](http://www.pkal.org)
- Hesburgh awards – faculty dev. Focus
- Pew Prizes – institutional focus
- EDUCAUSE- [www.educause.org](http://www.educause.org)
- Syllabus – [www.syllabus.com](http://www.syllabus.com)
- EdMedia - <http://www.aace.org/conf/edmedia/default.htm>
- TLTR and Flashlight: <http://www.tltgroup.org/>

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**The End**

# The Studio at other Universities

- **The University of Amsterdam** (<http://www.science.uva.nl/research/amstel/>)
- **Penn State University** (<http://www.science.psu.edu/facaffairs/strategic.htm> )  
(<http://www.psu.edu/ur/archives/news/GE.html> ) (<http://dps.phys.psu.edu/about.htm> )
- **Arizona State University** (<http://www4.eas.asu.edu/phy132/> )
- **Indiana State Univ.** (<http://physicsstudio.indstate.edu/> )
- **Cal Poly San Luis Obispo** (<http://www.cob.calpoly.edu/Evan/polyplan/polyplan.htm>)  
(<http://chemweb.calpoly.edu/phys/> )
- **Ohio State University** ([http://www.physics.ohio-state.edu/~ntg/26x/2064\\_pictures.html](http://www.physics.ohio-state.edu/~ntg/26x/2064_pictures.html) )
- **The University of Amsterdam** (<http://www.wins.uva.nl/research/amstel/> )
- **The University of New Hampshire** (<http://einstein.unh.edu/academics/courses/> )
- **Curtin Univ. of Tech. (Australia)** (<http://www.physics.curtin.edu.au/teaching/studio/> )
- **Univ. Of Mass. –Dartmouth** (<http://www.aps.org/meet/CENT99/BAPS/abs/S3455002.html> )
- **The Colorado School of Mines** (<http://einstein.mines.edu/physics100/frontend/main.htm>)
- **Acadia Univ. (Canada)** (<http://ace.acadiau.ca/math/boutilie/> )
- **Santa Barbara City College**  
([http://www.cs.sbccc.net/physics/redesign/final\\_report/reportb.html](http://www.cs.sbccc.net/physics/redesign/final_report/reportb.html) )