Integrating Synchronous and Asynchronous Internet Distributed Education for Maximum Effectiveness

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Caveats

- The ideas described here have been used extensively in graduate education for Computer Science and Information Technology. The author contends that they are applicable to other disciplines, particularly to the sciences. However, this will be a matter of conjecture until it is tried.

- The work described here has been focused on *providing the most accessible and effective learning environment for the largest number of students* via low-cost, Internet-based technologies. It is highly likely that even more effective combinations of teaching/learning technologies will be developed as time and cost permit.

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Presentation Outline

- Two schools of thought
- Low-cost synchronous online education
- Characteristics of synchronous and asynchronous modes
- Blending the two modes with classroom teaching
- Innovations to support economies of scale
- Student outcomes
- Summary/conclusions

Two Schools of Thought

- The majority of Internet-based distance education today is delivered asynchronously, via webpages
  - Natural progression from earlier "correspondence courses" and course library compilations
  - Web offers faster delivery, flexible linkage
- However, a growing fraction is delivered synchronously, as it is being taught
  - Progression from TV and VTC teaching
  - But offers interaction, desktop delivery, high quality graphics, and replay

Which is Best?

- Research shows students learn about as well either way
  - "no significant difference"
- So, "best" would mean a system that
  - Minimizes student time to learn the same amount of material
  - Minimizes faculty time to present
  - Minimizes institutional cost to deliver

Background:
Low-cost Synchronous
Online Education

## Low-Cost Synchronous Online Education

- Ubiquitous Internet offers greater accessibility of education
  - Electronic delivery of course materials
  - Real time delivery of courses
  - GMU has been a pioneer
- Combination of synchronous & asynchronous delivery
  - Live streaming of class accessed through Web interface
  - Playback of streaming delivery
  - Course materials accessed via webpages
  - Supporting Learning Management System
    - Accessed by Web
    - With links to Playback for review
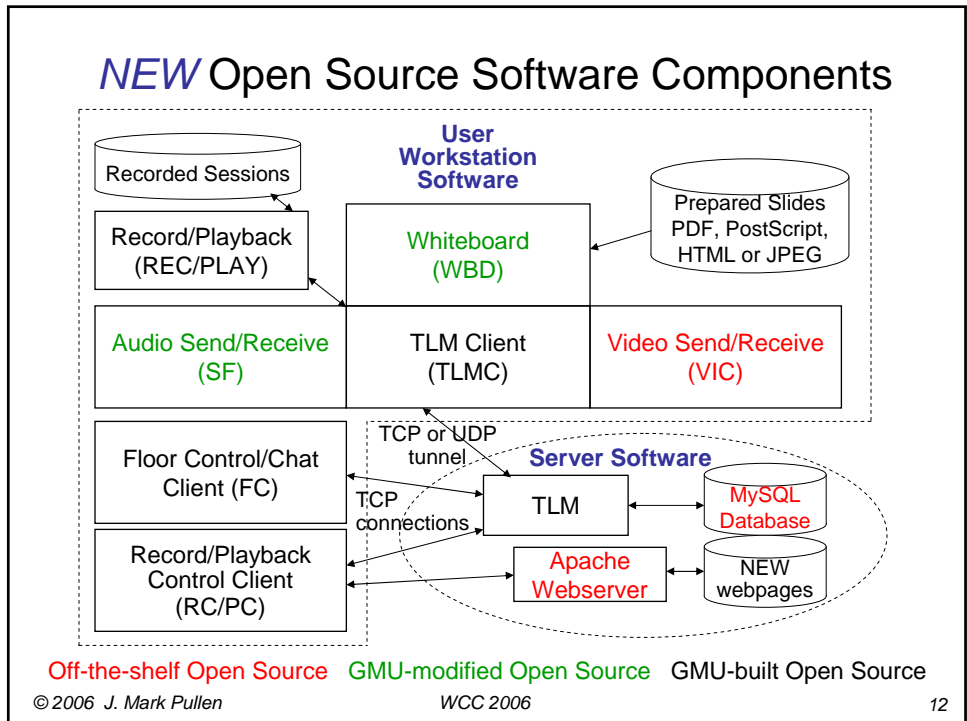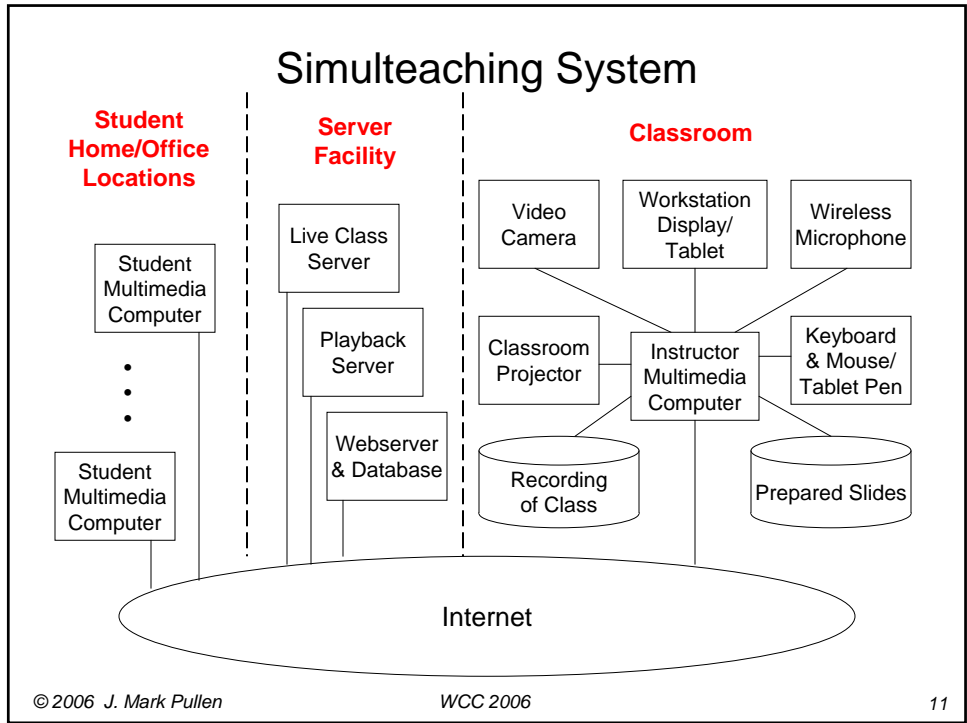
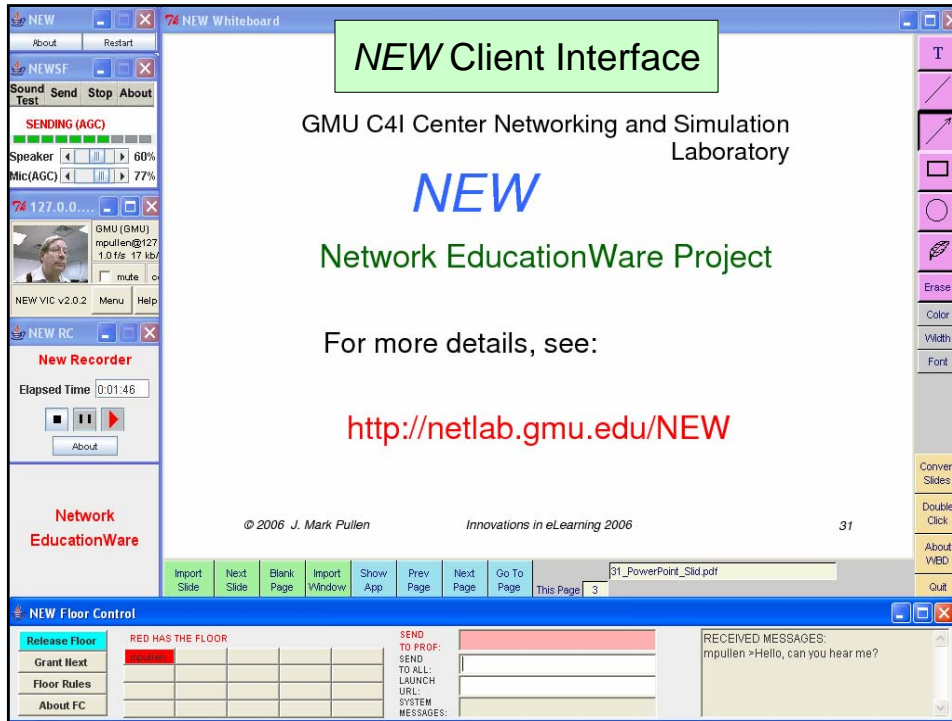## Temporality of Student Interaction
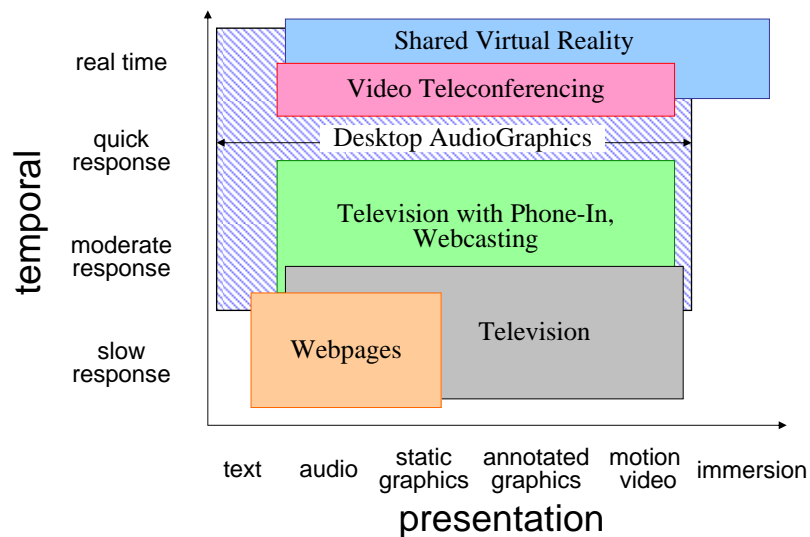
The *Simulteaching* Model

- Regional online course delivery
  - Avoids long travel time to attend class
- Students may attend in-person or online
  - or time-delayed via recording
- Classroom and online students have equal access to class and opportunity for interaction
- Low-cost approach
  - No new webpages to create; use existing slides
  - Teaching two groups at same time lowers costs
  - Video benefit marginal
    - Major cost is Internet connection
    - Should provide if network is available

Network EducationWare (*NEW*)
Open Source Online Teaching Software

- Based on freely available Internet multimedia/multicasting software
  - Audio/whiteboard/video
  - Control software by GMU
- Client package for Windows and Linux
  - GMU porting to Macintosh platform
- Server package in Java runs on any platform
  - By GMU software supports client multicasting
  - Uses TCP tunnels to deal with NAT
- Web-based access and course management

Simulteaching System

Student Home/Office Locations

Server Facility

Classroom

Student Multimedia Computer

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Student Multimedia Computer

Live Class Server

Playback Server

Webserver & Database

Video Camera

Workstation Display/ Tablet

Wireless Microphone

Classroom Projector

Instructor Multimedia Computer

Keyboard & Mouse/ Tablet Pen

Recording of Class

Prepared Slides

Internet

NEW Open Source Software Components

Recorded Sessions

User Workstation Software

Record/Playback (REC/PLAY)

Whiteboard (WBD)

Prepared Slides PDF, PostScript, HTML or JPEG

Audio Send/Receive (SF)

TLM Client (TLMC)

Video Send/Receive (VIC)

Floor Control/Chat Client (FC)

TCP or UDP tunnel

TCP connections

Server Software

TLM

MySQL Database

Record/Playback Control Client (RC/PC)

Apache Webserver

NEW webpages

Off-the-shelf Open Source   GMU-modified Open Source   GMU-built Open Source

NEW Client Interface

GMU C4I Center Networking and Simulation Laboratory

NEW

Network EducationWare Project

For more details, see:

http://netlab.gmu.edu/NEW

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NEW Web Portal

- Simple interface to complex functions
  - Software load and test
  - Live access
    - Multiple client configurations from webpage
  - Playback
    - Multiple client configurations from webpage
  - Chat rooms
- Focal point for course management
  - For instructors, database management and statistics
  - For administrators, server and webpage management
- Scalability
- *NEW* won International Competition for non-commercial Web-based education software

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Comparison of
Synchronous & Asynchronous
Modes

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Synchronous Characteristics

- Most information flows instructor to student
- Response to questions important
- Students mostly communicate among themselves by typed chat
  - Although Internet voice is available
- Little increase in faculty time to prepare for class

Synchronous Characteristics

- Simulteaching allows economy of scale
  - One presentation supports two sets of students using smaller classroom
- Regular meetings encourage student completion
- Recordings capture ambiance and currency of class for asynchronous delivery

Asynchronous Characteristics

- Significant student freedom from schedule
- Self-disciplined students can learn without instructor or peers
- Peer interaction is difficult
- Many students are not capable of totally independent study
  - Need interaction via email or chat

Asynchronous Characteristics

- Interactive tutorials via LMS can be very effective
  - WebCT, Blackboard, Moodle
  - But preparing webpages and interactive materials is extremely time consuming
- In dynamic topic areas, significant maintenance is required

Three-way Blended Mode:
Classroom + Synchronous + Asynchronous

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Combining the Best Features

- Web browser is the most effective user interface
  - Text and graphics, hyperlinks, front-end to software
- Goes without saying: webpage for every course
  - And email answered at least daily
- Simulteaching for accessibility with lower cost
  - Allows the student to trade classroom experience against commuting time
  - And some students to select *not* to be in classroom
  - Asynchronous recordings automatic byproduct
- Interactive LMS tutorials and homework/quizzes
  - If time/resources permit
  - May be feasible only for large-enrollment courses

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Question 7 (3 points)

The QAM signal represents 15 bits, beginning at t=0. What is the coded value?
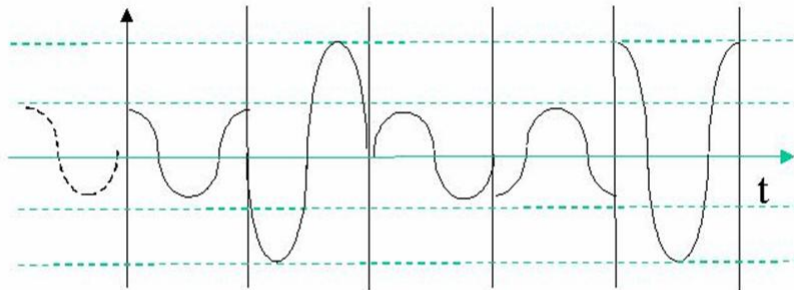
- a. 010 011 100 110 101
- b. 110 001 100 010 101
- c. 011 100 001 111 100
- d. 010 101 000 110 011

Save answer

Important Basics

- Administrative support needs to be considered explicitly
  - Real distance education means the student can access all facilities online (bookstore, exams, labs…)
  - Regional support is easier to provide
- Software should be supported on wide range of platforms and operating systems
- Most important goal is accessibility for students

Innovations Supporting
Economy of Scale

Innovations for Scale-Up

- Enrollment management database & webpages
- Help-desk assistance for students
- Help-desk assistance for faculty
- File management database & webpages
- Special attention to scheduling

Innovations for Scale-Up

- Asynchronous online integration
  - Recorded synchronous sessions, some with LMS
- Office hours in chat rooms
- Administrative support for regional students only
  - Others by exception
- Software enhancement under careful quality control

Operating Costs Per Classroom
Using *NEW* with existing electronic classroom supporting 16 courses

- One Linux server
- Small fraction (<10%) of a system administrator's time
- Two graduate student Information Technology Assistants
  - provide class setup
  - monitor outgoing session quality
  - post recordings, etc.
- Network cost
  - if usage grows beyond existing capacity

Student Outcomes

GMU MSCS Degree

- 30 credits Computer Science graduate study
- Specializations
  - Systems and Networks (now online)
  - Artificial Intelligence
  - Image Processing and Graphics
  - Parallel and Distributed Systems
  - Software Engineering
- Breadth requirement
 - Courses from 3 specializations

GMU MSCS Online Courses

Course Number	Course Name	Offered at Least
CS 540	Language Processors	Annually
CS 571	Operating Systems	Annually
CS 580	Introduction to Artificial Intelligence	Annually
CS 583	Analysis of Algorithms	Annually
CS 631	Object-Oriented Design Patterns	Annually
CS 635	Foundations of Parallel Computation	Biannually
CS 640	Advanced Compilers	Biannually
CS 656	Computer Comms and Networking	Annually
IT 657	Advanced Network Science	Biannually
CS 672	Computer System Perf Evaluation	Annually
CS 706	Concurrent Software Systems	Biannually
CS 755	Advanced Computer Networks	Biannually
CS 756	Perf Analysis of Computer Networks	Biannually

NEW Usage Statistics

CS/IT Enrollment in Simulteaching Sections

Legend: online, classroom
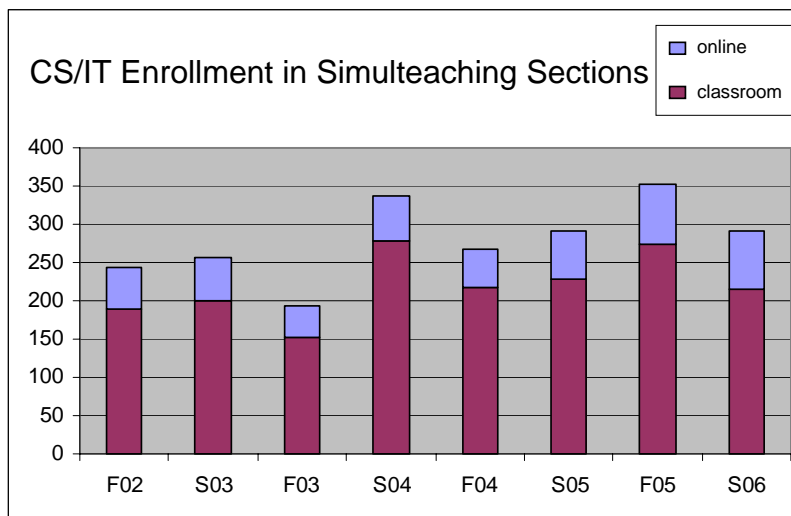
Initial Student Outcomes
Grades – "No Significant Difference"

Grade Average vs. Course Level bar chart comparing CLASSROOM and ONLINE
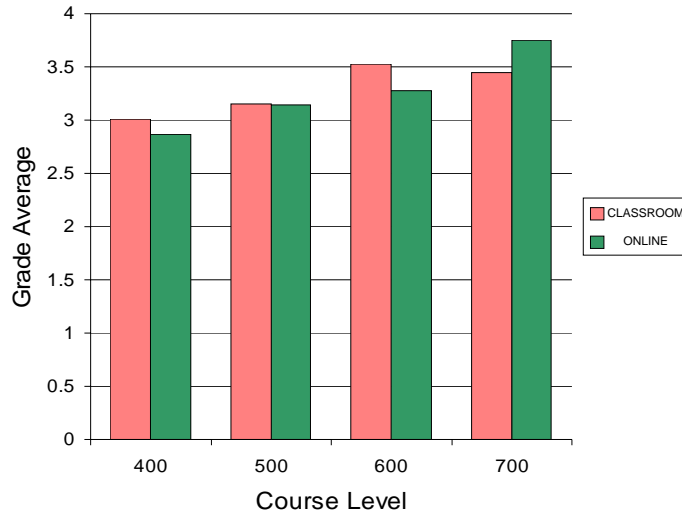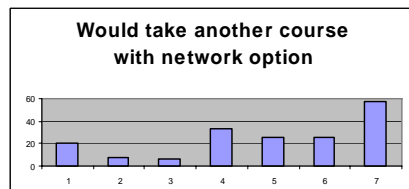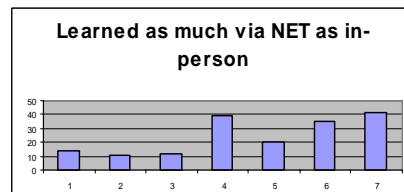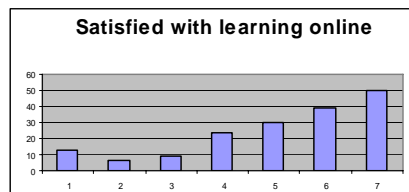
Student Course-End Survey

Typical online student comments: The online mode allowed me to attend the lecture without commuting to school… I never head a problem connecting to NEW server and joining the class… one simply logs into the system and chooses a live connection from a web page menu … I find NEW to be a great tele-learning tool.

Satisfied with learning online

Learned as much via NET as in-person

Would take another course with network option

Network option was more convenient
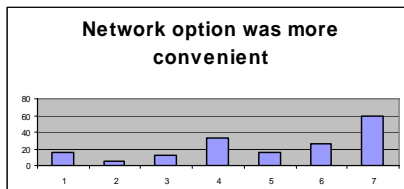
Summary/Conclusions

- Online delivery increases accessibility of education
- Simulteaching with synchronous plus asynchronous delivery minimizes costs and additional faculty time
- Network EducationWare provides these functions in free, easy to use software for academia/government
  - See http://netlab.gmu.edu/NEW to download
- For best effect, combine asynchronous DE & LMS
- GMU has used this approach to extend its MSCS online to reach more regional students
- Results are highly promising
  - Enrollment, grades, student evaluations all good

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Networking and Simulation Laboratory

NEW

Network EducationWare Project

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