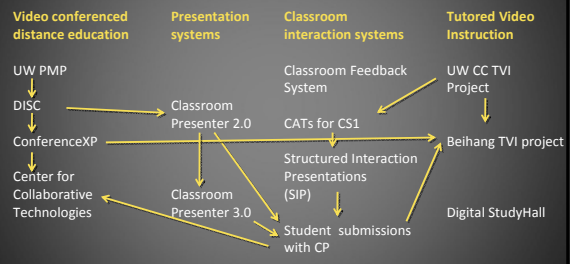
Research In Educational Technology: Expanding Possibilities

Richard Anderson
Department of Computer Science and Engineering
University of Washington

Research in Educational Technology

- How can computing technology enhance education?
  - Focus on classroom instruction
- Challenges:
  - Extending reach of education
  - Increasing interaction
  - Addressing problems of scale
  - Facilitating expression of ideas

Past and Current Research Projects



Research Approach

- Deployment driven
  - Classroom use
  - Technology development and promotion
- Goals and success criteria
  - Adoption of technology and methodology
  - Influence educational practice
- This is a model that has been working for us
  - Target specific deployments that are innovative in some dimensions

Today's Talk

- Significant point of time for the project
  - Substantial number of completed projects
  - Formation of Center for Collaborative Technologies
  - Deployment of Classroom Presenter 3.0
  - Opportunity to develop classroom technologies that will have a broad impact
- Summary of educational technology projects
  - Lessons learned and remaining challenges
- Future projects

Video Conferenced Teaching

- Multi-site internet based audio-video conferencing
- UW PMP Program
  - Site-to-site courses between UW and Microsoft since Winter 1997
  - www.cs.washington.edu/education/dl/course_index.html
  - Master's level courses
  - Goal: interaction across sites
    - Approximate single classroom
  - Various technologies have been used since the program was introduced

Video conferencing in the PMP

- Winter 1997 – Winter 2002
  - Polycom + Netmeeting for PPT and SmartBoard
- MSR DISC Project
  - Target: UW, CMU, UCB, Brown graduate class
  - Spring 2002
- MSR ConferenceXP
  - Since Spring 2003
  - Four way courses, Autumn 2004, Autumn 2005, Autumn 2006
    - UW, MSR, UCB, UCSD
    - Ed Lazowska, Steve Mauer

DISC (PMP spring 2002)

- What went wrong
  - Technology and systems failures
  - High cost of interruptions
  - Loss of trust
  - Room configuration issues
  - Lack of control of lecture room
  - Production quality
- Meta lesson
  - Learn more from failures than from successes
- How to Fail at VideoConferenced Teaching
  - Microsoft Faculty Summit 2002
  - Anderson & Beavers

ConferenceXP

- Target: High bandwidth internet video conferencing
- Technology: Multicast networking, Internet2
- Vision: Single machine deployment, ease of use
- Designed as extensible platform
  - Integration of other information channels
    - Slides and Ink
  - Source released by MSR as shared source
- Production use in UW PMP since Spring 2003

Center for Collaborative Technologies at University of Washington

- UW center funded for continued work on ConferenceXP Platform
  - http://cct.cs.washington.edu
- Extend functionality of ConferenceXP
  - Diagnostics, Security, Remote management, HDTV integration, . . .
- Build community of users and developers
- Deploy ConferenceXP in new scenarios
  - International education
  - Developing world

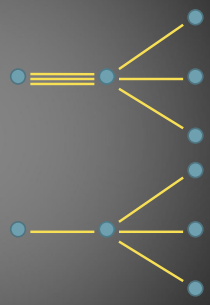
Microsoft Research

Success in distance classes

- Goals
  - Real time interaction between sites
  - High quality video
- Challenges
  - High bandwidth connections
  - Classroom Audio
  - Establishing a pattern of interaction

Hardware Multicast

- Technology bet (2001)
  - Multicast networking to support multisite courses
  - Substantial bandwidth savings
  - Multicast not uniformly supported



Dealing with multicast problems

- Reflector service
  - Plug in unicast to replace multicast
- Used as backup in our courses
- Solution when connecting to networks without multicast

Going International

- March 29, 2008, LACCIR Meeting
  - Latin American and Carribbean Collaboration for ICT Research
- Seattle and University of Chile, Santiago, Chile
- Seminar presentation
- CXP Unicast reflector

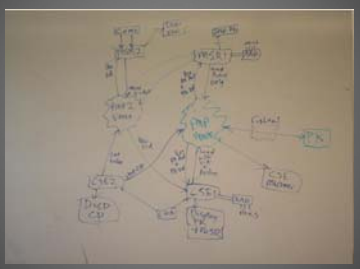
Masters class, UW - Pakistan

- Masters class
  - University of Washington
  - Lahore University of Management Science
  - Microsoft
- Computing for the Developing world

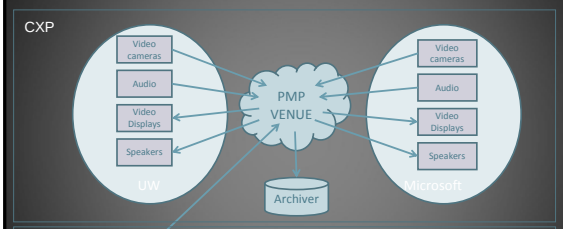
Technical Challenges

- Ensuring adequate bandwidth
  - Limited bandwidth to Pakistan
  - Reliability
  - Multicast
  - Ensuring this did not compromise UW-MS class
  - Limited time to prepare

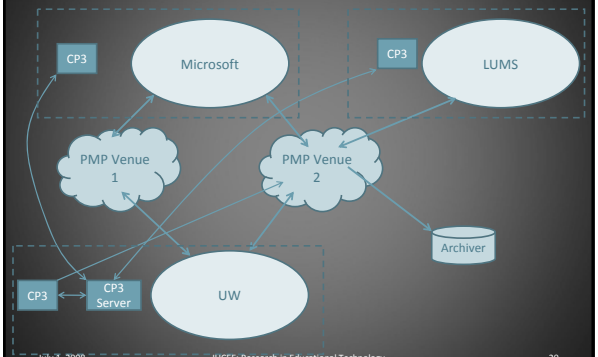
Fred's whiteboard



Basic PMP setup (2 sites)

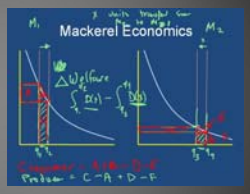


3-way setup for UW, MS, LUMS

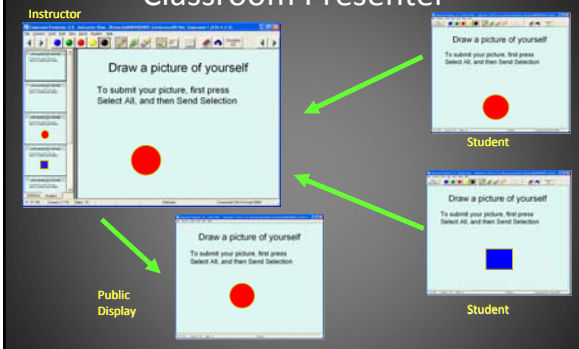


Use of Classroom Presenter

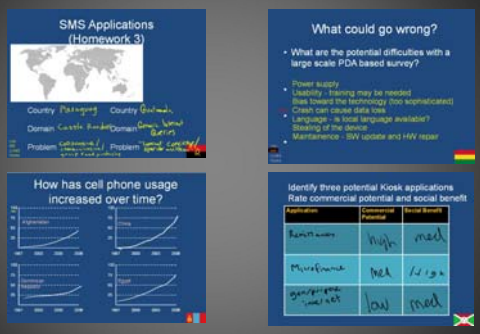
- Tablet PC based presentation and classroom interaction system
- Ink based presentation
- Classroom Activites



Classroom Presenter



Classroom Activities



Projects related to distance learning

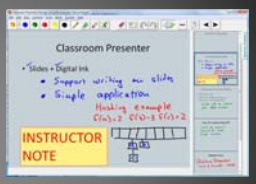
- Working with archived lectures
- Large library of recorded lectures available
  - Autumn 2006 Algorithms class recorded with close talking microphone
- Lecture indexing – support text search of speech (and slides and ink)
  - Language modeling necessary (train on algorithms or CS content)
- Lecture summarization
  - Classify lecture episodes
    - Support for lecture browsing
    - Feedback to the instructor
- Lightweight lecture capture

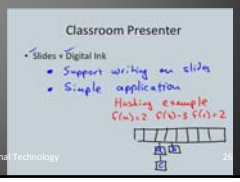
Classroom Presenter

- Support electronic slides and digital ink
- Initially developed for whiteboard integration of DISC
  - "PowerPoint sucks the life out of a lecture", EDL
- Tablet PC application
  - Digital ink overlay on slide images
  - Feature set aimed at lecture presentation

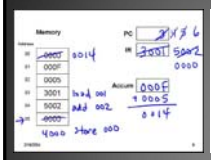
Ink based presentation

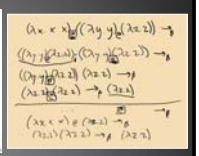
- Tablet PC Inking on images
- Simple pen based controls
- Whiteboard, slide extension
- Multiple views – instructor/display
  - (dual monitor)
- Multiple slides decks with filmstrip navigation
- Instructor notes

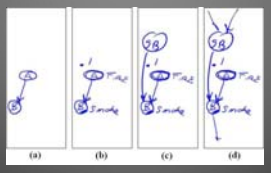




Ink usage







Classroom Presenter Deployments

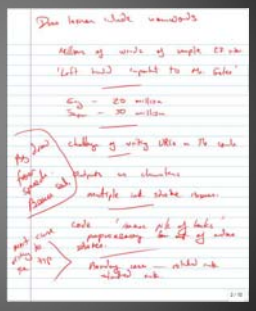
- Adoption in wide range of subjects and institutions
- Many of the key ideas have been generated by users
- Emphasis on simplicity of UI and application

Ink Based Presentation

- Challenge in developing UI to support presentation
  - Low attention UI
  - Introduce a richer set of operations without compromising usability
- Inking behavior very complicated
  - Post processing instructor ink
    - Lecture summaries and visualization

Tablet PC Project: Analysis of Handwritten Notes

- Note taking
  - Many applications exist for taking notes, but the real value of TPC notes (over paper) is being able to work with them digitally
  - Notes vary greatly in structure and are often messy
  - Search: Find "dynamic programming"
  - Type search: Find all phone numbers
  - Classification: Find all pseudocode

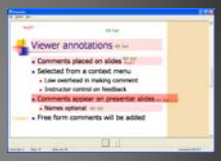


Classroom Interaction Systems

- Integration of electronic devices into the classroom to support instruction
- General motivation is to involve students in ways that achieve specific pedagogical goals
  - E.g., Classroom networks have been demonstrated be very effective for science instruction

UW CSE Work on Classroom Interaction Systems

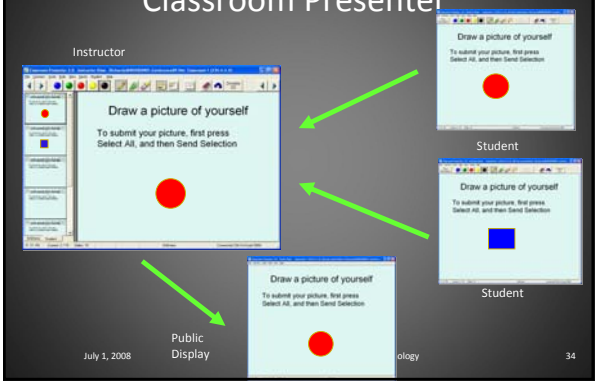
- Tutored Video Instruction
  - Activities to support the facilitator
  - Classroom Assessment Techniques (Angelo and Cross)
- Classroom Feedback System
  - Student response system associated with lecture slides
- Structured Interaction Systems
  - Steve Wolfman's thesis
  - Rich activity model built into slides



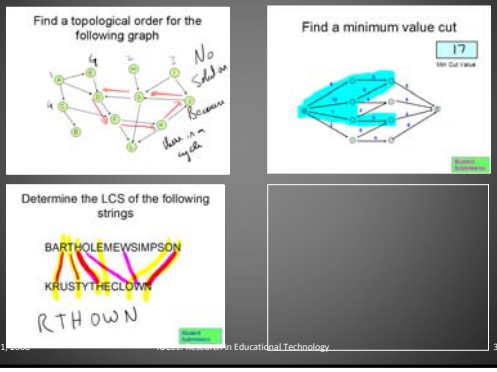
Student Submissions

- Simple model for activity taking advantage of digital ink
- Students write answers on slides, send them to the instructor
- Instructor previews results and selects slides to display to the class

Classroom Presenter



Activity Examples



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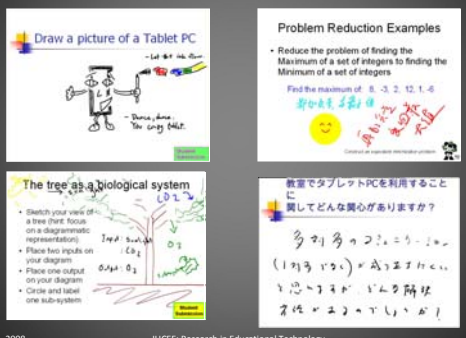


Deployments

- Algorithms, Digital Design, Software Engineering, Data Structures, Environmental Science at UW
- Outside UW: Physics, Calculus, Ethics, Biology, Electrical Engineering, Introductory Programming, . . .
- Used at all levels
  - High School, Community College, University

Classroom goals

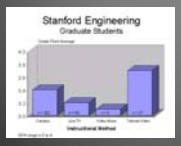
- **Active Learning**
- Encourage students to contribute in multiple ways
- Promote engagement in the class
  - Interest
  - Alertness
- Demonstrate that all students have important opinions
- Peer interaction
- Feedback – classroom assessment
- Collection of ideas
  - Collective brainstorm
- Student generation of examples
- Discovery of a pedagogical point
- Gain understanding of an example
- Show misconceptions

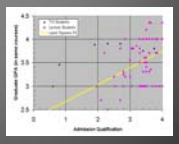
Impact

- Instructors successful at achieving classroom goals
- Significant participation by students
- Change in classroom dynamics
- Negative: deployment overhead

Tutored Video Instruction

- Video recorded lectures shown with facilitator
  - Original model: lectures stopped by students for discussion
  - Peer tutors
- Developed by Jim Gibbons at Stanford University
- Positive results reported in Science [1977]





UW TVI Projects

- Introductory programming
  - Address community college articulation
  - Experiment with alternate approaches to introductory computing instruction
- UW – Beihang Algorithms course
  - Offering of CSE 421 in China
- Digital StudyHall
  - Primary education in rural india

UW – Community College

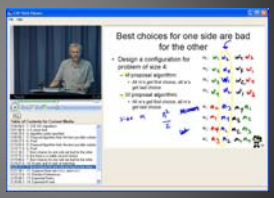
- Lectures recorded from UW Intro Class
- Shown at CCs with local instructors as facilitators
- Project lasted 3 years, involving 9 CCs
- Phase I
  - Materials from live lecture, centralized grading, management from UW
- Phase II
  - Studio created materials, CC grading

Lessons Learned

- Results were mixed
- Complicated institutional relationships
  - CC students concerned about competition with UW students
- Facilitation model
  - Did not achieve peer facilitation
    - Co-teaching a more accurate description
  - Facilitators wanted external support (e.g., classroom activities)
- Program helped with instructor development

UW-Beihang CSE 421

- Materials captured from live classes
  - Slides, talking head, digital ink
- Classroom Technology
  - Students used Tablet PCs to participate in classroom activities
  - Tablets PCs used both at Beihang and UW



Results

- Offering successful
  - Technology, institutional relationship
- Cross-cultural issues
  - English language materials were comprehensible
  - Classroom discussion primarily in Chinese
- Facilitation model
  - Significant support for facilitators
  - Classroom activities successful (and popular)
  - Facilitators innovative and reproduced some of the instruction
  - Interactive and informal classroom atmosphere

Digital StudyHall

- Affiliated Project
- Randy Wang, Paul Javid (MSRI, Bangalore)
- Richard Anderson, Tom Anderson (UW)
- Tutored Video Instruction for primary education in rural india
- YouTube + Netflix

What we've learned from all of this

- Value of electronic materials in the process of classroom instruction
- Tools for teaching
  - Teacher and students drive the process
  - Flexible and unpredictable use
- Structured Interaction model
- Broader context – interplay of technology and other issues

Deployment Driven Research

- Development and deployment of educational technology
- Internal
  - Working with our own classes
  - Opportunity to innovate
  - Pressure to make things work
- External
  - Broad range of ideas
  - User suggestions
  - Feedback on ideas

Fan mail

To: Richard Anderson
Subject: UW CSE Web: Classroom Presenter FAQs
Dear Mr Anderson,
i am edy from jakarta, indonesia. What a great software i found , made by UW CSE.

To: Richard Anderson
Subject: CSE Home Page: Classroom Presenter FAQs
Dear Dr. Anderson,
So, I think you can say I'm trying out CP for the first time. I really thank you for your enormous effort to provide such an excellent tool.

To: Richard Anderson
Subject: UW CSE Web: UW Classroom Presenter
May I take a moment to say, once again, THANKS for creating CP! I've used it during a conference presentation and in all but one of my classes this year.

To: Richard Anderson
Subject: Re: TP Mode
Richard,

Thanks again for your support of this great product. Seriously, I would not be lecturing with my tablet pc without it. Powerpoint was way too restrictive and made me REALLY nervous.

Classroom Technology Challenges

- Make it universal
- Deepen level of interaction with materials
- Expand the reach

Broader Access

- Critique of Classroom Presenter
  - . . . but students don't have Tablet PCs
  - High overhead in deployment
  - Many different costs
- Sustainable deployment
  - Student owned devices
  - Heterogeneous deployment of devices
  - Value to all participants

The next steps

- Electronic, slide based lecture supporting flexible instructor control
- Extend device and interaction models
- Wide range of interaction models available
  - Polling, Group Scribbles, Multipoint, shared whiteboard, student submissions
- Challenge
  - Maintain focus and simplicity

Richer content support for slide based lectures

- Slide model: static content or build slide animations
- Challenge: provide a richer model of content for dynamic presentations
  - Particular domain of interest: mathematical content
- Starting points
  - Instructor notes
  - Structured Interaction Presentations (SIP) [Wolfman]
  - Geometrical structure for slides

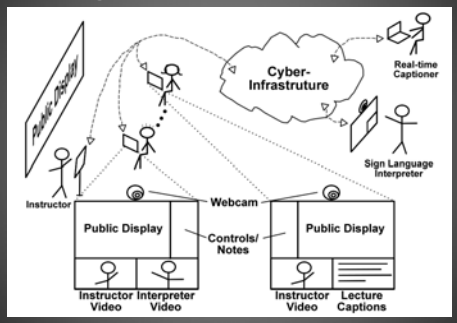
Facilitation for Tutored Video Instruction

- Teaching with recorded materials
  - Peer discussion vs. co-teaching
- Regular interruptions for active learning
- Beihang class
  - Facilitators made substantial use of Classroom Presenter
  - Activity structure was successful
- Projects
  - Develop integrated TVI replay, presentation and classroom interaction tools
  - Refine methodology for combining active learning with TVI
  - Replay tools for DSH scenarios

Classroom Accessibility

- Opportunities in electronic classroom for greater accessibility
- Classroom capture and archiving
- Real time interpretation
  - Captioning/Screen reading
- Input
  - Instant messaging, shared whiteboard, custom input facilities
- Collaborative work with Richard Ladner

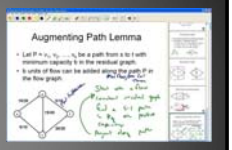
Enabling Access to STEM Education



Slide courtesy of Richard Ladner/Anna Cavender

Classroom Presenter 3.1

- Richer Feature Set
  - Display Control
  - Classroom Interaction
    - Quick Poll
  - Expanded interaction models
    - New classroom activities
  - Additional source content
- Performance
  - Scalability in wireless classroom



Center for Collaborative Technologies

- Development of ConferenceXP Platform
- Establish as a shared source project
- System enhancements
  - Multicast diagnostics
  - Security
- Deployments
  - Collaboration with Microsoft sponsored Latin America Virtual Institute
  - UW Professional Master's Program

Domains of Special Interest

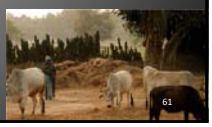
- Higher Education
- International Courses
- Developing World
- Global Health

International Education

- Multi-site classes with ConferenceXP
- Challenges
  - Networking issues (firewall, multicast)
  - Identifying cases where interactivity is needed
  - Time zones
    - West Coast US (6:00 pm) & China (9:00 am)
- Short term
  - Pilot tests with Chinese Universities
  - Latin America Virtual Institute
  - International guest lectures for UW CSE PMP Class (spring)

Developing World

- Tremendous challenges faced in education in the developing world
- Technology supported instruction that is cost-realistic and sustainable
- Digital StudyHall
  - India, Bangladesh, Eritrea, . . .
- Interactive, Facilitated Video Instruction
- Low cost multi-person interaction
  - E.g., Multimouse
- Deployment issues
  - Lack of power, network connectivity



Global Health

- Strong regional opportunity
- Distance education to support medical education
- Alternate models of video based instruction

For more information

- Richard Anderson
  - anderson@cs.washington.edu
- Classroom Presenter
  - http://www.cs.washington.edu/education/dl/presenter/
- Center for Collaborative Technologies at UW
  - http://cct.cs.washington.edu/
- Digital StudyHall
  - http://dsh.cs.washington.edu/

- Other contacts
  - CCT: Fred Videon (fred@cs.washington.edu)
  - Digital StudyHall: Paul Javid (pjavid@cs.washington.edu), Tom Anderson (tom@cs.washington.edu)
  - Classroom Accessibility: Richard Ladner (ladner@cs.washington.edu)

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