Creating a flexible undergraduate program in computer science: curriculum, educational technology and pedagogy

PI: James F. Kurose
Faculty: W Richards, Adrion, Wayne Burleson

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Outline

- Educational Technology
- Leveraging partnerships
- Curriculum Development
- New Pedagogy
- Dissemination of research technology
- Factors for success
Previously Developed Educational Technology

- **MANIC:** Multimedia Asynchronous Networked Individualized Courseware

- Evolved from several NSF grants, 1996-present
  - multimedia systems research
  - new pedagogy

- The Overall Goal
  - To reach distance/professional and traditional students in new ways
Two new approaches to previously streaming technology

- DB (Database)-MANIC
  - Self Authoring
  - Sharing of Content Between Instructors
  - Web-based

- CD/DVD-MANIC
  - Allows for bandwidth intensive content
  - Beats VHS video – random access
  - reduced shipping
  - searchable
  - Usage Logging and Content Updates
DB-MANIC
Managing course 'Test Course'

Control this course
- Edit course
- Delete course

Author content for this course
- Add a new knu
- Create a new knu/topic/slide directly

Preview this course
- Preview course (in new window)

Misc
- Manage course files
Internal Structure

- cytoplasm
- organelles
- cytoplasm
- nucleus
CD/DVD-MANIC
CD-MANIC
Student’s Perspective

- Electronic Book Interface
- Media Player Interface
- Slide Viewer Interface
- Navigational Controls
- Search Feature
- Multiple View Index Interface
The Best of Both Worlds
CD and Internet

- CDs for bandwidth intensive content
- Internet for:
  - External Links
  - Collaboration
  - Assessment
  - Content Updates
  - Logging Student Usage
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Partnerships

- Classes videotaped by Professional Education for Engineering and Applied Sciences (Distance Ed.)

- Computer Science (CS) and Electrical and Computer Engineering (ECE) Departments each with EI grants come at problem from two sides and merge approaches
Partnerships Continued

- North Carolina State University
- Polytechnic University (Westchester)
- Participation by Smith College
  - UMass server on-site for DB-MANIC usage
- Entomology Department usage of CD-MANIC to supplement web course
- UMass Online – Interest in 5 campus system-wide usage
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Curriculum tailored for distance

- Meeting off-campus student requirements:
  - flexibility, asynchrony
  - the “real” thing: “real” classes by “real” professors
  - different needs/desires than PhD students: more applied, less theoretical

- Computer Science: new off-campus student track through MS program (Spring 2002)
  - no required project, more flexible course choices
  - collaborative with ECE
  - longer term: combined CMPSCI/ECE MS option

- ECE: under discussion as well
CD-MANIC Courses
Classes currently on CD-MANIC

Computer Science

  521  Advanced Software Engineering (Clarke)
  530  Programming Languages (Wileden)
  591E Computer Networks (Kurose)
  635  Modern Computer Architecture (Weems)
  677  Operating Systems (Shenoy)

Electrical and Computer Engineering

  242  Data Structures (Gao)
  564  Communication Systems (Kelly)
  565  Digital Signal Processing (Franks)
  566  Communication Systems (Goeckel)
  658  VLSI Design (Burleson)
  669  Parallel Computer Architecture (Moritz)
  697F Reconfigurable Computing (Tessier)
Fall 2002

- CMPSCI 673 Modeling and Performance Evaluation (Towsley)
- CMPSCI 683 Artificial Intelligence (Lesser)
- ECE 221 Digital Systems Design (Hill)
- ECE 563 Intro. to Communication & Signal Processing (Kelly)
- MIE 520 Probability and Statistics for Engineers (Smith)
Students Enrolled in CD-MANIC course

- Overall: ~1400 CD’s distributed
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Making the leap from a mathematically intensive “whiteboard” course to multimedia.
An experiment in using MANIC for “constructivist” learning within an on-campus course

- **results**
  - homework (and overall) grades improved substantially
  - distribution of grades also narrowed substantially

- **comments**
  - may partially result from an observed improvement in the overall performance of our undergraduate students
  - the addition of the problem-solving sessions was valuable (and was one of the goals of the framework)
  - change is dramatic enough, however, to indicate that the framework was effective
# Questionnaire

<table>
<thead>
<tr>
<th>Attended class</th>
<th>Most of the time</th>
<th>Once/week</th>
<th>Infrequently</th>
<th>MANIC affect?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>59%</td>
<td>24%</td>
<td>18%</td>
<td>24%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Used</th>
<th>Text/handout</th>
<th>MANIC</th>
<th>Videotape</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>82%</td>
<td>53%</td>
<td>59%</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Useful</th>
<th>Not useful</th>
<th>% used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Text/course-pack</td>
<td>29%</td>
<td>65%</td>
</tr>
<tr>
<td>Handouts</td>
<td>88%</td>
<td>12%</td>
</tr>
<tr>
<td>Online Power Point</td>
<td>89%</td>
<td>11%</td>
</tr>
<tr>
<td>MANIC</td>
<td>90%</td>
<td>10%</td>
</tr>
<tr>
<td>Videotape</td>
<td>67%</td>
<td>33%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Replace class</th>
<th>Review</th>
<th>Homework</th>
<th>Supplemental</th>
</tr>
</thead>
<tbody>
<tr>
<td>Used MANIC for</td>
<td>30%</td>
<td>70%</td>
<td>60%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Office hours</th>
<th>email</th>
<th>Web</th>
<th>MANIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>For questions, used:</td>
<td>50%</td>
<td>44%</td>
<td>65%</td>
</tr>
</tbody>
</table>
How do my students use my CD/DVD-based course?

<table>
<thead>
<tr>
<th>Add/Edit Remove Users</th>
<th>Change Password</th>
</tr>
</thead>
<tbody>
<tr>
<td>Define Course Periods</td>
<td></td>
</tr>
<tr>
<td>Define Filters</td>
<td></td>
</tr>
<tr>
<td>Delete Reports</td>
<td></td>
</tr>
<tr>
<td>Generate Reports (Advanced)</td>
<td></td>
</tr>
<tr>
<td>Generate Reports (Standard)</td>
<td></td>
</tr>
<tr>
<td>Generate Reports (Delegate)</td>
<td></td>
</tr>
<tr>
<td>Get Session Data</td>
<td></td>
</tr>
<tr>
<td>Update Course Info</td>
<td></td>
</tr>
<tr>
<td>Update Log Data</td>
<td></td>
</tr>
<tr>
<td>View Reports</td>
<td></td>
</tr>
</tbody>
</table>

**CD-Manic Specific Queries**

- Percent of time the Audio/Video is on
- Session length distribution
- Plays per session distribution
- Navigation event occurrence
- Time of day usage
- Number of events per user
- Event type usage
- Automatic vs. manual show slide event
- Session length - A/V on vs. off
- Number of sessions per user

**Time Queries**

- The 1 most popular viewing dates for all sessions
- Popular days of the week for all sessions ordered by: Earliest in Week
- Average viewing start time for all sessions
- Average time between human interaction for all sessions

**Other Queries**

- Percent of students who accessed the chatroom
- Percent of students who accessed the webpages
- Percent of students who used the quizzes
- The 1 most popular dates for using the quizzes
- The 1 slide most often clicked from the index

**Video Queries**

- Videos viewed, ordered by: Most to Least
- Videos stopped, ordered by: Most to Least
- Percent of students who chose to view all lectures

**Slide Queries**

- The 1 most often viewed slides
- The 1 most often fast-forwarded slides
- The 1 most often backwarded slides
- The 1 most often replayed slides
- The 1 most often paused slides

**Search Queries**

- Most popular searches
- Least popular searches
- What search term was used (AND/OR)
- Where search was used from (Slide/Book/Both)

**Lecture Queries**

- Lectures viewed, ordered by: Most to Least
- Lectures fast-forwarded, ordered by: Most to Least
- Lectures backwarded, ordered by: Most to Least

**Textbook Queries**

- Textbooks viewed, ordered by: Most to Least
- Textbooks fast-forwarded, ordered by: Most to Least
- Textbooks backwarded, ordered by: Most to Least
Sample output from web-based log data reporting tool
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A Sampling of Student Use

- UMass Professional Education Program
- National Technological University
- NC State
- Westchester campus of Polytechnic University

Full survey results:
http://ripples.cs.umass.edu/surveyresults.html
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**Factor for Success**

—or—

**“How are you able to get so many faculty to sign up for this?”**

- **faculty involvement:** minimal in creating CD MANIC version of course
  - faculty focus more on content, live students
- **balance:** understanding how CMPSCI/ECE faculty balance research, on-campus teaching, “a life”, and distance learning
- **new tools for instructors:** window into student behavior with course material without potentially biased surveys
Programmatics: what’s been required?

- **grant funding**: three NSF grants over 6 years: $1.3M
- **UMass Professional Education facilities**: professional technical, support staff
  - leverage existing facilities, courses
- **faculty “goodwill” and interest**: little/no rewards for off-campus teaching
  - “research rules”
More About Ripples

http://ripples.cs.umass.edu
CRCD
Curriculum Development and Infrastructure for an Advanced Systems Laboratory

PI: James F. Kurose
Faculty: A. Ganz, L Gao, C.M. Krishna, B. Levine, P. Shenoy, D. Towsley, J. Wileden

NSF EIA 0087945
**Project Goals:**

- Integrate research results into curriculum via laboratory-based course modules
  - Computer networking
  - Operating systems
  - Multimedia systems
  - Real-Time systems
  - Distributed Systems
  - Computer system security

- Two new courses: internetworking lab, systems lab
Curricular Elements

- Operating Systems
- Distributed Systems
- Computer Networks
- Real-Time Systems
- Multimedia Systems

New lab-based research-oriented curriculum modules

New courses

Internetworking lab

Computer systems lab
Laboratory Infrastructure

- 40 linux-based PCs
- 2 servers
- two air-gapped networks: 8 PC’s, 8 Cisco 3600 routers, 8 hubs
Operating Systems Lab Modules

- CPU scheduling
- Memory management
- File systems
- Centralized P2P file-sharing system
- Distributed P2P file-sharing system
- Maintaining consistency
Networking Lab Modules

- Single-segment IP networks
- Multiple-segment IP networks
- Dynamic routing protocols
- LAN switching
- Transport layer protocols
- NST, DHCP
- Multicast
- DNS
- Network Management
Security Lab Modules

- Avoiding overflow
- Securing linux
- Snort/sniff/hijack
- Intrusion detection
- DNS/BIND security
Multimedia Systems Lab Modules

- Implementation, measurement of link schedulers
- Parallelized MPEG decoding
- Device-driver lab
- Lazy-receiver processing