Information Technologies
Enabling New Modes of Learning

Alice Agogino
Associate Dean for Special Programs
Professor of Mechanical Engineering

Brandon Muramatsu
NEEDS Project Manager

5th Annual Undergraduate Faculty Enhancement Workshop
University of California at Berkeley
July 14, 1998
Synthesis Coalition Goals

• Reform curricula
• Improve retention
• Link to K-14
• Develop digital infrastructure (NEEDS database & quality review of courseware)
Synthesis Coalition Strategy

- Introduce multidisciplinary systems design
  - Mechatronics
  - Architecture/Engineering/Construction
- Bring industry and research into the classroom
- Enhance laboratory/hands-on learning
- Increase social context of technology
- Improve student’s communication and teaming skills
- Introduce new delivery/learning styles
Lower Division Strategy

- Mechanical (Artifact) dissection.
- Multidisciplinary, multimedia case studies.
- Integrated design projects.
- Early introduction of embedded computing (mechatronics design).
is an approach to teaching students about engineering concepts and design principles by having them explore the engineered products around them.

involves having students work in small teams to disassemble and reassemble machines.

leads to insight on materials, function, design alternatives, human factors and manufacturing.

motivates and promotes integrative thinking.
Multidisciplinary, Multimedia Case Studies

- highlight examples of successfully engineered design products.
- brings “best practices” from industry into the classroom:
  - customer-driven design
  - quality and continuous improvement
  - multifunctional teams
  - design for ‘x’ (assembly, environment, service, etc.)
- complements dissection and design activities.
- promotes integrative thinking.
Freshman/Sophomore Class

Design and develop a Multimedia Case Study

http://maclab.me.berkeley.edu/ME39C/
Multimedia Cases & Dissection
Promote Integrative Learning

Integrates multimedia case, dissection and design activities

Mattel Color Spin Example

QuickTime™ and a Cinepak decompressor are needed to see this picture.
Multidisciplinary Mechatronic Cases and Dissection Exercises

Some of the Disciplines Involved:

- Mechanical Engineering
- Electrical Engineering
- Computer Engineering
- User Interface
- Manufacturing
- Industrial/Process Engineering
- Business and Management of Technology
Synthesis Courseware Integrates Research, Education and Industry

**Technical Research**
- Disk Drive
- High Speed Networks
- Multimedia & Video Servers
- Design & Manfg. Integration

**Industry**
- Western Digital
- IBM Almaden Research
- Berkeley Computer Mechanics Lab

**Education Research**
- peer, scaffolded & experiential learning

Virtual Disk Drive Case Study - Game, Dissection Example
The Multimedia Virtual Disk Drive Design Studio is a project aim to develop multimedia interactive courseware for undergraduate engineering and science students. This project is funded by the Synthesis Coalition, a national engineering coalition supported by the National Science Foundation. The purpose of the Synthesis Coalition is to design, implement and assess new approaches to undergraduate engineering education that emphasize multidisciplinary synthesis, teamwork and communication, hands-on and laboratory experiences and open-ended problem formulation and solving.

The Multimedia Virtual Disk Drive Design Studio is an example of courseware that integrates interactive multimedia with hands-on dissection and design exercises.
> message 

From:  Ms. Elliott, president of ACME Engineering
To:    chief project engineer
Subject: new product design
The purpose of this multimedia project is to introduce students to the world of mechatronics and "real-life" engineering practices. This piece of role-playing interactive software allows students to become design engineers in a fictitious disk drive design firm. Obviously, most students will not have any in-depth knowledge of disk drives and will have to mine out the necessary information from a multimedia archives. Subsequently, they will have to select from various design options and construct their own disk drives.

At the same time, students will have to keep track of the development and production cost. They will also be asked to launch their new disk drives in a certain time frame, simulating the idea of time-to-market. ACME President Eliot gives the initial design goals and final product evaluation.
The user interface allows students to feel like they are sitting in front of a computer terminal. The right side of the screen is the navigation panel. It displays the current status and allows users to access a design logbook or visit the tutorial at anytime. This is a screen shot of the assembly view. A 3-D animation movie disassembles the hard drive and introduces individual components.

The disk drive components form the main navigational path. As the user clicks on different components, more information will appear. The component layout also provides an ideal link to a disk drive dissection exercise.
As the user clicks on the motor, this screen will appear. At the top left is a 3-D animation of the spindle motor rotating in space, giving the users a 3-D feel of the motor.

From this point on, there are three choices: to perform a literature search on spindle motors, consult experts on motor related issues or head straight to the virtual motor design studio. The student can choose which mode of learning he or she prefers at any point.
When the drive controller issues a read or write command, the voice coil motor rotates the entire HSA to the position where data is stored or needs to be encoded. To minimize seek time, or the time for the HSA to align itself to the correct data track, a critical factor in actuator body design is to minimize inertia.
This is a screen shot of the literature search section for the head stack assembly. The literature search sections contain text, images, 3-D animations and video clips related to the components of interest.

The web version will point to related on-line links.

Matlab and spreadsheet exercises which integrate math and physics equations are under development.
<table>
<thead>
<tr>
<th>Read-write Head Type</th>
<th>Cost</th>
<th>Max. TPI</th>
<th>Max. BPI</th>
<th>Pre-amp Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIG</td>
<td>$8</td>
<td>5000</td>
<td>90000</td>
<td>$2</td>
</tr>
<tr>
<td>Thin-film Inductive</td>
<td>$10</td>
<td>6000</td>
<td>100000</td>
<td>$2.50</td>
</tr>
<tr>
<td>MR</td>
<td>$18</td>
<td>8000</td>
<td>110000</td>
<td>$5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Actuator Body Material</th>
<th>Cost</th>
<th>Inertia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum</td>
<td>$4</td>
<td>45</td>
</tr>
<tr>
<td>Magnesium</td>
<td>$7</td>
<td>38</td>
</tr>
<tr>
<td>Hybrid</td>
<td>$3</td>
<td>40</td>
</tr>
</tbody>
</table>
This is a screen shot of the head stack assembly design studio. Students are asked to choose from several design options based on the information they have gathered in the literature and expert consultation sections. The design information is automatically recorded in the design logbook.

Similar options must be determined in the design studio for the other components — voice coil motor, spindle motor, disk platter and printed circuit board. Students soon realize the multiobjective performance goals and design trade-offs.
<table>
<thead>
<tr>
<th>Component</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>HSA</td>
<td>Head Type</td>
</tr>
<tr>
<td></td>
<td>Thin-film Inductive</td>
</tr>
<tr>
<td>Actuator</td>
<td>Actuator Body Material</td>
</tr>
<tr>
<td>Disk</td>
<td>Magnesium</td>
</tr>
<tr>
<td>PCB</td>
<td>Number of Platters</td>
</tr>
<tr>
<td></td>
<td>3</td>
</tr>
<tr>
<td>PCB</td>
<td>Channel Type</td>
</tr>
<tr>
<td></td>
<td>Peak Detect</td>
</tr>
<tr>
<td>Power Driver</td>
<td>Power Driver Type</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
</tr>
<tr>
<td>Controller</td>
<td>Controller Type</td>
</tr>
<tr>
<td></td>
<td>Mid-range</td>
</tr>
<tr>
<td>VCM</td>
<td>Coil Turns</td>
</tr>
<tr>
<td></td>
<td>300</td>
</tr>
<tr>
<td>Motor</td>
<td>Flux Density</td>
</tr>
<tr>
<td></td>
<td>8000</td>
</tr>
<tr>
<td>Motor</td>
<td>RPM</td>
</tr>
<tr>
<td></td>
<td>5400</td>
</tr>
</tbody>
</table>
Students can access this design logbook at anytime. The logbook not only restates the design goals but also displays the design parameters as determined at that point.

Students can periodically visit the logbook to review the design. Once the design is finalized, the user can click on the "Performance Test" icon and the program will evaluate the disk drives performance.
<table>
<thead>
<tr>
<th>DESIGN PARAMETER</th>
<th>CURRENT DESIGN</th>
<th>DESIGN GOALS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>2556</td>
<td>1200 MB</td>
</tr>
<tr>
<td>Access Time</td>
<td>0.0128</td>
<td>0.015 sec</td>
</tr>
<tr>
<td>Cost</td>
<td>186.0000</td>
<td>$150.00</td>
</tr>
<tr>
<td>Power (used/available):</td>
<td>6.5000 / 8</td>
<td></td>
</tr>
</tbody>
</table>

- product launch
- fix it... redesign
- frustrated? take a break
This section evaluates the disk drive's performance. After reviewing its performance, the user can decide whether to launch the product, redesign or simply give up and take a coffee break!

If the student decides to launch the product, the “time to market” will be determined along with a technical evaluation of the design. The President of ACME Disk Drive logs on to give a final performance review.
VDDS - Future Work

- Develop Web Version
- Add New Features
  - Link to Matlab or spreadsheet exercises to allow changes in the design parameters, introduce new design goals and link to math and physics equations
- Continue User Testing and Case Study Revision
National Engineering Education Delivery System (NEEDS)

Three Components Connected Through the Internet

Delivery
- Classrooms
- Instructional Labs
- Small Study Groups
- Residences
- Libraries
- Anywhere

Development
- Courseware Studios
- Instructional Labs
- Faculty Offices & Residences
- Libraries
- Anywhere
Synthesis Courseware is on the NEEDS Database

NEEDS Database: www.needs.org
Quality Review of Courseware on the NEEDS Database

- Establish Credibility of NEEDS as a Source of Quality Educational Material
- Enhance Recognition of Scholarly and Creative Effort of Courseware Developers
- Three Levels of Review
  - Non-reviewed
  - Gestalt Peer Review: Endorsed Courseware
  - National Competition: Premier Courseware
The NEEDS Database of Multimedia Courseware and Quality Review

- Integrated Database of Multimedia Engineering Courseware
  - Bibliographic records with downloadable courseware
  - Multimedia elements - downloadable movies, images, and text
- Multilevel Courseware Evaluation System
  - Peer Review of Courseware
  - Premier Award for Excellence in Engineering Education Courseware
Long Term Vision

Global Digital Library of Science, Math, Engineering and Technology Courseware

www.needs.org