The Use of Technology in Engineering Education

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Session 4A “The Use of Technology in Engineering Education” (1 PDH)
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ABSTRACT: Computers have since the late 1960s had an impact on how and what we teach in engineering programs at the college/university level. We have progressed from walking 4 miles each way uphill in the dead of winter to submit our punch cards to where we can sit pretty much anywhere in the world and watch our favorite “Three Stooges” television episodes. While the technology has made amazing advancements that have impacted most peoples’ lives, the use of these advancements in engineering education have been a much greater challenge. Students can crunch many more numbers in a shorter amount of time and the visualization of data is extremely advanced. The real challenge is what level of knowledge does a structural engineering student really need to know? Do they really need a course in Statics that involves mathematics or should the course be modified to just discuss the concepts of forces, loadings, reactions, displacements and stresses. The focus of this presentation is to provide some of the opportunities and challenges that face engineering educators at the college/university level due to the advancements in technology.
Agenda for Our Conversation

- Impact on Teaching
- Computer Technology
  - Changes in Hardware Available to Students
- Classroom Technology
  - Changes in Hardware and Software
- Information Technology
  - Changes in Availability of Information
  - Quality of Available Information
Questions

- How can technology be used in engineering education?
- How should technology be used in engineering education?
- What are the opportunities technology offers us?
- What are the challenges that technology offers us?
Where to Start?

- Let's start by looking at a specific course
- CiE 783 / 883 – Matrix Structural Analysis
- Senior and graduate level civil engineering course
- I started teaching this course in 1982
- I took this course as an undergraduate in 1972
- The books available now are very similar to what was available 40 years ago.
Impact on Course Curriculum

- CiE 783 – Matrix Structural Analysis

- Does the available technology impact the topics to be covered in the course?

- The answer is both yes and no

- Let us investigate!
Impact on Course Curriculum

- CiE 783 – Matrix Structural Analysis
  - Course Goals
    - Be able to develop a mathematical model for a structural system
    - Be able to analyze an indeterminate structures
    - Understand a structural analysis using matrix methods
    - Understand advanced analytical techniques
    - How to analyze non-prismatic members
Impact on Course Curriculum

CiE 783 – Matrix Structural Analysis

Course Goals

- Become competent in the use of structural analysis software packages
- Understand the use of approximate techniques
- Understand coordinate transformation, matrix algebra, shape functions, stiffness matrices, and statically equivalent nodal loads
# Big Questions?

- **#1 - What topics should be covered**
  - The list presented seems reasonable
  - The description of course goal probably needs some rewording
  - There is an major issue to consider first
    - How much hand work and how much computer work?

- **#2 - What is the best format to present the material?**
#1 - Topics

- Partial topic list from the 1990s (and earlier)
  - Slope Deflection
  - Moment Distribution
  - Matrix Algebra
  - Energy Methods
  - Hand Assemblage of element stiffness matrices
  - Approximate analysis methods – hand calculations

- Which ones are still needed????
#1 - Topics

- How much hand work and how much computer work?
  - Hand work - risk losing student interest
    - Should students be able to write their own analysis programs?
  - Computer work – risk students not developing a strong understanding of the fundamental concepts
#1 - Topics

- Computer Software
  - What is the comfort level of the students
  - One time requirement for Civil students
  - How much should be taught in class
  - Should students be required to learn certain programs on their own
  - Risk losing a group of students
- Which programs to use?
  - Department has not selected a particular analysis package or mathematical package
#1 - Topics

- Computer Software
  - Do students need to be able to run some hand calculations to verify computer result?
  - If so to what level?
  - How much should they know about the mathematical workings of the analysis package?

- How much theory?
  - Most textbooks are full of theory and expensive
    - $200+ for hardcover
This is tricky

Let's look at the options available to the teacher

- Computer hardware
- Software available
- Classroom hardware
Computer Technology

How has computer technology changed in the past 15 years
## Computer Technology

<table>
<thead>
<tr>
<th>Year</th>
<th>Laptop</th>
<th>1995</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>150 MHz Processor</td>
<td>2.4 GHz Processor</td>
</tr>
<tr>
<td></td>
<td></td>
<td>16 MB RAM</td>
<td>6 GB RAM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.35 GB Hard Drive</td>
<td>500 GB Hard Drive</td>
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<tr>
<td></td>
<td></td>
<td>11.3” Display</td>
<td>15” Display</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.2 lbs</td>
<td>5.2 lbs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Modem</td>
<td>Wireless / bluetooth</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.5” floppy</td>
<td>DVD</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$3200</td>
<td>$430</td>
</tr>
</tbody>
</table>
Computer Technology

1995

2012
Harware Changes

- Mac Book Air
  - 2.4 lbs
  - 0.68 inches thick
  - 1.7 GHz Processor
  - 4 GB RAM
  - 64 GB Solid State
  - 7 hours battery
  - $950
Hardware Changes

- iPad
  - 1.4 lbs
  - 0.37 inches thick
  - 32 GB Solid State
  - Touch sensitive high resolution screen
  - 2 cameras
  - WiFi / Bluetooth
  - $599
Interesting 1986 Video

Knowledge Navigator
Are We There Yet?

- How Close are we 26 years later?

- Features
  - Touch Sensitive Screen – iPad
  - Voice Response – Siri
  - Simulation – MatLab, Excel, etc.
  - Communication – WiFi, 4G, etc.
  - Two Way Video – Skype, many phones, iPads

- 95% of the Features Available Now
### Software Changes

<table>
<thead>
<tr>
<th>1995</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Common Usage</strong></td>
<td><strong>Additional Usage</strong></td>
</tr>
<tr>
<td>E-mail</td>
<td>Social Networks</td>
</tr>
<tr>
<td>Word-processing</td>
<td>You Tube</td>
</tr>
<tr>
<td>Presentations</td>
<td>Skype</td>
</tr>
<tr>
<td>Spreadsheets</td>
<td>Simulations</td>
</tr>
<tr>
<td>CAD</td>
<td>Clouds</td>
</tr>
</tbody>
</table>
Engineering Related Software

- Construction Animation
- Pile Foundation
- 3-D Animation from a Blueprint
- Foundation Connection to Column
- Composite Floor System
Engineering Related Software

- BIM - Building Information Modeling
- Construction Sequencing
- Realistic Visualization
Impact on Engineering Education

- How Does the Classroom Change?
- How Does Delivery of Material Change?
- How Does it Impact Homework Assignments?
- Are the Students Better Educated?
Classroom of Old

All one needed was a chalk board and chalk.
Classroom Changes

Typical Classroom Infrastructure

- Computer projection systems
- Internet connections
- WiFi services
- White boards instead of chalk boards
Classroom Changes

- Newer Features
  - Electronic White boards
  - Lecture Capture Cameras
Classroom Issues

- Increased Costs
  - 3 to 4 year replacement cycle – hardware
  - Yearly costs for software
  - Increased square footage per student
  - Longer initial course development time
  - Getting faculty familiar with equipment & software
  - Additional support personnel

- What Students Bring to Class
  - Laptops
  - iPads
Educational Resources

- Electronic Textbooks

- The Internet
  - Wikipedia
  - YouTube
  - Search engines (Google, Bing, etc.)
  - Skype
  - Free content lectures
    - Khan Academy - video
What Should a Course Look Like?

- Instruction Delivery Method?
- Nature of the Instructional Materials?
- How Does this Impact the Topics Covered?
Instructional Delivery Method?

- Several to Select From
  - Face-to-Face Delivery Model
  - Online Delivery Model
  - Hybrid or Blended Delivery Model
Face-to-Face Delivery

- Traditional Lecture
- Interactive Lecture / Discussion
- Studio Format
  - Mostly students working in small groups on problem solving during class time
- Which format is used depends on the size of the class and the person teaching the course.
- Where does Technology play a role?
Technology Enhancements

- Presentation of Lectures
  - Just write on a white board or chalk board
  - PowerPoint slides
    - Availability?
  - A blend of slides and writing on a board
  - Videos and animations
Technology Enhancements

Course Management Software
- UNH uses blackboard
- Provides
  - Posting of class notes
  - Posting of assignments and solutions
  - Electronic submission of homework by students
  - Listing interesting links to relevant web sites
  - Group chat sessions & Blogs on topics
Technology Enhancements

- Electronic submission of homework by students
- Teacher can provide comments directly on the assignment
- Teacher then e-mails the assignment back to the student
Technology Enhancements

- Grades are available online.
- Help information is available to all students at the same time.
- Easy to provide announcements to students in a timely fashion.
- Students can easily communicate with other students.
- Online quizzes and surveys are available.
Announcements

New Announcements appear directly below the repositionable bar. Reorder by dragging Announcements to new positions. Move priority Announcements above the repositionable bar to pin them to the top of the list and prevent new Announcements from superseding them. The order shown here is the order presented to Students. Students do not see the bar and cannot reorder Announcements.

Create Announcement

Now announcements appear below this line

Spring element problem
Posted on: Friday, September 28, 2012
The problem I began discussing in class is shown in the class notes that have been posted.
Go to the Assignment section of blackboard to get the information.
The idea is for you to work out the problem in order to discuss it in class on Monday.
I will post additional homework later this weekend.
Prof. Henry

Solutions
Posted on: Sunday, September 23, 2012
Solutions are posted in a folder in the Assignments section of blackboard

Assignment #4 is posted
Item is not available.
Technology Enhancements

- Lecture Capture
  - During Class
    - Records the class audio – faculty and student questions
    - Records the PowerPoint presentation
    - Can capture the video of the faculty member during class
Technology Enhancements

- Lecture Capture
  - Outside of Class
    - Records a PowerPoint presentation
    - Records a teacher using a tablet to present a lecture
      - PowerPoint Slides
      - Writing on a tablet
      - Audio of the teacher
Technology Enhancements

- Use of Lecture Capture
  - Student can review the material at their own pace
  - Enhancements to a lecture
  - Multiple points of view – guest lecturer
  - Can be viewed from any location
Online Delivery

- Synchronous learning
  - a group of people learning the same things at the same time in the same place. (Wikipedia)

- Keys –
  - Live performance
  - Real time interaction
  - Faculty teaching from their office or home or anywhere in the world.
  - Students participating from anywhere in the world
Online Delivery

- Asynchronous Learning
  - a student-centered teaching method that uses online learning resources to facilitate information sharing outside the constraints of time and place among a network of people (Wikipedia)

- Keys –
  - Captured faculty performance
  - Self-paced student review
Online Delivery
Hybrid or Blended Delivery

Mixing of different learning environments that combine traditional face-to-face classroom methods with computer-mediated activities (Wikipedia)
A civil engineer should be able to understand the relationship between an actual structural system and a mathematical model of that system.

The mathematical model includes:
- Applied loads
- Support conditions
- Connections between structural elements
- All assumptions
CiE 783 - Objective

- This has not changed since 1982
  - The way the statement is worded has
  - The methods used to achieve the objective are constantly evolving

- Interesting balances
  - student expectations vs. faculty expectations
  - Student learning styles vs. faculty teaching style
CiE 783 - Changes

- Changes that are being made
  - Provide students an opportunity to work out example problems in class
  - Provide class notes so that they can review them prior to class
  - Try to stimulate questions and discussion during class
  - Modifying homework to focus more on concepts and interpretation of analytical results
CiE 783 – Impact of Technology

- No change to the course objective
- Major impact on delivery
  - Presentation and availability of class notes
  - Interaction with students
    - E-mails
    - Blackboard
- Types of structural systems that can be analyzed
Any Questions