A Hands-On Product Dissection Workshop for Engineering Educators

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Motivation

• Product dissection has become a popular pedagogy in the past 10-15 years to give engineering students “hands on” experience in the classroom and help:
  □ Anchor the knowledge and practice of engineering [1]
  □ Develop curiosity, proficiency, and manual dexterity [2]
  □ Increase students’ motivation and retention in engineering [3]
  □ Couple engineering principles with visual feedback [4]
  □ Provide starting points for design proposals, kinesthetic memory triggers, or thinking props [5]
  □ Identify relationships among engineering fundamentals and product (hardware) design [6]
  □ Increase awareness of the design process [7]
  □ Teach competitive assessment and benchmarking [8,9]

Organized by: T. Simpson, G. Kremer, K. Lewis, R. Stone, S. Shooter  
Supported by: NSF Grant No. OCI-0636273
Origins

- Prof. Sheri Sheppard's *ME 99: Mechanical Dissection* at Stanford is credited with over 150 new courses and related advancements since its introduction in 1991.

MECHANICAL DISSECTION

"Mechanical Dissection" is an approach to teaching students about engineering concepts and design principles by having them explore the engineered products around them. This exploration involves having students work in small teams to disassemble and reassemble machines. This exploration leads to insights on materials, function, design alternatives, human factors, and manufacturing. Much of this work was sponsored by the Synthesis Coalition. The home of much of this activity is the Center for Design Research at Stanford.

http://www-adl.stanford.edu/

Today’s Schedule

2:00 - 2:15pm  Welcome and Introduction (Tim)

2:15 - 3:15pm  Dissection Activity & Framework (Rob & Gül)

3:15 - 3:30pm  Break

3:30 - 4:15pm  Dissection Examples & Assessment (Kemper, Rob, and Steve)

4:15 - 4:45pm  Dissection Brainstorming Activity (Steve)

4:45 - 5:00pm  Wrap-up (Tim)
Before We Begin…

- Please introduce yourself:
  - Name, Department, University
  - Previous experience with product dissection?
  - What do you hope to achieve today?

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4:45 - 5:00pm Wrap-up (Tim)
Framework for Classifying Dissection Activities [10]

**INQUIRE**
- Reinforce engr concepts
- Active-learning activities

**EXPLORE**
- Engr (re)design activities
- Discover design rationale
- Illustrate Rev Engr process
- Problem-based learning

**EXPOSE**
- Understanding of artifacts
- Early exposure to principles
- Learning engr vocabulary & terminology
- Reduce apprehension to engr
- Active-learning activities

**INSPIRE**
- Intro to engr principles
- Ground fundamental principles
- Problem-based learning as part of other topics (e.g., CAD)

EXPOSE
- Best suited for 1st and 2nd year courses
- Goal: Familiarize students with physical artifacts in a structured way
- The structure not only ensures proper progression through the activities but also helps students overcome the anxiety
- Used to increase the learning of engineering terminology
- Typically only require high school level of mathematics, physics and chemistry

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INSPIRE

• Useful in 1st and 2nd year courses
• Goal: Introduce design, graphics, or reinforce fundamentals from foundation engineering courses such as statics and mechanics of materials
• Format is usually less structured (students can plan the tear down steps) to promote learning through self-discovery

<table>
<thead>
<tr>
<th>Art</th>
<th>Interproximal Brush</th>
<th>Dentition Squeegee</th>
<th>Pseudoc Section</th>
<th>Interchangeable Heads</th>
<th>Varnished Bristle Head</th>
<th>Collagen fiber of polyester/cotton/elestene</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orthoorthodontic Brush</td>
<td>US0001105</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>Dental Device</td>
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<td>Oral System</td>
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<tr>
<td>Orthodontic Brush</td>
<td>US0602027</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Facilitating oral prosthesis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>US3000081</td>
</tr>
</tbody>
</table>

INQUIRE

• Primarily used in 3rd and 4th year courses
• Goal: Reinforce engineering principles through hands-on activities
• Artifacts are carefully selected to reinforce theory, and the steps are prescribed by the instructor to ensure that the material is covered appropriately.

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EXPLORE

- Appropriate for 3rd/4th (and graduate) year design courses
- Goal: Support redesign and benchmarking
- Completed in an unstructured way with students planning their own tear down steps to foster self-discovery

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4:45 - 5:00pm  Wrap-up (Tim)
**Overview of Dissection Exercises**

- **Penn State** - Dissection to identify and explore products and the design and production of their components

- **Univ. at Buffalo** - Implementation to discover component function, form, manufacturing, and assembly

- **Bucknell Univ.** - Reinforcing design principles through dissection

- **Missouri Science & Technology** - Design synthesis using a repository of dissected products

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**Overview of Dissection Exercises**

Dissection exercises can be implemented…

- in various **institutional settings**

- in many **types** of courses

- to fulfill broad **objectives**
Product Dissection at Penn State

- EDSGN100: Introduction to Engineering Design
  - Introduction to engineering design processes, methods, and decision making using team design projects

- ME240: Product Dissection is taught each spring
  - 18-20 students in ME, IE, EE, and ESci (sophomore-senior)
  - 3 credit course that is part of the Product Realization Minor

- ME240 taught concurrently with three 1st year seminars
  - ME 105S: Product Dissection – Bicycles
  - ME 106S: Product Dissection – Appliances
  - ME 107S: Product Dissection – Engines
  - Each seminar has 10-12 first-year students who are interested in engineering but have not yet declared a major

Product Dissection at Penn State

- EDSGN100: Exercise Requirements:
  - Full disassembly of the product, analyzing function of each component
  - Parts list (Bill of Materials) for the entire product, including function, mass, material, manufacturing process, dimensions, and cost
  - Sketches or pictures of components
  - Create a tree structure to show the relationships between components and subassemblies
  - Energy analysis
Product Dissection at Penn State – Bicycles

- MAE240: In the first 5 weeks of the course, bicycles (typically 10 speed models) are disected and analyzed.
- The “final exam” is a test ride by the instructor.

<table>
<thead>
<tr>
<th>Date</th>
<th>Activity</th>
<th>Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan. 13</td>
<td>Video: Bicycle Evolution</td>
<td></td>
</tr>
<tr>
<td>Jan. 15</td>
<td>Session 0. Getting the patient ready</td>
<td>BM 1, 2, 4</td>
</tr>
<tr>
<td>Jan. 15</td>
<td>Session 1. Brakes and gears</td>
<td>BM 13, 17</td>
</tr>
<tr>
<td>Jan. 20</td>
<td>Session 2. Shifters and chains</td>
<td>BM 9, 10</td>
</tr>
<tr>
<td>Jan. 22</td>
<td>Session 3. Derailleur, Freewheel, and Hub</td>
<td>BM 11, 12</td>
</tr>
<tr>
<td>Jan. 27</td>
<td>Session 4. Crankshaft</td>
<td>BM 6</td>
</tr>
<tr>
<td>Jan. 29</td>
<td>Session 4 (cont.)</td>
<td></td>
</tr>
<tr>
<td>Feb. 3</td>
<td>Session 5. Reassemble and Adjust</td>
<td>BM guide</td>
</tr>
<tr>
<td>Feb. 5</td>
<td>Session 5 (cont.)</td>
<td></td>
</tr>
<tr>
<td>Feb. 10</td>
<td>Session 8. Wiring and Testing</td>
<td></td>
</tr>
<tr>
<td>Feb. 12</td>
<td>Project presentations, hand in journals</td>
<td></td>
</tr>
</tbody>
</table>

- Through lectures and labs, students explore engineering principles such as work, energy, power transmission, biomechanics, and material selection.

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Assessment at Penn State

- Use pre-test and post-test analysis
  
  a. Before dissection, name as many parts as you can in your stapler and postulate the function, material, and manufacturing method for each. Document your answers in the following table:

<table>
<thead>
<tr>
<th>Part Name</th>
<th>Function (What function does the part provide?)</th>
<th>Material (What is the part made of?)</th>
<th>Production Method (What is the manufacturing process used?)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

  b. How do you think the stapler works internally (use sketches to help you explain)?

- Perceptions towards dissection and its impact on understanding design concepts

  Dissection Items | Mean | Standard Deviation |
  -----------------|------|-------------------|
  The dissection activity has helped my team to design a better electric toothbrush. | 3.72 | 0.97 |
  The dissection activity helped me to understand inner workings of an electric toothbrush. | 4.09 | 0.75 |
  The dissection activity has helped my team to redesign the electric toothbrush faster. | 3.50 | 0.99 |
  The dissection activity has helped my team to redesign the electric toothbrush easier. | 3.73 | 0.90 |

Multi-University Summer REU Program

- In Summer 2006, we organized and hosted a multi-institutional REU program centered around dissection
  
  - 5 students from PSU, UB, Drexel, and MST spent 4 weeks at Penn State dissecting and creating CAD models of these products:

    (a) Kodak Water & Sport One-Time-Use Camera
    (b) Mr. Coffee DCF20 Coffee Maker
    (c) Tosterast TH100 Hand-Held Mixer
    (d) Dowlit D20/217 Corded Drill
    (e) Sog N Spy Children’s Toy

  - Students then spent 4 weeks at Drexel learning to use a 3D scanner and creating Wiki documentation for each product
    - [http://gicl.cs.drexel.edu/wiki/CIBER-U](http://gicl.cs.drexel.edu/wiki/CIBER-U)
Examples of Wiki Pages

### See N Say Toy

**Description**

The See N Say Toy is a children's toy, where the user puts a coin into a slot and the toy tells the user what the coin is. The toy also has a button that activates the coin insertion.

**How It Works**

When the user inserts a coin into the toy, a small motor rotates a gear inside the toy. This mechanism is activated by a拉动 lever, which opens the coin insertion slot. The motor then engages the coin and releases it into the toy's mouth. The toy then speaks the name of the coin.

**Parts**

- Coin insertion slot
- Motor
- Gear
-拉动 lever

### Kodak Waterproof One-Time-Use Camera

**Description**

This product is a single-use waterproof camera that contains a Kodak film roll. The camera has a film roll that holds 8 sheets of 35mm film.

**How It Works**

The camera is operated with a button and a film roll. When the button is pressed, the film is advanced to the next sheet. After the last sheet is used, the film roll is replaced and the camera is ready for use again.

**Parts**

- Button
- Film roll
- Film sheet

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### Product Dissection at UB

- **MAE277: Introduction to Mechanical and Aerospace Engineering**
  - Second year required fall course (190-200 students per offering)

- **Course was introduced and became a requirement in 2002**
  - Impacts ABET Outcomes:
    - (f): An understanding of professional and ethical responsibility
    - (h): The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context

- **Course project is a group dissection and reassembly project**
  - 10 weeks to complete
  - 5 person teams
  - Groups fill out preference form for major categories (Major Automotive Components, Large Office Equipment, Lawn Equipment, Computer Components, Small Consumer Products)

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Product Dissection at UB

- Project Requirements:
  - Full disassembly and reassembly procedures, including the difficulty of each step and the required tools
  - Parts list (Bill of Materials) for the entire product
  - Functional design analysis of the product and its components
  - CAD diagrams of some of the product components
  - Design analysis of the complete product, including recommendations, and economic/environmental impact
  - 7 minute oral presentation to entire class

- In 2006 and 2007, digital resources were integrated into the dissection project
  - In 2006, 9 groups were designated CIBER-U, 30 groups were standard
  - In 2007, 16 groups were designated CIBER-U, 16 groups were standard

- CIBER-U groups given Wiki template for reports
  - [http://gicl.cs.drexel.edu/wiki/Template_for_UB_MAE_277_Class](http://gicl.cs.drexel.edu/wiki/Template_for_UB_MAE_277_Class)

CIBER-U WikiMedia Template

- **Executive Summary**
  This section is meant like an abstract and summarizes the entire report

- **Introduction**
  This section should include an introduction of the product and a brief description of group members (i.e., who was responsible for which sections on wiki)

- **Before Disassembly Section**
  General notes about the product (its condition, how it works, how many parts, types of materials, etc.)

- **Disassembly Procedure**
  - Document each step to disassemble the product
  - How difficult was each disassembly step?
  - What types of tools were required to perform this step?
  - Include a picture of each disassembly step

- **After Disassembly**
  - Document each step to reassemble the product
  - How difficult was each assembly step?
  - What types of tools were required to perform this step?
**Examples of Wiki Project Reports**

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Assessment of Results at UB (cont.)

<table>
<thead>
<tr>
<th>Statements 4, 5, 9 and 10 from Survey</th>
<th>CIBER-U</th>
<th>Non CIBER-U</th>
<th>t-stat</th>
</tr>
</thead>
<tbody>
<tr>
<td>The availability of digital resources helped further my understanding of the product my group had.</td>
<td>4.11</td>
<td>3.66</td>
<td>3.02</td>
</tr>
<tr>
<td>The digital resources that I used (CIBER-U, Internet) communicated information in an efficient and user-friendly way.</td>
<td>4.33</td>
<td>3.58</td>
<td>6.02</td>
</tr>
<tr>
<td>I have learned how to use digital formats to record and convey information.</td>
<td>4.02</td>
<td>3.42</td>
<td>4.41</td>
</tr>
<tr>
<td>I was able to use digital formats (MediaWiki, CAD files, pictures, etc.) to learn about my project.</td>
<td>4.20</td>
<td>3.87</td>
<td>2.69</td>
</tr>
</tbody>
</table>

High School Outreach

NYSCEDII invites you to apply for the 2008 Cyber Engineering Workshop for Young Women at the University at Buffalo.

Dates: July 14th - July 18th
Time: 8:30 am - 4:00 pm
Application Due: May 16, 2008

Participants will learn the fundamentals of computer graphics, motion control, and virtual prototyping. Students entering grades 10-12 will experience developing a product and see how computer-based technologies are used in engineering. Accepted applicants will be notified by May 30, 2008.

For more information, please contact NYSCEDII at 645.2395 or visit http://www.nyscedi.buffalo.edu for application materials.

The New York State Center for Engineering Design and Industrial Innovation

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**HS Outreach Activities – 2007 REU Program**

- **Dissection activities**
- **Virtual roller coaster designs**
- **Roller coaster repository components**
- **Motion simulation experiences**

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**Product Dissection at Bucknell University**

- **MECH392: Mechanical Design**
  - Principles and techniques for creative design of machines in relation to specifications and user requirements.
  - Third year required spring course (25-30 students per offering)

- **Mechanical Dissection Lab**
  - TIME: Two-2 hour lab periods. 3 person teams. 3 weeks total to complete.
  - OBJECTIVE: Recognize and formulate the connection between qualitative user requirements, quantitative engineering specifications, and appropriate engineering analysis.

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Product Dissection Requirements

- Lab Assignment Requirements:
  - Identify components of a product
  - Determine how a product accomplishes its function
  - Identify user requirements and formulate engineering specifications

Example: Black and Decker Grinder

<table>
<thead>
<tr>
<th>Part #</th>
<th>Part Name</th>
<th>Category</th>
<th>Function</th>
<th>Material</th>
<th>Picture</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bottom Disk Holder</td>
<td>Support Element</td>
<td>Attaches to bottom disk holder to lock grinding disk in place</td>
<td>Metal</td>
<td><img src="image1.png" alt="Image" /></td>
</tr>
</tbody>
</table>

Product Dissection Requirements

- Requirements (cont.)
  - Determine and apply appropriate analysis to measure engineering specifications.
    - Hand Calculations.
    - Dynamic Simulation (MSC.ADAMS, Working Model) of CAD components.
  - Comment on the product’s ability to address user requirements based on measured engineering specifications.
  - Oral presentation to entire lab section

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Wiki Example

Black and Decker Grinder

**Description**

This product is a product by Black and Decker. The product is used to grind down metal. The purpose of this Wiki is to give the reader insight as to why this grinder works, through the use engineering specifications.

**How It Works**

Inside the grinder there is an electric motor that spins a shaft connected to a bevel gear. The bevel gear is then attached to another driving shaft. A grinding wheel is clamped onto the driving shaft, causing the grinding wheel to spin.

**Why It Works**

Every component in the assembly has a life expectancy due to wear generated by constant friction and other forces acting on the parts. This expectancy varies between individual parts based on the location, direction and magnitude of the forces acting on the parts and also the geometry and material composition of the part.

For the force requirement on the gears to rotate the grind wheel at 10,000 RPM, the power consumption of the grinder was researched. From the power consumption the torque was calculated to be 0.315 ft-lb, which equates to about 2.81 lbs of force on the workspace from the grind wheel. This calculates to 12.462 ft-lb of force at the gears to rotate the grind wheel at 10,000 RPM.

Learning Objectives Assessment

**Assessment**

- Directly assessed student learning using rubric
- Rubric is linked to course outcome, which relates back to course objective, which is linked to program outcomes

<table>
<thead>
<tr>
<th></th>
<th>COURSE OUTCOMES</th>
<th>Content Assessed</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ability to formulate and solve an open-ended design problem using established methods.</td>
<td>Lab 1a: Q1</td>
<td>Device function is articulated with consideration given to all relevant functional phenomena.</td>
<td>Device function is clearly articulated in consideration given to all relevant functional phenomena and how it will be used.</td>
<td>Device function is clearly articulated in consideration given to all relevant functional phenomena and how it will be used.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Device function articulated with consideration given to all relevant mechanical phenomena.</td>
<td>Device function articulated with consideration given to all relevant mechanical phenomena and how it will be used.</td>
<td>Device function articulated with consideration given to all relevant mechanical phenomena and how it will be used.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lab 1a: Q2</td>
<td>Listed user requirements are relevant and consider some user needs.</td>
<td>Listed user requirements are relevant and consider some user needs.</td>
<td>Listed user requirements are relevant and consider all user needs.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Component list is comprehensive. Each part</td>
<td>Component list is comprehensive. Each part</td>
<td>Component list is comprehensive. Each part</td>
<td></td>
</tr>
</tbody>
</table>

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Product Dissection at MST

IDE 20: Engineering Design – 1st year students
- Produce a broad array of creative, partial solutions to sub-functions of a device using online design repository

<table>
<thead>
<tr>
<th>YEAR</th>
<th>MATH, SCIENCE &amp; GENERAL EDUCATION</th>
<th>ENGINEERING FUNDAMENTALS</th>
<th>SYSTEMS &amp; DESIGN</th>
<th>SPECIALIZATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freshman Year</td>
<td>MATH 14-Calculus 1 (4)</td>
<td>FE 10-Careers in Engineering (1)</td>
<td>IDE 20-Engineering Design (3)</td>
<td></td>
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<tr>
<td></td>
<td>Chem 1A-Lab Intro (1)</td>
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<td></td>
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<tr>
<td></td>
<td>Chem 1B-Chemistry 1 + lab (5)</td>
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<td></td>
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<tr>
<td></td>
<td>Eng 11-English Composition (5)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>MATH 16-Calculus 2 (4)</td>
<td></td>
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<tr>
<td></td>
<td>Phys 23-Physics 1 (4)</td>
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<tr>
<td>Sophomore Year</td>
<td>MATH 22-Calculus 3 (4)</td>
<td>EE 151/152-Circuits I + lab (4)</td>
<td>IDE 105-Design Representations (2)</td>
<td></td>
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<tr>
<td></td>
<td>Phys 222-Elem. DE/Matrices (3)</td>
<td>IDE 105-Design Representations (2)</td>
<td>IDE 106-Design Perceptions (1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Phys 24-Physics 2 (4)</td>
<td>IDE 105-Design Representations (2)</td>
<td>IDE 106-Design Perceptions (1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gen Ed elective (5)</td>
<td>IDE 106-Design Perceptions (1)</td>
<td>IDE 106-Design Perceptions (1)</td>
<td></td>
</tr>
<tr>
<td>Junior Year</td>
<td>Communication skills elective (3)</td>
<td>Cpl/EE 111/112-Intr. Cp. Eng.-lab (4)</td>
<td>IDE 220-Design Methodology (3)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Statistics elective (3)</td>
<td></td>
<td>Engineering focus (5)</td>
<td></td>
</tr>
<tr>
<td>Senior Year</td>
<td>Gen Ed elective (5)</td>
<td></td>
<td>Engineering focus (5)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gen Ed elective (5)</td>
<td></td>
<td>Engineering focus (5)</td>
<td></td>
</tr>
</tbody>
</table>

Product Dissection at MST

- IDE 105/106 Design Representations/Perceptions – 2nd year
  - Dissect products to expose manufacturing processes and then sketch/model the components to motivate redesign (project)

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Product Dissection at MST

IDE 220 – Design Methodology

- Concept Variants for Quantitative Tools (homework)
  - Create a product family and synthesize concept variants using Design by Analogy technique
  - Create concept using concept generator software
  - Include in part 1 of the Reverse Engineering Project

Disassembly Plan Example

Learning Outcomes Fulfilled

- Improve students understanding of engineering principles
  - Identify function of each component for a product
- Improve student’s practice of design
  - Identify components that solve same functionality
  - Generate design alternatives
- Improve CI competency of engineering students
  - Uses cyber-infrastructure for collaborative file sharing
  - Uses collaboration software to work in virtual teams
  - Utilizes CS/IST tools
Virtual Dissection

- We are also starting to explore virtual dissection activities whereby the student analyzes a virtual representation of the product on the Wiki [12]
  - 3D PDFs w/animation

Product Dissection at Our Partner Universities

- At Northwestern University, physical and virtual dissections were conducted and compared for the power drill example in ME 240 (Introduction to Design & Manufacturing, 45 students).

- At Virginia Tech, physical dissections were conducted for electric toothbrushes and virtual dissections for See & Say’s in ENGE 1114 Exploration of Engineering Design (300 students).
Current Exercises at Universities

6th Grade
- Digging up the past and putting it back together – Lewisburg Middle School (Associated with Bucknell)

9-12th Grade
- Product Rip-Downs w/Fisher-Price – NYSCEDII Summer HS Workshop on Cyber-Engineering for Women (Buffalo, Penn State, MST, and Drexel)

Freshmen
- Reverse engineering to design forward stapler dissections seminar in Exploring Engineering course – Bucknell
- Mechanical dissection and static analysis activity in Mechanics course – Bucknell
- Partial solution generation in Engineering Design and Computer Applications course – MST
- Electric toothbrush dissection activity – Virginia Tech
- Product dissection - Appliances in seminar course – Penn State
- Product dissection - Bicycles in seminar course – Penn State
- Product dissection - Engines in seminar course – Penn State
- Product dissection in Introduction to Engineering Design course – Sweet Briar College

Sophomores
- Dynamic analysis of a dissected jigsaw in Dynamics course – Bucknell
- Fixed-Axis rotation of power screwdriver in Dynamics course – MST
- Power screwdriver gear train modeling activity in Dynamics course – MST
- Product virtual exploration in Introduction to Mechanical Design and Manufacturing course – Northwestern
- Virtual exploration lab in Introduction to Mechanical Design and Manufacturing course – Northwestern
- Electric toothbrush torque calculation exercise in Dynamics course – Penn State
- Reverse engineering product in Mechanical and Aerospace Engineering Practice course – Buffalo
- CAD and wiki bicycle project in Product Dissection course – Penn State

Organized by: T. Simpson, G. Kremer, K. Lewis, R. Stone, S. Shooter

Supported by: NSF Grant No. OCI-0636273
**Current Exercises at Universities**

**Juniors**
- Mechanical dissection in Mechanical Design course – Bucknell

**Seniors**
- Product dissection postulation in Engineering Design course – Northwestern
- Dissection lab in Introduction to Mechatronics course – Bucknell
- Dissection and reverse engineering in select projects in Senior Design course – Bucknell
- Product dissection lab in Engineering Design course – Northwestern
- Evaluation of virtual dissection in Product Design course – Penn State (open to any year)

**Graduates**
- Toy dissection to understand product family design – Penn State
- Commonality assessment by dissecting product families – Penn State
- Concept variants from quantitative tools in Product Design course – MST

**Challenges of Product Dissection [11]**

- Acquiring products for dissection can be very costly
- Large workspace needed for dissecting products
- Products and dissection tools require storage space
- Maintenance and support costs can be high:
  - $300/year for a 50 person course at Penn State
  - $1000/year for 200 person course at University at Buffalo
  - $5000/year for 1200 person course at Virginia Tech
- Extra TA support may be needed to ensure safety
- First-time instructors may be intimidated
- Considerable planning and forethought needed to prepare a successful dissection activity
Today’s Schedule - Update

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
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<tbody>
<tr>
<td>2:00 - 2:15pm</td>
<td>Welcome and Introduction (Tim)</td>
</tr>
<tr>
<td>2:15 - 3:15pm</td>
<td>Dissection Activity &amp; Framework (Rob &amp; Gül)</td>
</tr>
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<td>3:15 - 3:30pm</td>
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<tr>
<td>3:30 - 4:15pm</td>
<td>Dissection Examples &amp; Assessment (Kemper, Rob, and Steve)</td>
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<td>Dissection Brainstorming Activity (Steve)</td>
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<td>Wrap-up (Tim)</td>
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How Can You Use Product Dissection?

- Brainstorming:
  - Identify opportunities in your curriculum where dissection activities can be implemented
- Think about various course levels
- Think about framework and objectives – *Expose, Inspire, Inquire, and Explore*
- Think realistically given the experienced challenges
How Does Exercise Fit into Dissection Framework?

**INQUIRE**
- Reinforce engr concepts
- Active-learning activities

**EXPLAIN**
- Engr (re)design activities
- Discover design rationale
- Illustrate Rev Engr process
- Problem-based learning

**EXPOSE**
- Understanding of artifacts
- Early exposure to principles
- Learning engr vocabulary & terminology
- Reduce apprehension to engr
- Active-learning activities

**INSPIRE**
- Intro to engr principles
- Ground fundamental principles
- Problem-based learning as part of other topics (e.g., CAD)

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2008 ASEE Annual Conference & Exposition
A Hands-On Product Dissection Workshop for Engineering Educators

Workshop Wrap-Up

• We have EXPOSED you to a variety of product dissection activities that we hope will INSPIRE you to INQUIRE and EXPLORE product dissection for own use

• To learn more, we encourage you to visit:
  - CIBER-U: http://gicl.cs.drexel.edu/wiki/CIBER-U
  - Mechanical Dissection: http://www-adl.stanford.edu/
  - Product Dissection Course at Penn State: http://www.mne.psu.edu/simpson/courses/me240/

References Cited