NSDL/NSTA Web Seminar
Teach Engineering: Because Dreams Need Doing

Thursday, February 19, 2009
Who's presenting today

Mindy Zarske
K-12 Engineering Coordinator
Integrated Teaching and Learning Program
University of Colorado at Boulder
Boulder, CO
"Nobody ever suggested engineering to me."

Mike Mooney
Associate Professor of Engineering
Colorado School of Mines
Golden, CO
“a high school guidance counselor told me I wasn’t *smart enough* to be an engineer”

http://nsdl.org
http://nsdl.org

- NSDL Pathways for specific content & audience
- NSDL Engineering Pathway: K-Gray
- Rich variety of materials found in one place

http://engineeringpathway.org
Goal: Use of Engineering Design to Engage Students in Learning

A collection of high-quality curriculum within the NSDL Engineering Pathway

http://teachengineering.org
Outline:

✓ What do engineers do?
✓ What is the engineering design process?
✓ What are types of engineering?
✓ What are some engineering activities that I can use with my students?

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What do Engineers Do?
Stamp all the ones you think apply

<table>
<thead>
<tr>
<th>Fix Broken Cars</th>
<th>Design Medical Equipment</th>
<th>Build new wind turbines</th>
<th>Design sport shoes</th>
<th>Create a sculpture</th>
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<tbody>
<tr>
<td>technician</td>
<td>technician</td>
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<td>artisan</td>
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[http://nsdl.org](http://nsdl.org)
Engineers *design* everything…

- Medical devices
- Roller coasters
- Computer games
- Music studio technology
- iPods, cell phones
- Alternative energy technologies
- Water filtration systems
- Hybrid cars
Grand Challenges for Engineering

- Make solar energy economical
- Provide energy from fusion
- Develop carbon sequestration methods
- Manage the nitrogen cycle
- Provide access to clean water
- Restore and improve urban infrastructure
- Advance health informatics
- Engineer better medicines
- Reverse-engineer the brain
- Prevent nuclear terror
- Secure cyberspace
- Enhance virtual reality
- Advance personalized learning
- Engineer the tools of scientific discovery

...awaiting engineering solutions in the 21st century!

*As determined by a committee of the National Academy of Engineering. [http://www.engineeringchallenges.org/](http://www.engineeringchallenges.org/)
Engineering Design Process
common to all designed items

What order is typically followed?

Order the steps below from 1 to 5…

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<td><strong>Square</strong></td>
<td><strong>Triangle</strong></td>
<td><strong>Circle</strong></td>
<td><strong>Diamond</strong></td>
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<tr>
<td>Select &amp; Test</td>
<td>Define Problem or Need</td>
<td>Research Investigate Gather Info</td>
<td>Analyze Evaluate Solutions</td>
<td>Propose Design Solutions</td>
</tr>
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Engineering Design Process

- Define Problem or Need
- Propose Design Solutions
- Research Investigate Gather Info
- Select & Test
- Analyze Evaluate Solutions
- Brainstorming

- Does it work?
- Modify & redesign
- Does solution meet need?
- What similar things exist?
Engineering Design Process

What is the problem? What do we want to accomplish? What are the project requirements? What are the limitations? Who is the customer? What is our goal?

Gather information and conduct research - talking to people from many different backgrounds.

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There is always more than one possible way to solve a problem .... lots of brainstorming involved. This is where really creative ideas come from.

Engineers evaluate multiple design solutions to determine if and how well they meet the design criteria.

Per qualitative or quantitative rating system, a final design is selected. The final design is then thoroughly tested.
What are the different types of engineers?

What are some types of engineers that you are familiar with?

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</tbody>
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Type your answers in the boxes

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There are many types of engineering

Here are some of them…

• Aerospace
• Agricultural
• Biological
• Biomedical
• Chemical
• Civil
• Computer Science
• Electrical
• Environmental

• Geotechnical
• Industrial and Systems
• Material Science
• Mechanical
• Metallurgical
• Nuclear
• Petroleum
• Software
Welcome to the world of K-12 engineering!

Engineers have a hand in designing, creating or modifying nearly everything we touch, wear, eat, see and hear. Introducing engineering into the K-12 classroom connects science and math concepts to the everyday engineering that surrounds us. This teacher resource, TeachEngineering.com, helps teachers enhance learning, excite students and stimulate interest in science and math through the use of hands-on engineering.

The TeachEngineering digital library provides teacher-tested, standards-based engineering content for K-12 teachers to use in science and math classrooms. Engineering lessons connect real-world experiences with curricular content already taught in K-12 classrooms. Mapped to educational content standards, TeachEngineering's comprehensive curricula are hands-on, inexpensive, and relevant to children’s daily lives.

There are many ways to access the materials in this collection:

- **Search** the collection by specifying keywords, grade levels, educational standards, or other criteria
- **Browse** curricular contents by subject area, curricular units, lessons or activities
- Access your favorite items and submit reviews in your own personalized **MyTE** area

And remember — you don't need knowledge of engineering to use these curricula!
Biomedical engineering

What is it?
Biomedical engineering applies the engineering design process to the medical and biological sciences to improve health care and people’s quality of life.

What K-12 science does it relate to?
Biology, life science, human body
Example TeachEngineering Activities for Biomedical Engineering

Prosthetic party
Student teams investigate biomedical engineering and the technology of prosthetics. Students create a model prosthetic lower leg using various materials. Each team demonstrates its prosthesis' strength and consider its pros and cons, giving insight into the characteristics and materials biomedical engineers consider in designing artificial limbs.

No Valve in Vain
In this activity, students will design and create their own heart valves out of a variety of materials. This activity will not only test their understanding of how a one-way valve works and its purpose, but will also allow them a chance to think outside of the box and practice engineering problem-solving.
Let’s go check it out!

http://teachengineering.org
Environmental engineering

What is it?
Environmental engineering applies the engineering design process to air, water and land resources to improve the quality of human life and other organisms, and to remediate pollution.

What K-12 science does it relate to?
Life science, ecology, water, geology

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Example TeachEngineering Activities for Environmental Engineering

**Engineers Speak for the Trees**
Students begin by reading Dr. Seuss' The Lorax as an example of how overdevelopment can cause long-lasting environmental destruction. Student teams are asked to serve as natural resource engineers, city planning engineers and civil engineers with the task to replant the nearly destroyed forest and develop a sustainable community design that can co-exist with the re-established natural area.

**Groundwater Detectives**
Student teams locate a contaminant spill in a hypothetical site by measuring the pH of soil samples. Then they predict the direction of groundwater flow using mathematical modeling. They also use the engineering design process to come up with alternative treatments for the contaminated water.
How engaging do you think these types of activities are for girls?

(A) Very engaging
(B) Somewhat engaging
(C) Definitely engaging
How engaging do you think these types of activities are for girls?

Girls want a career that *makes a difference*. Engineering design activities give young women an opportunity to be creative and a context for how they can help improve the health, happiness and safety of others.
Geotechnical engineering

What is it?
Geotechnical engineering applies the engineering design process to subsurface conditions and materials to determine physical and chemical properties of an area.

What K-12 science does it relate to?
earth science, rocks & minerals, geological processes
Example TeachEngineering Activities for Geotechnical Engineering

Asteroid Impact unit

An asteroid is on a collision course with earth; it is projected to impact somewhere in North America. The surface of the earth will be uninhabitable for one year. Your engineering team must design underground caverns to house the 10 million people of Alabraska for one year.

Unit Summary
- 8 lessons
- 450 to 550 minutes

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Student teams:
(1) explore general and geological maps
(2) determine the area of their classroom to help determine the cavern size
(3) learn about map scales
Student teams:
(4) test and classify rocks
(5) identify important rock properties for underground caverns
(6) choose a final location and size

In what rock type would you build caverns?

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How likely are you to try an engineering activity in your classroom?

(A) Not very likely
(B) I might give one a try
(C) I definitely want to try one
(D) I already do engineering activities.
http://engineeringpathway.org
http://teachengineering.org

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THANK YOU!
Learn about new tools and resources, discuss issues related to science education, find out about ways to enhance your teaching at:

http://expertvoices.nsdl.org/learningdigitalK12

Resources from this seminar:

http://www.diigo.com/list/nsdlworkshops/web-sem-engineering

Search for “diigo nsdl workshops engineering”

http://nsdl.org
National Science Teachers Association
Dr. Francis Q. Eberle, Executive Director
Zipporah Miller, Associate Executive Director
Conferences and Programs
Al Byers, Assistant Executive Director e-Learning

NSTA Web Seminars
Flavio Mendez, Senior Director
Jeff Layman, Technical Coordinator

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