STEM: Engineering Is at the Heart of It

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STEMSmart
WHY ENGINEERING IN K-12?
Educational Context is Changing

• Great societal interest in successful K-12 STEM education
• Very large fraction of STEM jobs will be in engineering and technology
• Engineering is woven throughout the Next Generation Science Standards
• Employers are looking for “soft skills” such as teamwork, communication, problem solving
• Technology is increasingly integrated into our lives
Engineering improves understanding of science and math topics

- Provides meaning, real-world applications
- Provides integration across disciplines
- Provides inquiry- and project-based exploration of the world
- Can start in elementary grades
- From knowing to creating

Bloom’s Taxonomy (Revised)

Based on an APA adaptation of Anderson, L.W. & Krathwohl, D.R. (Eds.) (2001)
Engineering is Fun!

• Encourages collaboration
• Empowers through problem solving
• Encourages creativity
• Engages and inspires all kinds of students
HOW TO INTEGRATE ENGINEERING?
What is Engineering?

• The engineering process, according to Engineering is Elementary

Kids love to do these things!
Engineering in the K-12 Classroom

• Start with core math, science, and technology
• Build on these when introducing engineering design activities into existing curricula
• Use existing resources and appropriate engineering examples – engineering serves as a unifying topic, emphasizes the interconnectedness of STEM subjects
Engineering Activities

• Project-based learning
  – Best if real-world projects
  – Even better if projects include service learning (helping people with disabilities, helping the environment)

• Work done in teams
  – Students learn collaboration and compromise
  – They learn to use their own strengths to fit a specific situation, using their talents to be valued by the team

• Open-ended problems
  – No “one right solution”
  – Special needs students thrive in these settings
It’s Roller Coaster Season!
The Physics of Roller Coasters
(from www.teachengineering.org/)

• Grade 7 activity
• Uses students’ existing physics knowledge of forces, gravity and friction, Newton’s Second Law of Motion, position, velocity, acceleration, and kinetic and potential energy
• Students explore the most basic physical principles of roller coasters, which are crucial to the initial design process for engineers building roller coasters
• Students explore the physics used by engineers in designing today’s roller coasters, including potential and kinetic energy, friction, and gravity
• Afterwards, students will be able to analyze the motion of any existing gravity-driven coaster and design the basics of their own roller coasters
• During an associated activity, the students design, build, and analyze a roller coaster for marbles out of foam tubing
WHAT ENGINEERING RESOURCES ARE THERE?
Informal Education

• Maker Movement (http://makerfaire.com)
• Hacker Scouts (www.Hacker-Scouts.org)
• Industry activities
  – Intel Science Talent Search
• Professional Societies
  – National Engineers Week (www.futurecity.org)
NSF Example Projects

• Integrating Engineering and Literacy at Tufts University
• Studio STEM at Virginia Tech
• UTeach Engineering at University of Texas at Austin
NSF Partnerships – RETs

• NSF Research Experiences for Teachers
  – STEM teachers perform engineering and computer science research and translate their research experiences and new knowledge into classroom activities
  – 90 sites, 500 teachers per year
  – www.ret-eec.org
NSF Partnerships - ERCs

- NSF Engineering Research Centers
  - Build relationships with K-12 teachers and students to help integrate engineering concepts into precollege education
  - Over 46,000 K-12 students participated in ERC outreach programs in 2012.
  - [www.erc-assoc.org](http://www.erc-assoc.org)
Classroom Resources

• Engineering is Elementary [www.eie.org](http://www.eie.org)
• Engineering, Go for It! [www.egfi-k12.org](http://www.egfi-k12.org)
• Engineering Pathway [www.engineeringpathway.org](http://www.engineeringpathway.org)
• Engineer Your World [www.engineeryourworld.org](http://www.engineeryourworld.org)
• Teach Engineering [www.teachengineering.org](http://www.teachengineering.org)
Engineering Ecosystem

• Engineering colleges spread throughout the nation
• Faculty, graduate students, undergraduate students, deans, department chairs, ...
• Practicing engineers in industry
• Government labs
• *Enormous untapped resources*
High School Student Pursues Visionary Doctoral Research

• Noelle Stiles, an 11th-grader at Villa Park High School, began working with BMES ERC Prof. Tanguay in Fall 2003.

• Now a doctoral student at Caltech, her graduate research focuses on devices for rehabilitation of the blind—a direct progression from her early association with the BMES ERC.
Conclusions

• Infusing engineering into K-12 STEM education offers a novel direction to address a critical educational and societal challenge
• NSF is supporting and catalyzing this change
• Engineering community will engage
• We will all benefit from the change

Questions?

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