



Science vs. Engineering

different goals

- **Science:** The study of the universe. An attempt to explain everything – seeking *answers to questions*.
- **Engineering:** The use of science and math concepts to *solve problems*. Technology is a result of this process.

Science vs. Engineering

similar procedure

- **Creative**
- **Iterative**
new designs / explanations tested and revised
- **Systematic**
each involves a somewhat defined process used to reach goals

Why engineering?

Key component of the Next Generation Science Standards (NGSS)

- “To reflect the importance of understanding the human-built world”
- “recognize the value of better integrating the teaching and learning of science, engineering, and technology”

NGSS overview

- Foundation: The K-12 Science Framework
- Reflects advances in science & a better understanding of how students learn
- Divided into three general categories
 - **Practices**
 - **Concepts**
 - **Ideas**

8 Science & Engineering Practices

- These are the **knowledge** and **skills** required *to do* science and engineering
 - Asking questions (**S**) and defining problems (**E**)
 - Planning and carrying out investigations
 - Analyzing and interpreting data
 - Developing and using models
 - Constructing explanations (**S**) and designing solutions (**E**)
 - Engaging in argument from evidence
 - Using mathematics and computational evidence
 - Obtaining, evaluating and communicating information

7 Crosscutting Concepts

- Fundamental concepts that bridge all the ideas
 - Patterns
 - Cause and effect: mechanism and explanation
 - Scale, proportion and quantity
 - Systems and system models
 - Energy and matter: flows, cycles and conservation
 - Structure and function
 - Stability and change

44 Disciplinary Core Ideas

- These are the content of the NGSS by grade level
- Focus on deep understanding and application of the content
- Presented as a progression
- Divided into 4 broad categories:
 - Physical sciences
 - Life sciences
 - Earth and space sciences
 - Engineering, technology and applications of science

Connections to CCSS-ELA standards

- **RL: Reading literature**
 - *Those Darn Squirrels* (Adam Rubin, ill: Daniel Salmieri)
 - Other books to spark interest
- **RI: Reading informational texts**
 - Connects projects to real world
 - Background information for projects
- **W: Writing**
 - Make & display posters about science projects
- **SL: Speaking and listening**
 - Productive discussions
 - Create presentations, informational videos etc.

Why teach engineering?

- Key component of the NGSS
- Fun – “children are natural engineers”
- Increasing demand for engineers, fewer students enrolling
- Interdisciplinary
- **Develops critical thinking, communication & problem solving skills (connect to Common Core)**

Engineering design challenges

2 Components:

- The challenge
What is the problem to be solved?
- The constraints
limits, such as materials, time, other “rules”
For almost any engineering design challenge activity, you can adapt and extend by changing one or both of these elements!

Engineering design process

- Ask**
 - Define the problem
 - Do background research
 - Specify requirements
- Imagine**
 - Brainstorm solutions
- Plan**
 - Choose the best solution
 - Develop the solution
- Create**
 - Build a prototype
 - Test
- Improve**
 - Evaluate results, then redesign
 - Cycle can start at any point!

Graphic from www.teachengineering.org

Design Challenge: House of Cards

Graphic from www.teachengineering.org

ASK *(the challenge)*

What is the tallest structure you can make from these materials?

- What do you know about paper as a building material?
- What do you know about tape?
- Any strategies for building tall things?

IMAGINE

- What shapes are good for building?
- What designs might work? What won't work?
- What kind of base will you use?
- How will you give your structure stability?
- Sketch some possible designs – Brainstorm!

PLAN

- Look at your brainstorm ideas and sketches.
- Which one seems like the best idea to try?
- Choose one!
- How will you begin?

CREATE!

- Build your structure.
- You have __ minutes.

EVALUATE & REVISE

- How did you do? Measure your structure.
- What worked? What didn't?
- What else could you try or do differently?

House of Cards

- How to adapt for the library?
- How to incorporate writing, speaking, listening – key ELA standard skills?
- How to differentiate?
- How to turn this into a more in depth project?
- Variations using same materials but different challenges?

Other engineering project ideas

- Slow a falling marble
- Launch something towards a bucket/target
- Stomp rockets
- Paper airplanes
- Marshmallow toothpick structures
- Index card bridges
- Solar oven design
- Redesign band-aids
- Kinetic sculpture / mobile
- Design something to pick something else up
- Design a switch
- Invent musical instruments
- Find a way to keep an ice cube from melting
- Redesign packaging to make it less likely to entrap marine wildlife
- Build an earthquake resistant structure and test it
- Marble roller coaster

Resources

- **CRS** – call, email, website (crscience.org)
- **NSTA** has many resources related to NGSS
- CA Department of Education
- Tryengineering.org and teachengineering.org

Engineering Design process:

- Stanford d.school
- *What I Wish I Knew When I Was 20*
Tina Seelig