

ENGINEERING IN MIDDLE SCHOOL SCIENCE


Presented by

Jarred Corwin

Mary Rinehart

Indiana Department of Education





What does it mean to incorporate Engineering into Science?

- Engineering is a way to apply scientific principles!
 - Ask questions about the natural and man-made world
 - Design solutions to solve a problem
 - Look to the process standards for guidance
- [Another Way to Look at It...](#)
 - [NASA Engineering](#)
 - [Crash Course Kids](#)

6-8 Indiana Science Standards

Engineering (E)

6-8.E.1 Identify the criteria and constraints of a design to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

6-8.E.2 Evaluate competing design solutions using a systematic process to identify how well they meet the criteria and constraints of the problem.

6-8.E.3 Analyze data from investigations to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

6-8.E.4 Develop a prototype to generate data for repeated investigations and modify a proposed object, tool, or process such that an optimal design can be achieved.



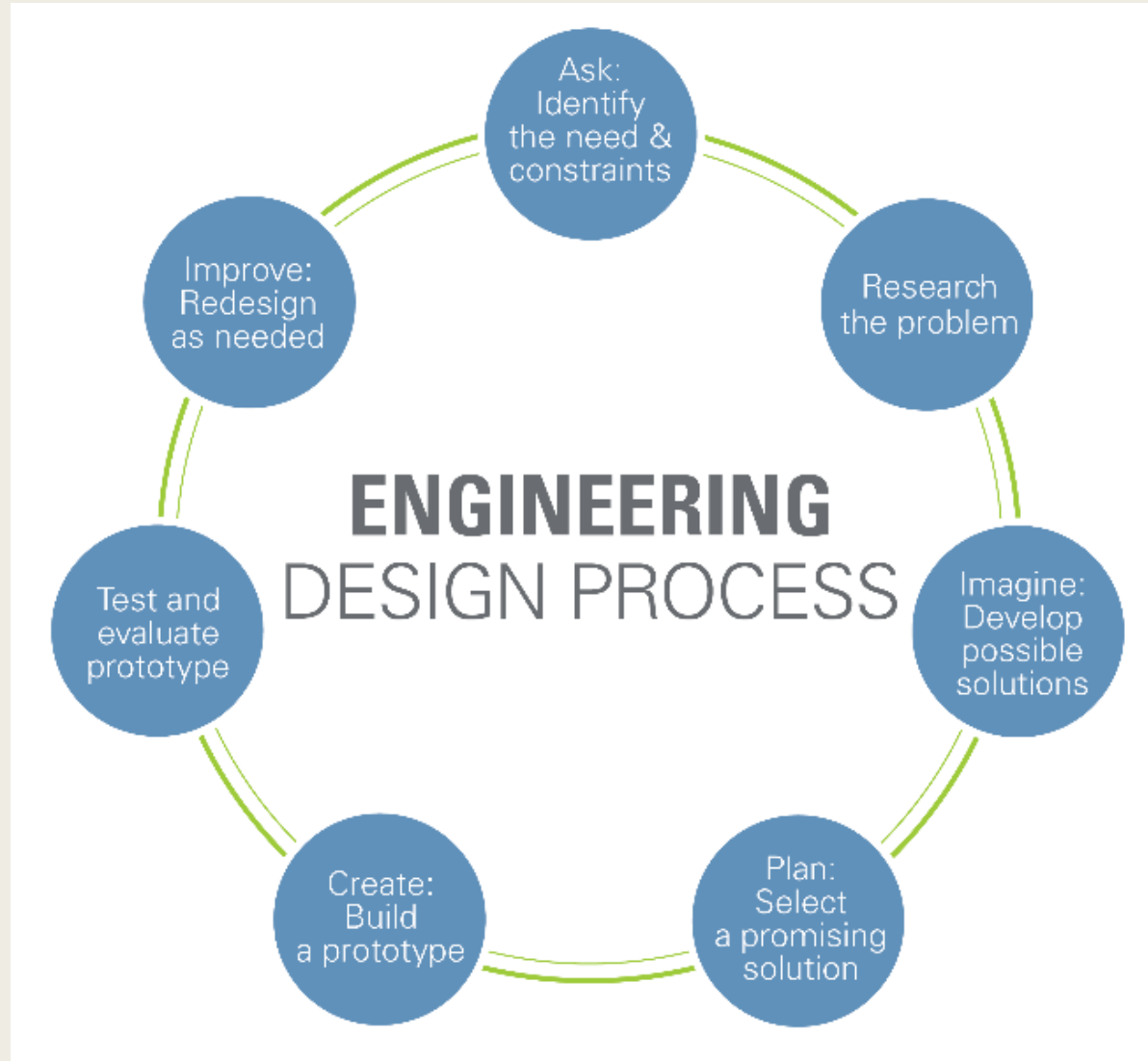
IDOE Science Standards

- Grade bands
- Integrated with content (not stand alone)
- Freedom to pair
- Not instructional practice
- Not curriculum

IN DOE Science Standards can be found at:

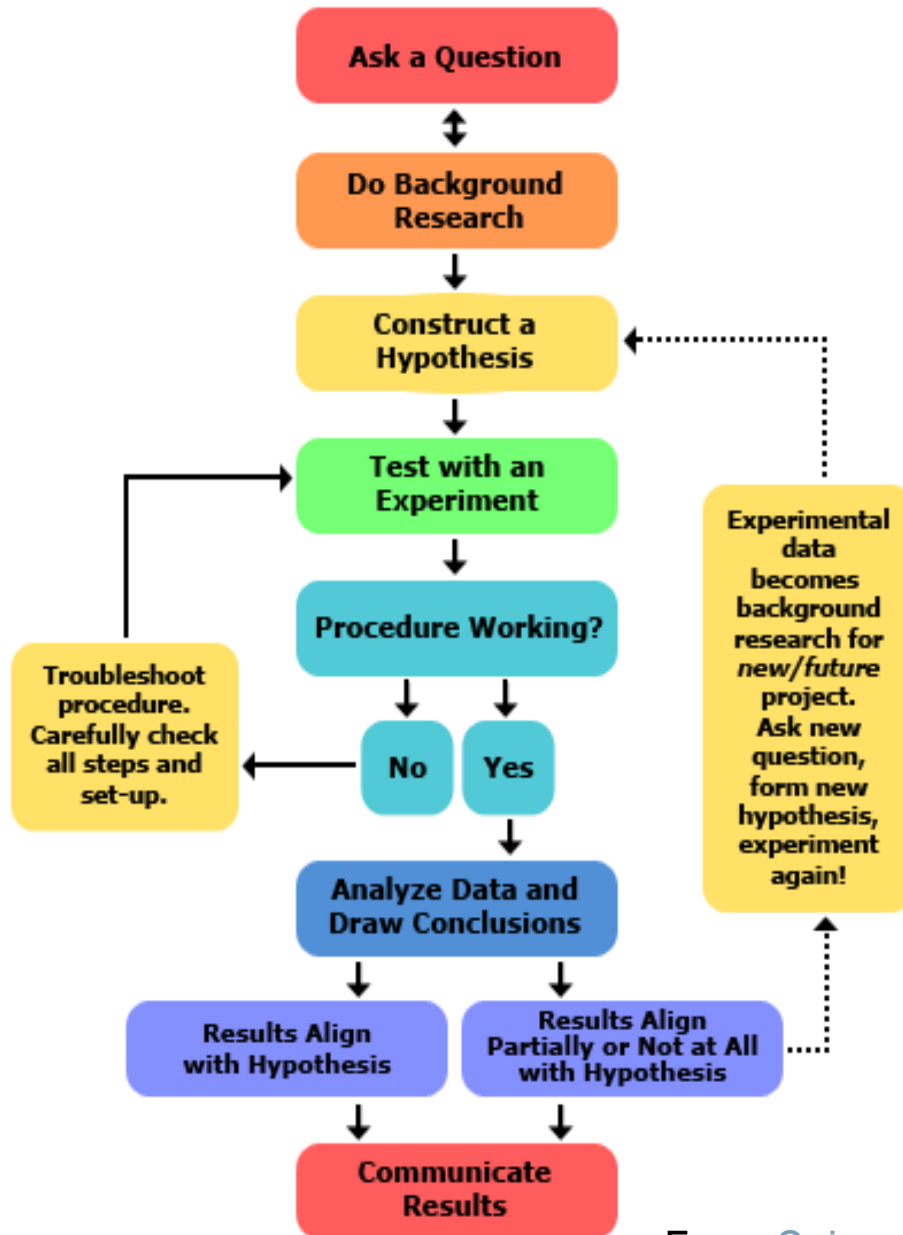
- <http://www.doe.in.gov/sites/default/files/standards/indiana-sixth-grade-standards-2016-41116.pdf>
- <http://www.doe.in.gov/standards/science-computer-science>

Engineering Design Process

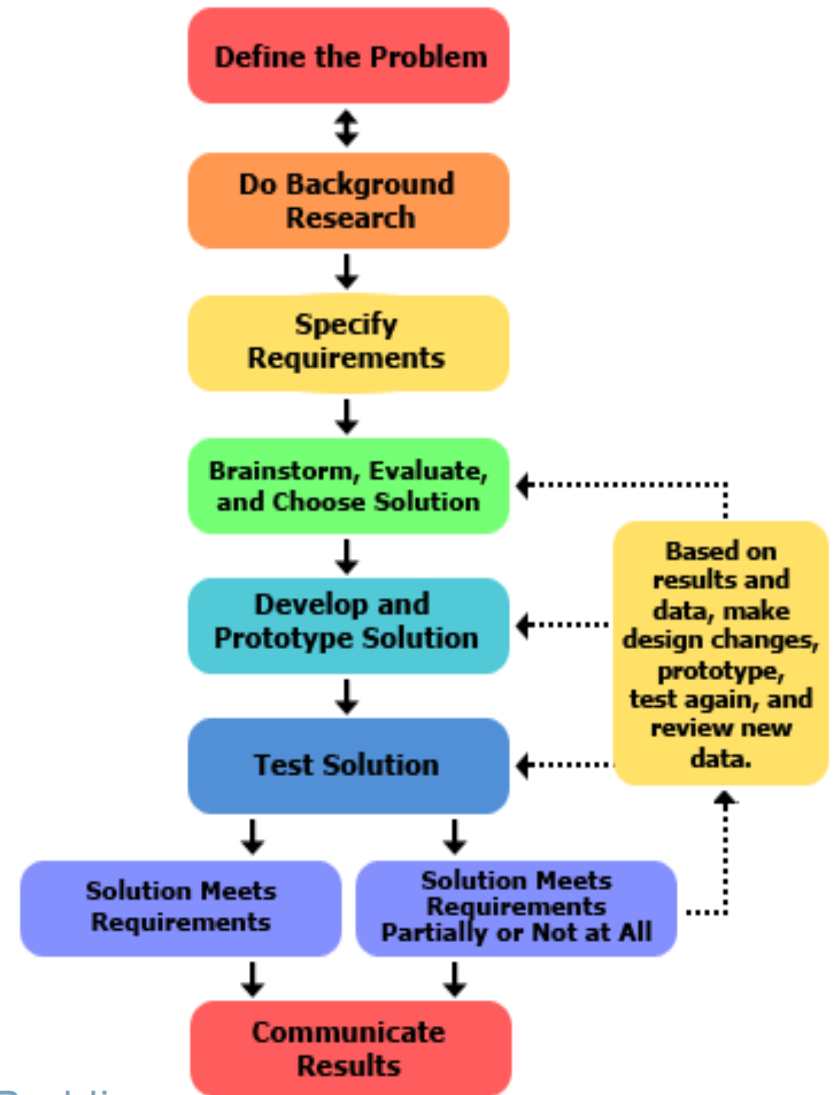


From [Teach Engineering](#)

Scientific Method



Engineering Method



From [Science Buddies](#)



Are you ready for a vocab quiz?

Vocabulary

- Criteria
- Constraint
- Design
- Engineering
- Prototype
- Testing
- Evaluate
- Technology
- Solution
- Problem
- Systems & Processes
- [Vocabulary Cards](#)

Criteria & Constraints

Criteria – Guidelines or rules used to judge or make a decision about something

Constraints - Limitations or restrictions on your design.

Example:

Instructions

1. Work with your team to design, sketch, and build a model of an animal rescue device that can rescue a trapped zoo animal. Your group will decide how to rescue the animal by lifting and moving it to a safe area. Follow these criteria and constraints for your design:

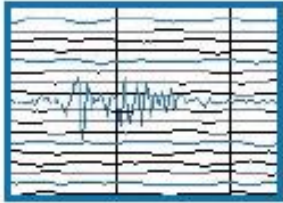
Criteria	Constraints
<p>Criteria are guidelines or rules for your design.</p> <ul style="list-style-type: none">• The group will design, build, and test a device to rescue a trapped zoo animal.• The device must safely lift the animal at least 4 inches and set it down in a safe area away from where the animal was trapped.• You must include a magnet in your design.• Your design must include a compound machine consisting of at least two simple machines.• A harness for the animal must be created that safely supports the animal and does not pull on the animal's tail, legs, or head.	<p>Constraints are the limitations or restrictions on your design.</p> <ul style="list-style-type: none">• Your teacher will determine the amount of time you have to design, sketch, and build your model.• You are limited to the following materials:<ul style="list-style-type: none">○ VEX IQ® Kits○ String <p>https://www.pltw.org/indyvex</p>

Criteria & Constraint Activity

- Take a moment to examine the sample activity
- Complete the first task on the Engineering & Design template – identify the problem, criteria, and constraints

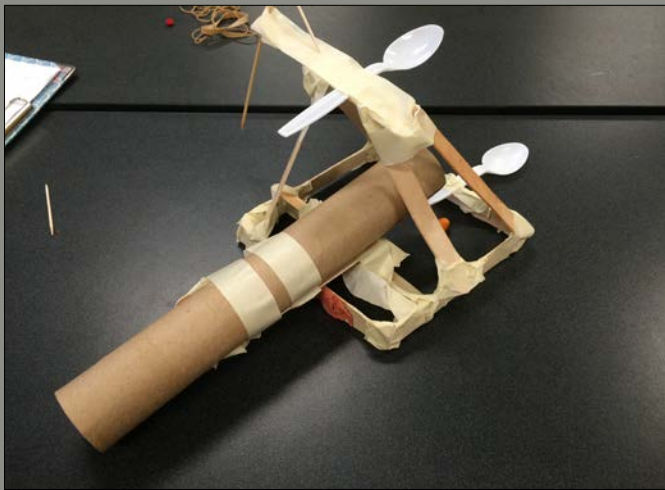
Shake It Up with Seismographs

Record earthquake activity in your classroom by designing your own seismograph.



Step	Write your responses in these blocks.
1. ASK What is the problem?	
1. ASK What are the criteria (requirements)?	
1. ASK What are the constraints?	

Prototyping



- The “Create” phase of the design process
- Develop then test
- Prototypes can be made out of...anything!
 - *Logs results in an engineering notebook*
 - *Evaluate results*
 - *Did the prototype meet the requirements for the design solution or not?*
 - *If not, fix prototype → back to the drawing board!*
 - *If yes, finalize prototype and communicate results. Can be virtual...although something to actually test is preferable for students.*
- Can be virtual...although something to actually test is preferable for students.

Engineering Notebooks vs. Science Notebooks

- **Purpose** – Legal record of engineering design process
- **Similarities** – Both require log record; both structured; both should be bound together with no loose pages; both can be digital
- **Differences** – Engineering notebook less formally structured; Requires dates and signatures; Meant as a legal document

Continue From Page # **86**

Entries

This Page # **87**

1st Idea for a Wheel and Axle Sub-System

5/15 I came up with a way to use the wheel and axle in my design & weight falls into the bucket and causes the axle to spin. The wheel (what looks like a hand crank in this case) is attached to the axle and would also spin hitting something and transferring its energy to the next part of the system. Now I have to figure out how to use it in my system.

My instructor let me borrow a book to help me get some ideas for my system. I found a great idea for a screw and wedge mechanism on page 194.

Chironis, N. and Sclater, N. (1996). Mechanisms and Mechanical Devices Sourcebook (2nd edition). New York, NY: McGraw-Hill

5/15 It's Sunday, and I came in at 10:00 AM to work on the project. I spent the morning modifying the wheel and axle design, because I think it is going to cause too much friction between the side walls and the bracket that will hold it in place. I also went to the other Technology Lab and found some 1/2 diameter aluminum bar stock to make my wheel and axle.

Too much friction

Chamfer creates less surface contact

Smaller diameter keeps string from binding

2nd Idea Modified Wheel and Axle address potential friction issue

OWNER / DESIGNER <i>Brook Norton</i>	DATE May 15, 2010	UNIT <input type="checkbox"/> PROJECT <input checked="" type="checkbox"/> Axle
WITNESS / TEACHER <i>G. Platt</i>	DATE May 15, 2010	PROPRIETARY INFORMATION



Project Ideas

- Use Engineering to apply scientific principles you are already working on in class and to increase understanding.
- Community projects already in place
- Example?
- STEM certified schools?



NAE GRAND CHALLENGES FOR ENGINEERING

NATIONAL ACADEMY OF ENGINEERING

- The NAE Grand Challenges are the 14 Challenges that the National Academy of Engineering has identified that our children will face in their lifetime.
- It is what Engineering is all about!

NAE Grand Challenges for Engineering:

Advanced Personalized Learning
Make Solar Energy Economical
Enhance Virtual Reality
Reverse-Engineer the Brain
Engineer Better Medicines
Advanced Health Informatics
Restore and Improve Urban Infrastructure
Secure Cyberspace
Provide Access to Clean Water
Provide Energy from Fusion
Prevent Nuclear Terror
Manage the Nitrogen Cycle
Develop Carbon Sequestration Methods
Engineer the Tools of Scientific Discovery



Resources for Teachers

- [Teach Engineering](http://www.teachengineering.org) www.teachengineering.org
- [Science Buddies](http://www.sciencebuddies.org) www.sciencebuddies.org
- [DiscoverE](http://www.discovere.org) www.discovere.org
- <http://www.k12stemplans.com/my-blog/increasing-cognitive-rigor-with-scienceengineering>



Questions?



Contact Information



Jarred Corwin

Secondary Science and
STEM Specialist

317-232-9175

jcorwin@doe.in.gov

@JarredCorwin

Mary Rinehart

Engineering and Technology
State Program Leader

317-232-0815

mrinehart@doe.in.gov

  @IndianaETE

