



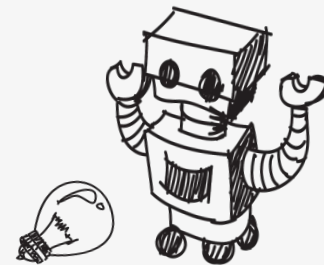
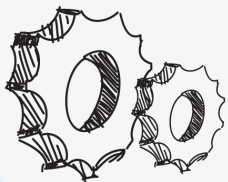
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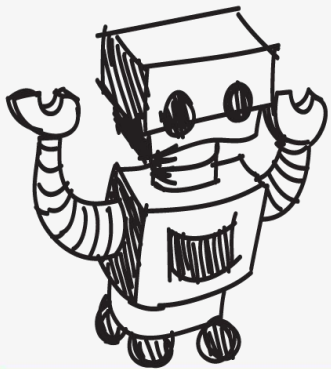


**Lesson Plan:**

# Salamander Crossing



# The Design Challenge



# The Design Challenge

In the springtime, adult salamanders leave their forest homes and return to vernal pools where they breed and lay eggs. If a roadway exists between these two habitats, they have to cross the road to reach this very important destination.

You are a team of engineers working together to design a way to get a salamander safely from one side of the road to the other. You will first build a model habitat that includes a wooded area on one side, a vernal pool on the other side and a road running in between. Then, you will need to change your model into a salamander-friendly habitat by building a way for the salamander to get from the woods to the vernal pool without having to cross the road.



# The Design Challenge

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Remember that you may need to build something to help guide salamanders to your crossing as well. Salamanders also have to remain damp in order to survive. Think about how your crossing will allow for this.



# Defining the Challenge: Criteria & Constraints

## Criteria

- Habitat must have a wooded area on one side, a vernal pool on the other side and a road running in between
- Salamander has to remain damp to survive

## Constraints

- Use only the materials provided.



# Material

## Materials – Required (Table of Possibilities)

- Student worksheets with photo of salamander (for students to cut out and color) or provide pre-cut salamanders
- Clay or play dough, in multiple colors (including blue, green, and black)
- Clay or play dough tools (rollers/rolling pins, cookie cutters)
- Paperclips
- String
- Strips of paper or cardstock



# Material

- Paper towel and toilet paper tubes or sheets of cardboard to roll up
- Trays or small boxes or box tops
- Natural material, like twigs, pine needles, and leaves, which can be used to represent different natural areas in the model



# Testing Process

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Students test their salamander crossing by attaching string to their salamander and placing it in the woods. They will then pull the salamander through or over the crossing (it can be pulled through tunnels, etc., if necessary).



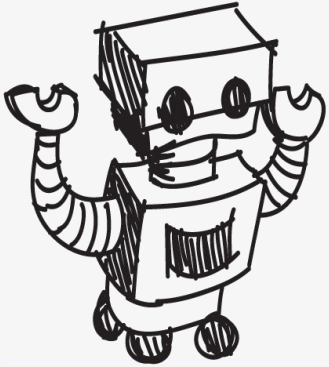


# Consider...

- Before you get started building, consider that you must first build a model habitat that includes a wooded area on one side, a vernal pool on the other side and a road running in between.
- Then, they will need to change the model into a salamander-friendly habitat by building a way for the salamander to get from the woods to the vernal pool without having to cross the road.



# Reflect & Debrief

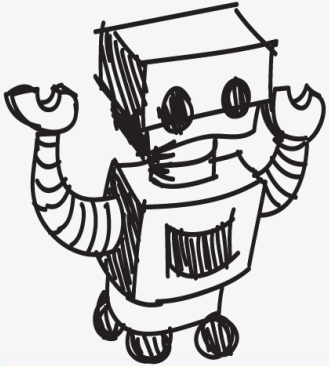


# Reflection

- What method did you choose for your salamander crossing? Why? How will your design make sure salamanders can stay damp?
- How did your crossing work when you tested it? Were there any problems?
- How do you think you could improve upon your design? What changes would you make to it?
- What ideas did your classmates come up with that you liked? Are there any ideas you would want to incorporate into your design?



# Engineering Design Process



# The Engineering Design Process



Learn about the engineering design process (EDP). The process engineers use to solve problems.  
*(Video 1:47)*



Source: TeachEngineering YouTube Channel <http://www.youtube.com/watch?v=b0ISWaNoz-c>

# Engineering Design Process

- Divide into teams
- Review the challenge and criteria & constraints
- Brainstorm possible solutions (sketch while you brainstorm!)
- Choose best solution and build a prototype
- Test then redesign until solution is optimized
- Reflect as a team and debrief as a class

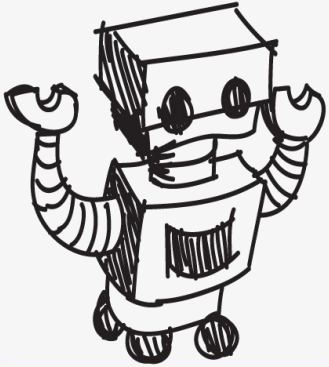


# Productive Failure

- The engineering design process involves productive failure: test, fail, redesign. Iterate again and again until you have the best possible solution.
- It is important to document iterations to keep track of each redesign. Use the engineering notebook to sketch ideas, document iterations and any measurement and/or calculations.
- It's also important to showcase the fact that there can be multiple solutions to the same problem. There's no one "right" solution.



# Vocabulary





# Vocabulary

- Conservationist: A person who tries many methods to help salamanders and other amphibians migrate safely.
- Constraints: Limitations with material, time, size of team, etc.
- Criteria: Conditions that the design must satisfy like its overall size, etc.
- Engineers: Inventors and problem-solvers of the world. Twenty-five major specialties are recognized in engineering ([see infographic](#)).
- Engineering Design Process: Process engineers use to solve problems.
- Engineering Habits of Mind (EHM): Six unique ways that engineers think.
- Iteration: Test & redesign is one iteration. Repeat (multiple iterations).



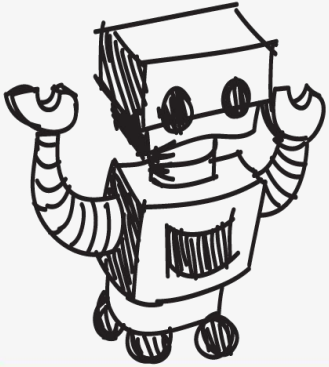
# Vocabulary

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- Method: Way to solve a problem or challenge.
- Migrate: To pass from one region to another on a regular basis. Many birds migrate south for the Winter.
- Prototype: A working model of the solution to be tested.
- Vernal pools: Where salamanders breed, lay their eggs, and the hatched larvae begin their lives living in the water.



**Dig Deeper**



# Dig Deeper into the Topic

## Internet Connections

- Animals Need Infrastructure Too  
([www.citylab.com/life/2018/07/wildlife-crossingsbridges-tunnels-animals-roads-highways-roadkill/566210/](http://www.citylab.com/life/2018/07/wildlife-crossingsbridges-tunnels-animals-roads-highways-roadkill/566210/))
- Banff Wildlife Crossing  
(<https://mymodernmet.com/wildlife-crossings/>)
- Wildlife crossings stop roadkill. Why aren't there more?  
([www.youtube.com/watch?v=ND0D3bVbM7Y](http://www.youtube.com/watch?v=ND0D3bVbM7Y))
- Salamander Crossing Brigade  
([www.wmur.com/article/tuesday-may-9thsalamander-crossing-brigade/9604209](http://www.wmur.com/article/tuesday-may-9thsalamander-crossing-brigade/9604209))



# Dig Deeper into the Topic

## Internet Connections

- Salamander Crossing ([www.youtube.com/watch?v=VbPljRb4zc8](http://www.youtube.com/watch?v=VbPljRb4zc8))
- There Are Teeny Tiny Underpasses for Salamanders in Massachusetts ([www.boston.com/cars/news-and-reviews/2015/03/25/there-are-teeny-tiny-underpasses-for-salamanders-in-massachusetts](http://www.boston.com/cars/news-and-reviews/2015/03/25/there-are-teeny-tiny-underpasses-for-salamanders-in-massachusetts))

## Recommended Reading

- Salamander Sky by Katy Farber (ISBN: 978-0999076644)
- Amphibian by Barry Clarke (ISBN: 978-0756613808)
- Salamander Dance by David FitzSimmons (ISBN: 978-1936607006)
- How Do Wildlife Crossings Save Animals? (ISBN: 978-1543541380)



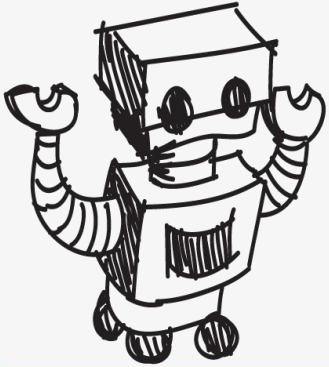
# Dig Deeper into the Topic

## Writing Activity

Think about where you live and the types of wildlife you encounter. Are there areas where these encounters are problematic? Or where natural movements of animals are disrupted? What do you think should be done to help keep humans and animals safe? If you could design a new structure in your community, or change an existing one, what would it be?



# Engineering Fields



# What is Engineering?



Learn about engineering and how engineers are creative problem solvers and innovators who work to make the world a better place.

*(Video 3:43)*



Source: TeachEngineering YouTube Channel - <http://www.youtube.com/watch?v=H9VDkvaGmVo>

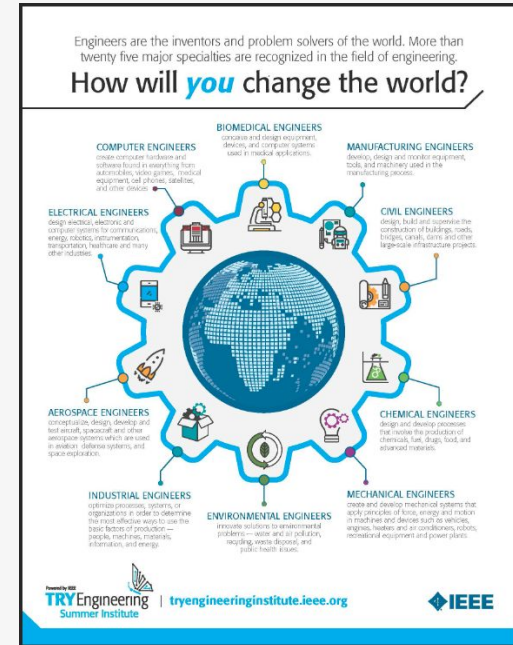
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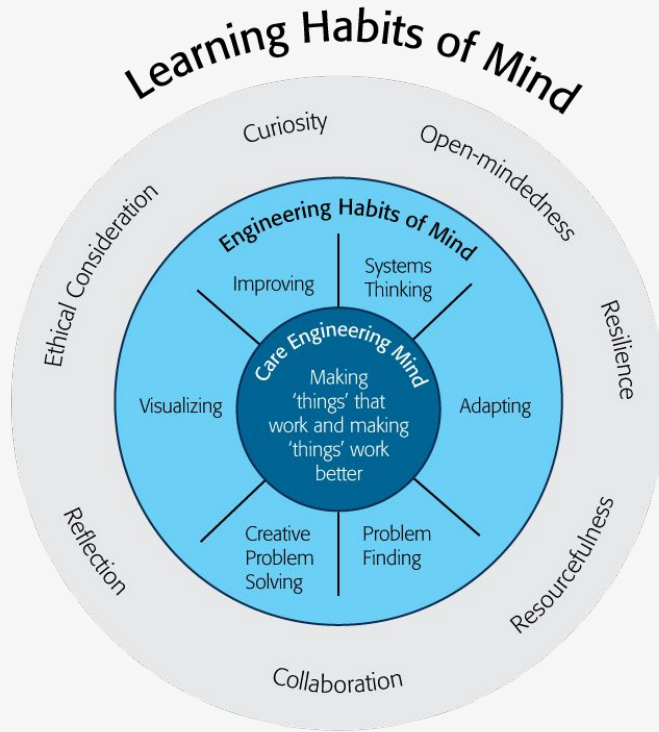


# Related Engineering Fields

- There are several types of engineering fields that are involved with designing safe ways to help animals. Here are just some of the related engineering fields.
  - Mechanical Engineering
  - Environmental Engineering
- Download the Engineering Fields Infographic  
How will **YOU** change the world?



# Engineering Habits of Mind



Engineering Habits of Mind (EHM) is about how engineers think everyday. The Core Engineering Mind is about making things that work and making them work better.

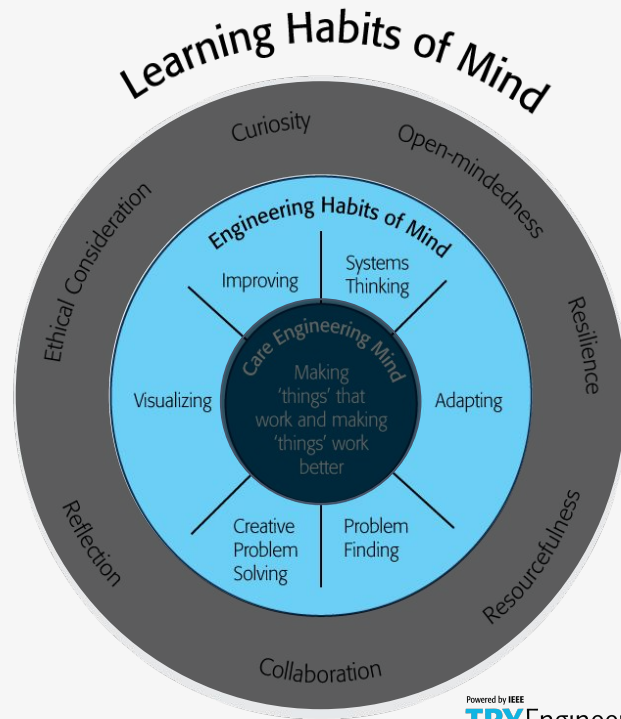
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<https://online-journals.org/index.php/i-jep/article/view/5366>



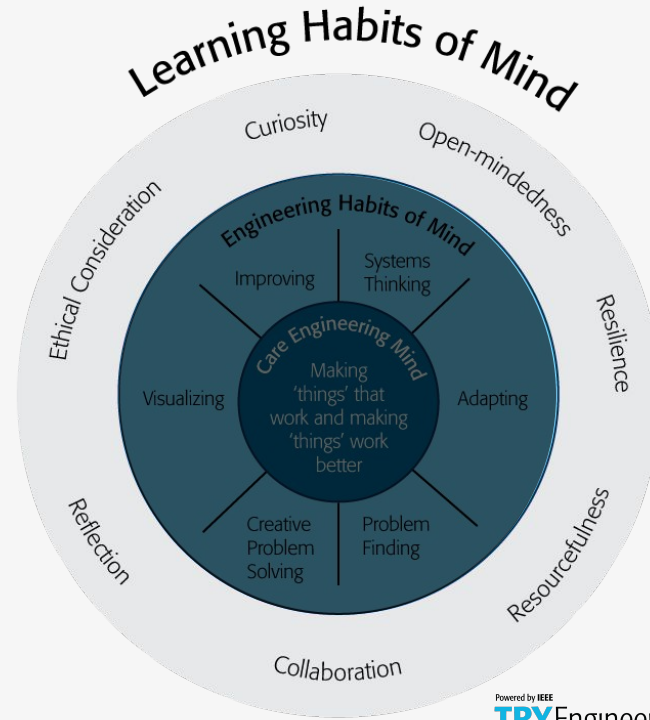
# Engineering Habits of Mind Checklist

- ❑ Systems thinking
- ❑ Problem-finding
- ❑ Visualising
- ❑ Improving
- ❑ Creative problem-solving
- ❑ Adapting



# Learning Habits of Mind Checklist

- ❑ Open-mindedness
- ❑ Resilience
- ❑ Resourcefulness
- ❑ Collaboration
- ❑ Reflection
- ❑ Ethical Consideration
- ❑ Curiosity



# Greatest Engineering Achievements of the 20th Century



## Greatest Engineering Achievements OF THE 20<sup>TH</sup> CENTURY

### Welcome!

How many of the 20th century's greatest engineering achievements will you use today? A car? Computer? Telephone? Explore our list of the top 20 achievements and learn how engineering shaped a century and changed the world.

1. Electrification
2. Automobile
3. Airplane
4. Water Supply and Distribution
5. Electronics
6. Radio and Television
7. Agricultural Mechanization
8. Computers
9. Telephone
10. Air Conditioning and Refrigeration

11. Highways
12. Spacecraft
13. Internet
14. Imaging
15. Household Appliances
16. Health Technologies
17. Petroleum and Petrochemical Technologies
18. Laser and Fiber Optics
19. Nuclear Technologies
20. High-performance Materials

LinkEngineering



Source: <http://www.greatachievements.org/>

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# Learn more about how engineers make the world a better place



The banner features the NAE logo (three interlocking puzzle pieces) and the text "NAE GRAND CHALLENGES FOR ENGINEERING" with "NATIONAL ACADEMY OF ENGINEERING" in smaller text below. Navigation buttons for "Challenges", "News", and "Community" are in green rounded rectangles. The main visual is a green puzzle piece with a white gear icon, set against a background of glowing green and yellow lines radiating from a central point. Below the puzzle piece, the text "Provide energy from fusion" is displayed, followed by a paragraph: "Human-engineered fusion has been demonstrated on a small scale. The challenge is to scale up the process to commercial proportions, in an efficient, economical, and environmentally benign way." A row of ten diamond-shaped icons represents various engineering fields: a smartphone, VR, a gear, a classical building, a water drop, a nuclear symbol, a CO2 molecule, a sun, a brain, a laptop, a padlock, and a gear.

NAE GRAND CHALLENGES FOR ENGINEERING  
NATIONAL ACADEMY OF ENGINEERING

Challenges News Community

## Provide energy from fusion

Human-engineered fusion has been demonstrated on a small scale. The challenge is to scale up the process to commercial proportions, in an efficient, economical, and environmentally benign way.



For more engineering lesson plans and resources like games, engineering careers, and STEM opportunities visit IEEE's [TryEngineering.org](https://www.tryengineering.org)

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