

## Adaptations Lesson 3: “The Engineer” Educator’s Resource Guide

### Objective:

Students will:

1. Design a prototype for a product that uses the function of an animal or plant adaptation as inspiration and provides a human with the same benefits.
2. Optional Extension: Build, test, and finalize prototype (Appendix C)

**Time Required:** 150 minutes

Materials Required	Safety/Other Considerations	Science & Engineering Practices
<ul style="list-style-type: none"> <li>• Student handout</li> <li>• Regular and colored pencils, erasers</li> <li>• Blank sheets for sketches (8.5 x 11)</li> <li>• Construction paper and markers (for final prototype design)</li> <li>• Computers (as option if making presentations on the computer)</li> <li>• Additional materials if doing the extension: building prototype</li> </ul>	None	<ul style="list-style-type: none"> <li>• Designing Solutions</li> <li>• Communicating Findings/Design (Oral Presentation)</li> </ul>

### Inquiry Scale: Leveling Information

**Level 1** (most teacher-driven) *(recommended for grades 4-5)*

Provide the table of potential products (Appendix A) that give the human client the benefit of an adaptation of the trait that the learner focused on in the “Make”. At this inquiry level, though learners are given the potential product types, their engineer process will bring it to life through a poster presentation and an optional construction extension. Initiate and model the entire engineer process of designing the product inspired by the adaptation. Learners then design poster presentations in small groups.

**Level 2:** *(recommended for grades 5-6)*

Provide the table of example adaptations and adaptation functions, but leave out the last column that outlines potential products (Appendix B). Using these examples, split students into small groups to select a focal adaptation and identify features before coming back to share as a class. Split students again into

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small groups to brainstorm ideas for product designs and finalize their product design in a final poster presentation and/or construction of the trait.

**Level 3:** *(recommended for grades 6-7)*

Students decide on their focal trait independently. Then, conduct a classwide brainstorm to pull out all key features of each adaptation chosen. Students split into small groups to brainstorm ideas for product designs and finalize their product design in a final poster presentation.

**Level 4:** *(recommended for grades 7-8)*

Students complete all parts of the Engineer process independently, including identifying key features of their adaptation, brainstorming and finalizing product design, and constructing their final poster presentation.

## Agenda:

### I. Show PowerPoint to introduce the Engineer Activity (7-10 minutes)

The PowerPoint will review essential concepts learned in “The Make” and provide context for their upcoming “Engineer” challenge.

#### PowerPoint Slide Guide

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Slide 2: Animal and plant adaptations have been the inspiration for countless innovations that have benefited humans. Camel humps are full of fat that allows them to go for long periods without water. The camel hump is an inspiration for backpack hydration systems.

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Slide 3: Has anyone ever noticed products that benefit humans that were probably inspired by observing the traits of animals and plants? The products could be inspired technologically, mechanically or aesthetically.

1. Think-pair-share
2. Share out responses.

*\*If students have trouble thinking of advancements, prompt them to think of how the adaptations highlighted in the Make Powerpoint could be inspirations for product prototype designs (Appendix A)*

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Slide 4-6: Now I am going to show you some examples of a process of observation and product prototype design that was used by Leonardo Da Vinci.

1. First, Leonardo would observe nature very closely
2. Then, he would make quick sketches with descriptions for many aspects of the form or function of the trait
3. Finally, he would create a very detailed sketch of the design for a prototype that was inspired by the trait or adaptation. Recently, people have used Leonardo Da Vinci’s drawings to actually build the prototypes designed in his sketches!

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Slide 7: Now it's your turn to design...

1. Using the trait or adaptation that was featured in your filmstrip, can you think of some of its key features that may inspire a product for the benefit of humans?
2. *Ask students to think to themselves for a moment, then have students discuss as a table group*

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Slide 8: Today, you're going to do the same! For your Design Challenge, you are going to use key aspects of the trait from the Make and design a product that will benefit your human client. After brainstorming form and function design ideas, you will sketch and describe your design in detail.

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Slide 9: Here is an overview of your design process. Do you have any questions?

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## II. Engineer Activity (120 minutes)

As guided by their planning organizers, students:

1. Identify the key features of their specific trait used in the Make.
1. Use separate sheets of paper for their labeled sketches.
2. Create a final prototype design drawing using construction paper, colored pencils, and markers.

If students need suggestions for products, feel free to give them suggestions from the "Engineering Suggestions" document in Appendix A, below the Assessment Rubric.

The Engineering Planning Organizer

What is your focus adaptation or trait?

1

Describe some key features of the adaptation or trait.

2

Brainstorm some ideas for product designs based upon the key features of the adaptation or trait. Label the parts on any sketches you make (55).

3

From your brainstorm ideas, choose one idea that you will develop further. This will become your final product. On the sketch, label the function of each part of your structural design.

4

## III. Presentation and Assessment (10 minutes)

Presentation/Assessment

Students present their final prototype designs; assessment parameters are suggested below.

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## Engineer Assessment: Project Grade and Rubric Score Sheet - Adaptations

Project Submitted by \_\_\_\_\_

### Adaptations Engineer Checklist: Content Concepts and Practices

The challenge: Design a product for a human based on an animal or plant adaptation.

#### Project Completeness

- The product and presentation meets all requirements and include:
  - A clear and creative title
  - A labeled drawing that identifies the organism and trait that the product is based on
  - A labeled diagram of the product design
  - Details about how the product benefits the human client
  - Well-organized diagrams and captions, arranged in a logical order

#### DCI Standards

- The product and presentation are accurate and includes:
  - A caption that explains the function of the trait
  - An explanation of how the trait helps the organism survive or reproduce
  - A caption that explains how an application of this trait could be helpful to humans

#### Science & Engineering Practices Rubric:

	Emerging (1)	Developing (2)	Proficient (3)	Advanced (4)
<b>Designing Solutions</b>	Applies no scientific principles and/or data to design, construct, and/or test a design of an object, tool, process or system.	Applies minimal scientific principles and/or data to design, construct, and/or test a design of an object, tool, process or system.	Applies adequate scientific principles and/or data to design, construct, and/or test a design of an object, tool, process or system.	Applies complete scientific principles and/or data to design, construct, and/or test a design of an object, tool, process or system.
<b>Communicating Findings/Design (Oral Presentation)</b>	Findings/Design are incompletely and inaccurately communicated. Or no evidence of using appropriate eye contact, adequate volume, or clear pronunciation.	Findings/Design are completely communicated with some misconceptions. Or Uses minimal eye contact, inappropriate volume, or inconsistent pronunciation.	Findings are completely communicated but lack depth. Or often uses eye contact and engaging and appropriate volume and pronunciation, but is inconsistent.	Findings/Design are completely communicated with depth and complexity. Or mostly uses eye contact and engaging and appropriate volume and pronunciation.

Teacher Comments:

Final Score:

Final Grade:

## Appendix A: Engineering Suggestions

Example Adaptation	Adaptation Function	Potential Products
Camouflage	Protect from detection	<ul style="list-style-type: none"> <li>• Jacket for a dog so that it cannot be easily spotted by hawks and coyotes</li> <li>• Exterior house paint colors that are designed to help house blend into its natural surroundings</li> </ul>
Mimicry	Copy aspects of the original as benefit	<ul style="list-style-type: none"> <li>• Honeycomb-shaped bricks that are stronger than rectangular and square bricks for building</li> <li>• Better wind turbines inspired by fins, tails and flippers</li> <li>• Eye make-up colors inspired by butterfly wing colors</li> <li>• Solar-powered delivery drones inspired by the flight patterns and wings of a bat</li> </ul>
Survival advantage	Physical characteristics that enhances fit for survival within certain environments	<ul style="list-style-type: none"> <li>• "Cherry pickers" to help pick fruit or deliver goods</li> <li>• Special eating utensils to help with difficult-to-manage foods (peas, spaghetti, etc.)</li> </ul>
Reproductive advantage	Physical characteristics that enhance attractiveness of potential mates	<ul style="list-style-type: none"> <li>• Clothing fabrics and accessories</li> <li>• Perfumes and colognes</li> </ul>
Mobility advantage	Attributes or characteristics that facilitate movement to or through locations with more food, more mates, etc	<ul style="list-style-type: none"> <li>• Concept vehicles</li> <li>• Specialty submarines</li> <li>• Specialty flight-vehicles</li> </ul>

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## Appendix B: Engineering Suggestions without Potential Products (Inquiry Scale Level 2)

Example Adaptation	Adaptation Function	Potential Products
Camouflage	Protect from detection	
Mimicry	Copy aspects of the original as benefit	
Survival advantage	Physical characteristics that enhances fit for survival within certain environments	
Reproductive advantage	Physical characteristics that enhance attractiveness of potential mates	
Mobility advantage	Attributes or characteristics that facilitate movement to or through locations with more food, more mates, etc	

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## Appendix C: Build Your Prototype

<p>1. Identify Materials and explain their representation</p> <ul style="list-style-type: none"> <li>•</li> <li>•</li> <li>•</li> <li>•</li> <li>•</li> <li>•</li> </ul>	<p>Teacher Approval Stamp</p>	
<p>2. Construct: Your teacher will specify the amount of “build time.”</p>		
<p>3. Test Prototype:</p>	<p>Plan your test:</p> <ol style="list-style-type: none"> <li>a. What will you test?</li>   <li>b. How will you test it? Write a summary of your procedure.</li>   <li>c. What do you expect to happen? Make a prediction.</li> </ol>	<p>Test your prototype. Record your observations here:</p>
<p>4. Make Modifications</p>	<p>What will you change based on test observations and why? Your teacher will specify the amount of “build time” for modification.</p>	
<p>5. Present your final design</p>	<p>*Use Adaptations Engineer Checklist to meet all requirements</p>	