

AkinEngineeringDesignChallenge

Phase I: Research and Planning

1. Identify the “Big” concept to be covered by the engineering design challenge.

How does Engineering Models help us learn and discover in Science, particularly in Life Sciences for Elementary Students 1st-5th grade? How can we tie this challenge into our Green Infrastructure project? How can we plant better plants in the greenhouse, when the containers make it hard for us to take the seedlings out?

2. Research appropriate learning standards associated with the topic.

1st -2nd Grade NGSS

1-LS1-1 From Molecules to Organisms: Structures and Processes

<p>Students who demonstrate understanding can:</p> <p>1-LS1-1. Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs.* [Clarification Statement: Examples of human problems that can be solved by mimicking plant or animal solutions could include designing clothing or equipment to protect bicyclists by mimicking turtle shells, acorn shells, and animal scales; stabilizing structures by mimicking animal tails and roots on plants; keeping out intruders by mimicking thorns on branches and animal quills; and, detecting intruders by mimicking eyes and ears.]</p>		
<p>The performance expectation above was developed using the following elements from the NRC document <i>A Framework for K-12 Science Education</i>.</p>		
<p style="text-align: center;">Science and Engineering Practices</p> <p>Constructing Explanations and Designing Solutions</p> <p>Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions.</p> <ul style="list-style-type: none"> Use materials to design a device that solves a specific problem or a solution to a specific problem. 	<p style="text-align: center;">Disciplinary Core Ideas</p> <p>LS1.A: Structure and Function</p> <ul style="list-style-type: none"> All organisms have external parts. Different animals use their body parts in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in food, water and air. Plants also have different parts (roots, stems, leaves, flowers, fruits) that help them survive and grow. <p>LS1.D: Information Processing</p> <ul style="list-style-type: none"> Animals have body parts that capture and convey different kinds of information needed for growth and survival. Animals respond to these inputs with behaviors that help them survive. Plants also respond to some external inputs. 	<p style="text-align: center;">Crosscutting Concepts</p> <p>Structure and Function</p> <ul style="list-style-type: none"> The shape and stability of structures of natural and designed objects are related to their function(s). <p style="text-align: center;">-----</p> <p style="text-align: center;"><i>Connections to Engineering, Technology, and Applications of Science</i></p> <p>Influence of Science, Engineering and Technology on Society and the Natural World</p> <ul style="list-style-type: none"> Every human-made product is designed by applying some knowledge of the natural world and is built using materials derived from the natural world.
<p><i>Connections to other DCIs in first grade: N/A</i></p> <p><i>Articulation of DCIs across grade-levels:</i></p> <p>K.ETS1.A ; 4.LS1.A ; 4.LS1.D ; 4.ETS1.A</p> <p><i>Common Core State Standards Connections:</i></p> <p><i>ELA/Literacy -</i></p> <p>W.1.7 Participate in shared research and writing projects (e.g., explore a number of “how-to” books on a given topic and use them to write a sequence of instructions). (1-LS1-1)</p>		

2-LS2-1 Ecosystems: Interactions, Energy, and Dynamics

Students who demonstrate understanding can:

- 2-LS2-1.** Plan and conduct an investigation to determine if plants need sunlight and water to grow. *[Assessment Boundary: Assessment is limited to testing one variable at a time.]*

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. <ul style="list-style-type: none"> Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question. 	LS2.A: Interdependent Relationships in Ecosystems <ul style="list-style-type: none"> Plants depend on water and light to grow. 	Cause and Effect <ul style="list-style-type: none"> Events have causes that generate observable patterns.
<i>Connections to other DCIs in second grade: N/A</i>		
<i>Articulation of DCIs across grade-levels:</i> K.LS1.C ; K.ESS3.A ; 5.LS1.C		
<i>Common Core State Standards Connections:</i>		
<i>ELA/Literacy —</i>		
W.2.7 Participate in shared research and writing projects (e.g., read a number of books on a single topic to produce a report; record science observations). (2-LS2-1)		
W.2.8 Recall information from experiences or gather information from provided sources to answer a question. (2-LS2-1)		
<i>Mathematics —</i>		
MP.2 Reason abstractly and quantitatively. (2-LS2-1)		
MP.4 Model with mathematics. (2-LS2-1)		
MP.5 Use appropriate tools strategically. (2-LS2-1)		

Structure, Function, and Information Processing

Students who demonstrate understanding can:

- 1-LS1-1.** Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs.* *[Clarification Statement: Examples of human problems that can be solved by mimicking plant or animal solutions could include designing clothing or equipment to protect bicyclists by mimicking turtle shells, acorn shells, and animal scales; stabilizing structures by mimicking animal tails and roots on plants; keeping out intruders by mimicking thorns on branches and animal quills; and, detecting intruders by mimicking eyes and ears.]*
- 1-LS1-2.** Read texts and use media to determine patterns in behavior of parents and offspring that help offspring survive. *[Clarification Statement: Examples of patterns of behaviors could include the signals that offspring make (such as crying, cheeping, and other vocalizations) and the responses of the parents (such as feeding, comforting, and protecting the offspring).]*
- 1-LS3-1.** Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents. *[Clarification Statement: Examples of patterns could include features plants or animals share. Examples of observations could include leaves from the same kind of plant are the same shape but can differ in size; and, a particular breed of dog looks like its parents but is not exactly the same.] [Assessment Boundary: Assessment does not include inheritance or animals that undergo metamorphosis or hybrids.]*

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

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Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<p>Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions.</p> <ul style="list-style-type: none"> Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena. (1-LS3-1) Use materials to design a device that solves a specific problem or a solution to a specific problem. (1-LS1-1) <p>Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in K–2 builds on prior experiences and uses observations and texts to communicate new information.</p> <ul style="list-style-type: none"> Read grade-appropriate texts and use media to obtain scientific information to determine patterns in the natural world. (1-LS1-2) <p>-----</p> <p style="text-align: center;"><i>Connections to Nature of Science</i></p> <p>-----</p> <p>Scientific Knowledge is Based on Empirical Evidence</p> <ul style="list-style-type: none"> Scientists look for patterns and order when making observations about the world. (1-LS1-2) 	<p>LS1.A: Structure and Function</p> <ul style="list-style-type: none"> All organisms have external parts. Different animals use their body parts in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in food, water and air. Plants also have different parts (roots, stems, leaves, flowers, fruits) that help them survive and grow. (1-LS1-1) <p>LS1.B: Growth and Development of Organisms</p> <ul style="list-style-type: none"> Adult plants and animals can have young. In many kinds of animals, parents and the offspring themselves engage in behaviors that help the offspring to survive. (1-LS1-2) <p>LS1.D: Information Processing</p> <ul style="list-style-type: none"> Animals have body parts that capture and convey different kinds of information needed for growth and survival. Animals respond to these inputs with behaviors that help them survive. Plants also respond to some external inputs. (1-LS1-1) <p>LS3.A: Inheritance of Traits</p> <ul style="list-style-type: none"> Young animals are very much, but not exactly like, their parents. Plants also are very much, but not exactly, like their parents. (1-LS3-1) <p>LS3.B: Variation of Traits</p> <ul style="list-style-type: none"> Individuals of the same kind of plant or animal are recognizable as similar but can also vary in many ways. (1-LS3-1) 	<p>Patterns</p> <ul style="list-style-type: none"> Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence. (1-LS1-2),(1-LS3-1) <p>Structure and Function</p> <ul style="list-style-type: none"> The shape and stability of structures of natural and designed objects are related to their function(s). (1-LS1-1) <p>-----</p> <p style="text-align: center;"><i>Connections to Engineering, Technology, and Applications of Science</i></p> <p>-----</p> <p>Influence of Science, Engineering and Technology on Society and the Natural World</p> <ul style="list-style-type: none"> Every human-made product is designed by applying some knowledge of the natural world and is built using materials derived from the natural world. (1-LS1-1)

Connections to other DCIs in first grade: N/A

Articulation of DCIs across grade-levels:

K.ETS1.A (1-LS1-1); **3.LS2.D** (1-LS1-2); **3.LS3.A** (1-LS3-1); **3.LS3.B** (1-LS3-1); **4.LS1.A** (1-LS1-1); **4.LS1.D** (1-LS1-1); **4.ETS1.A** (1-LS1-1)

Common Core State Standards Connections:

ELA/Literacy -

RI.1.1 Ask and answer questions about key details in a text. (1-LS1-2),(1-LS3-1)

RI.1.2 Identify the main topic and retell key details of a text. (1-LS1-2)

RI.1.10 With prompting and support, read informational texts appropriately complex for grade. (1-LS1-2)

W.1.7 Participate in shared research and writing projects (e.g., explore a number of “how-to” books on a given topic and use them to write a sequence of instructions). (1-LS1-1),(1-LS3-1)

W.1.8 With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question. (1-LS3-1)

Mathematics -

MP.2 Reason abstractly and quantitatively. (1-LS3-1)

MP.5 Use appropriate tools strategically. (1-LS3-1)

1.NBT.B.3 Compare two two-digit numbers based on the meanings of the tens and one digits, recording the results of comparisons with the symbols $>$, $=$, and $<$. (1-LS1-2)

1.NBT.C.4 Add within 100, including adding a two-digit number and a one-digit number, and adding a two-digit number and a multiple of 10, using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; relate the strategy to a written method and explain the reasoning used. Understand that in adding two-digit numbers, one adds tens and tens, ones and ones; and sometimes it is necessary to compose a ten. (1-LS1-2)

1.NBT.C.5 Given a two-digit number, mentally find 10 more or 10 less than the number, without having to count; explain the reasoning used. (1-LS1-2)

1.NBT.C.6 Subtract multiples of 10 in the range 10-90 from multiples of 10 in the range 10-90 (positive or zero differences), using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; relate the strategy to a written method and explain the reasoning used. (1-LS1-2)

1.MD.A.1 Order three objects by length; compare the lengths of two objects indirectly by using a third object. (1-LS3-1)

* The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.

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3rd-5th Grade

5-LS1-1 From Molecules to Organisms: Structures and Processes

Students who demonstrate understanding can:

- 5-LS1-1.** Support an argument that plants get the materials they need for growth chiefly from air and water. [Clarification Statement: Emphasis is on the idea that plant matter comes mostly from air and water, not from the soil.]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Engaging in Argument from Evidence Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). <ul style="list-style-type: none"> Support an argument with evidence, data, or a model. 	LS1.C: Organization for Matter and Energy Flow in Organisms <ul style="list-style-type: none"> Plants acquire their material for growth chiefly from air and water. 	Energy and Matter <ul style="list-style-type: none"> Matter is transported into, out of, and within systems.
<i>Connections to other DCIs in fifth grade:</i> 5.PS1.A		
<i>Articulation of DCIs across grade-levels:</i> K.LS1.C ; 2.LS2.A ; MS.LS1.C		
<i>Common Core State Standards Connections:</i> ELA/Literacy - RI.5.1 Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text. (5-LS1-1) RI.5.9 Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably. (5-LS1-1) W.5.1 Write opinion pieces on topics or texts, supporting a point of view with reasons and information. (5-LS1-1) Mathematics - MP.2 Reason abstractly and quantitatively. (5-LS1-1) MP.4 Model with mathematics. (5-LS1-1) MP.5 Use appropriate tools strategically. (5-LS1-1) 5.MD.A.1 Convert among different-sized standard measurement units within a given measurement system (e.g., convert 5 cm to 0.05 m), and use these conversions in solving multi-step, real world problems. (5-LS1-1)		

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Interdependent Relationships in Ecosystems: Environmental Impacts on Organisms

Students who demonstrate understanding can:

- 3-LS2-1.** Construct an argument that some animals form groups that help members survive.
- 3-LS4-1.** Analyze and interpret data from fossils to provide evidence of the organisms and the environments in which they lived long ago. [Clarification Statement: Examples of data could include type, size, and distributions of fossil organisms. Examples of fossils and environments could include marine fossils found on dry land, tropical plant fossils found in Arctic areas, and fossils of extinct organisms.] [Assessment Boundary: Assessment does not include identification of specific fossils or present plants and animals. Assessment is limited to major fossil types and relative ages.]
- 3-LS4-3.** Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all. [Clarification Statement: Examples of evidence could include needs and characteristics of the organisms and habitats involved. The organisms and their habitat make up a system in which the parts depend on each other.]
- 3-LS4-4.** Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.* [Clarification Statement: Examples of environmental changes could include changes in land characteristics, water distribution, temperature, food, and other organisms.] [Assessment Boundary: Assessment is limited to a single environmental change. Assessment does not include the greenhouse effect or climate change.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<p>Analyzing and Interpreting Data Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used.</p> <ul style="list-style-type: none"> Analyze and interpret data to make sense of phenomena using logical reasoning. (3-LS4-1) <p>Engaging in Argument from Evidence Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s).</p> <ul style="list-style-type: none"> Construct an argument with evidence, data, and/or a model. (3-LS2-1) Construct an argument with evidence. (3-LS4-3) Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem. (3-LS4-4) 	<p>LS2.C: Ecosystem Dynamics, Functioning, and Resilience</p> <ul style="list-style-type: none"> When the environment changes in ways that affect a place's physical characteristics, temperature, or availability of resources, some organisms survive and reproduce, others move to new locations, yet others move into the transformed environment, and some die. (<i>secondary to 3-LS4-4</i>) <p>LS2.D: Social Interactions and Group Behavior</p> <ul style="list-style-type: none"> Being part of a group helps animals obtain food, defend themselves, and cope with changes. Groups may serve different functions and vary dramatically in size. (<i>Note: Moved from K–2</i>). (3-LS2-1) <p>LS4.A: Evidence of Common Ancestry and Diversity</p> <ul style="list-style-type: none"> Some kinds of plants and animals that once lived on Earth are no longer found anywhere. (<i>Note: moved from K-2</i>) (3-LS4-1) Fossils provide evidence about the types of organisms that lived long ago and also about the nature of their environments. (3-LS4-1) <p>LS4.C: Adaptation</p> <ul style="list-style-type: none"> For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all. (3-LS4-3) <p>LS4.D: Biodiversity and Humans</p> <ul style="list-style-type: none"> Populations live in a variety of habitats, and change in those habitats affects the organisms living there. (3-LS4-4) 	<p>Cause and Effect</p> <ul style="list-style-type: none"> Cause and effect relationships are routinely identified and used to explain change. (3-LS2-1), (3-LS4-3) <p>Scale, Proportion, and Quantity</p> <ul style="list-style-type: none"> Observable phenomena exist from very short to very long time periods. (3-LS4-1) <p>Systems and System Models</p> <ul style="list-style-type: none"> A system can be described in terms of its components and their interactions. (3-LS4-4) <p>-----</p> <p>Connections to Engineering, Technology, and Applications of Science</p> <p>-----</p> <p>Interdependence of Engineering, Technology, and Science on Society and the Natural World</p> <ul style="list-style-type: none"> Knowledge of relevant scientific concepts and research findings is important in engineering. (3-LS4-4) <p>-----</p> <p>Connections to Nature of Science</p> <p>-----</p> <p>Scientific Knowledge Assumes an Order and Consistency in Natural Systems</p> <ul style="list-style-type: none"> Science assumes consistent patterns in natural systems. (3-LS4-1)
<p><i>Connections to other DCIs in third grade:</i> 3.ESS2.D (3-LS4-3); 3.ESS3.B (3-LS4-4)</p> <p><i>Articulation of DCIs across grade-levels:</i> K.ESS3.A (3-LS4-3),(3-LS4-4); K.ETS1.A (3-LS4-4); 1.LS1.B (3-LS2-1); 2.LS2.A (3-LS4-3),(3-LS4-4); 2.LS4.D (3-LS4-3),(3-LS4-4); 4.ESS1.C (3-LS4-1); 4.ESS3.B (3-LS4-4); 4.ETS1.A (3-LS4-4); MS.LS2.A (3-LS2-1),(3-LS4-1),(3-LS4-3),(3-LS4-4); MS.LS2.C (3-LS4-4); MS.LS4.A (3-LS4-1); MS.LS4.B (3-LS4-3); MS.LS4.C (3-LS4-3),(3-LS4-4); MS.ESS1.C (3-LS4-1),(3-LS4-3),(3-LS4-4); MS.ESS2.B (3-LS4-1); MS.ESS3.C (3-LS4-4)</p>		
<p><i>Common Core State Standards Connections:</i></p> <p>ELA/Literacy —</p> <p>RI.3.1 Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers. (3-LS2-1),(3-LS4-1),(3-LS4-3),(3-LS4-4)</p> <p>RI.3.2 Determine the main idea of a text; recount the key details and explain how they support the main idea. (3-LS4-1),(3-LS4-3),(3-LS4-4)</p> <p>RI.3.3 Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect. (3-LS2-1),(3-LS4-1),(3-LS4-3),(3-LS4-4)</p> <p>W.3.1 Write opinion pieces on topics or texts, supporting a point of view with reasons. (3-LS2-1),(3-LS4-1),(3-LS3-3),(3-LS4-4)</p> <p>W.3.2 Write informative/explanatory texts to examine a topic and convey ideas and information clearly. (3-LS4-1),(3-LS3-3),(3-LS3-4)</p> <p>W.3.8 Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories. (3-LS4-1)</p> <p>SL.3.4 Report on a topic or text, tell a story, or recount an experience with appropriate facts and relevant, descriptive details, speaking clearly at an understandable pace. (3-LS4-3),(3-LS4-4)</p> <p>Mathematics —</p> <p>MP.2 Reason abstractly and quantitatively. (3-LS4-1),(3-LS4-3),(3-LS4-4)</p> <p>MP.4 Model with mathematics. (3-LS2-1),(3-LS4-1),(3-LS4-3),(3-LS4-4)</p> <p>MP.5 Use appropriate tools strategically. (3-LS4-1)</p> <p>3.NBT Number and Operations in Base Ten. (3-LS2-1)</p> <p>3.MD.B.3 Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories. Solve one- and two-step "how many more" and "how many less" problems using information presented in scaled bar graphs. (3-LS4-3)</p> <p>3.MD.B.4 Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch. Show the data by making a line plot, where the horizontal scale is marked off in appropriate units—whole numbers, halves, or quarters. (3-LS4-1)</p>		

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Next Generation Science Standards. (2018, May 08). Retrieved from <https://www.nextgenscience.org/>

- Identify and discuss the different types of problem solving and declarative/procedure knowledge needed.

This project would need to use:

- Decision making problem solving- by identifying benefits and limits as well as selecting alternatives. You could also include justifying results. Decision making could use both declarative and procedural knowledge. It would be declarative because decisions are made in real time, and sometimes deal with the unknown. It would be procedural because in multi- step problem solving a decision one makes

may be based on previous knowledge that a student has used to solve a similar problem before, thus making the steps ingrained.

- Troubleshooting problem solving- given a problem in real life, a person troubleshoots based on symptoms or observations. Troubleshooting would involve procedural knowledge as students “check” off possible solutions and see if they solve the symptoms.
- Design problem solving- given a problem that needs solving with how something is designed and wanting to fix the problem seems to be how the curious human mind thinks. Designing solutions involves both the declarative and procedural knowledge because you would need to use the above decision- making problem solving along with a process to solve the problem.

I feel that this project would best use the NASA Best Engineering Model to solve: ask, imagine, plan, create, test and improve.

4. Explore objectives and ancillary concepts/content covered by the project.
 - Plan and design an investigation to determine if plants need sunshine and water to survive?
 - What is the best way plants can be planted?
Given materials, how would each one benefit from each.

An ancillary concept would be: use materials to design a solution to a human problem by mimicking how plants use their external parts to help them survive, grow and meet their needs. How do plants survive in their current setting in the greenhouse? How can we measure a plant’s needs such as how much water, space or temperature? Would these be separate investigations? Could we incorporate this into Language Arts, with journaling about how the plant is doing in the environment? What about presentation of the plant information?

5. Identify possible activities.

- Planting Thoughts

https://www.teachengineering.org/lessons/view/cub_bio_lesson04

Good lesson, but focuses on more complex learning than my multi grade level group has prior knowledge on. Would need to teach a lesson or two prior to this. Good application to plant uses and chemistry.

- Thinking Inside the Box: Redesigning Plant Packages

<https://www.eie.org/eie-curriculum/curriculum-units/thinking-inside-box-designing-plant-packages>

Focuses on plant packages and different materials. Would fit with greenhouse curriculum and be a good follow up to a student’s question of “ Why do we plant in these black containers, the plants are hard to get out.”

- Let’s Plan an Experiment: What Do Plants Need?

https://www.teachengineering.org/lessons/view/duk_sunflower_mary_lesson

Lesson focuses on light conditions, another interesting topic students have brought up as to why we have clear plastic in the greenhouse and not black to absorb the sun.

6. Select the best activity for your classroom.

- Thinking Inside the Box: Redesigning Plant Packages

<https://www.eie.org/eie-curriculum/curriculum-units/thinking-inside-box-designing-plant-packages>