Unit Title: House for the Fourth Pig **Date Developed/Last Revised:** 6/19/2013 **Unit Author(s):** Lynn Lum, Ryan Saito, Karen Umeda	**Grade Level:** K **Time Frame:** 25 50-minute sessions Note: Lessons can be selected to fit the instructional time frame of your classroom. **Primary Content Area:** Science/Engineering

UNIT DESCRIPTION:

Students will discover, invent, and investigate the nature of matter through engagement in the scientific inquiry process. They will use their senses to make observations of houses, ask questions about what they are made of, and collect data about the materials houses have in common. More specifically, they will investigate the attributes of various materials and apply this knowledge to build a house for The Fourth Pig. Knowledge of material properties enable students to understand how they are used and why, especially as it relates to engineering and technology. Through this process, students will also learn to identify the various technologies that are used in building a home.

The Engineering Design Process (EDP) enables us to solve problems, create, and redesign products and systems. Through engagement in this process, students will engage in creating prototypes of ideas while applying their knowledge in science, math, and technology. They will also practice the GLOs and the STEM Competencies as they apply the cooperative skills that are needed to work in engineering design teams to optimize their product. In this unit, students will work in teams and apply their scientific knowledge of forces and motion towards engineering a house for the Fourth Little Pig.

Big Ideas (Student Insights that Will Be Developed Over the Course of the Unit):

- Engagement in the science inquiry process allows students to discover, invent, and investigate the nature of matter
- The knowledge of material properties enables students to understand their purpose and use in building a home
- The Engineering Design Process enables us to solve problems, create and redesign products and systems
- Scientific knowledge of forces and motion are important towards engineering a house

Essential Questions (Questions that Will Prompt Students to Connect to the Big Ideas):

- How do we classify objects?
- What are the different technologies we use in our lives?
- What is the Engineering Design Process?
- How does the Engineering Design Process help us?

	BENCHMARKS/STANDARDS/LEARNING GOALS
Science	• **SC.K.1.1** Use the senses to make observations (L1) • **SC.K.1.2** Asks questions about the world around them (L1) • **SC.K.1.3** Collect data about living and non-living things (L1) • **SC.K.2.1** Identify different types of technologies at home, in the classroom, and/or in the world (L1) • **SC.K.6.1** Classify objects by their attributes (e.g., physical properties, materials of which they are made) (L3) *Note: The "L" codes at the end of each benchmark refer the Marzano's Taxonomic Level of Understanding which the benchmark was assigned. So for example, "L3" refers to Taxonomic Level 3: Analysis.*
Technology	• **CTE Standard 1:** Design, modify, and apply technology to effectively and efficiently solve problems
Engineering	• **CTE Standard 1:** Design, modify, and apply technology to effectively and efficiently solve problems o Engineering Design Process (EDP) o Engineering a House for the Fourth Pig
Mathematics	<u>Supporting Mathematical Standards</u> • **CCSS.Math.Content.K.MD.A.1** Describe measurable attributes of objects, such as length or weight. Describe several measurable attributes of a single object. • **CCSS.Math.Content.K.MD.A.2** Directly compare two objects with a measurable attribute in common, to see which object has "more of"/"less of" the attribute, and describe the difference. For example, directly compare the heights of two children and describe one child as taller/shorter. • **CCSS.Math.Content.K.G.A.1** Describe objects in the environment using names of shapes, and describe the relative positions of these objects using terms such as above, below, beside, in front of, behind, and next to. • **CCSS.Math.Content.K.G.B.5** Model shapes in the world by building shapes from components (e.g., sticks and clay balls) and drawing shapes. <u>Supporting Mathematical Practices</u> • **CCSS.Math.Practice.MP1:** Make sense of problems and persevere in solving them • **CCSS.Math.Practice.MP2:** Reason abstractly and quantitatively • **CCSS.Math.Practice.MP3:** Construct viable arguments and critique the reasoning of others • **CCSS.Math.Practice.MP4:** Model with mathematics

	• **CCSS.Math.Practice.MP5:** Use appropriate tools strategically • **CCSS.Math.Practice.MP6:** Attend to precision • **CCSS.Math.Practice.MP7:**Look for and make use of structure • **CCSS.Math.Practice.MP8:** Look for and express regularity in repeated reasoning
English Language Arts and Literacy	<u>Supporting Language Arts Standards</u> • **CCSS.ELA-Literacy.RL.K.1** With prompting and support, ask and answer questions about key details in a text. • **CCSS.ELA-Literacy.RL.K.3** With prompting and support, identify characters, settings, and major events in a story. • **CCSS.ELA-Literacy.RL.K.9** With prompting and support, compare and contrast the adventures and experiences of characters in familiar stories. • **CCSS.ELA-Literacy.W.K.2** Use a combination of drawing, dictating, and writing to compose informative/explanatory texts in which they name what they are writing about and supply some information about the topic. • **CCSS.ELA-Literacy.SL.K.1** Participate in collaborative conversations with diverse partners about kindergarten topics and texts with peers and adults in small and larger groups. a. Follow agreed-upon rules for discussions (e.g., listening to others and taking turns speaking about the topics and texts under discussion). b. Continue a conversation through multiple exchanges.
STEM Competencies	• **Indicator 2.2:** Collaborates with, helps and encourages others in group situations (in science and engineering teams) • **Indicator 2.5:** Demonstrates responsible and ethical behavior in decision making (while making choices for the team's implementation plans) • **Indicator 6.4:** Uses the appropriate technologies for communication, collaboration, research, creativity, and problem solving (multi-meter/internet/apps)

LESSON SEQUENCE

	Lesson Title/Description	Learning Goals (What Students Will Know and Be Able to Do)	Assessments	Time Frame
1	**Engagement Activity:** Students take a short walking tour of the neighborhood (or view pictures of a variety of houses).	*Students will know:* • How to make observations • How to ask questions • How to classify objects by their attributes • Relative positions of objects in the environment (above, below, beside, in front of, behind, next to) *Students will be able to:* • Participate in collaborative conversations with diverse partners about kindergarten topics and texts with peers and adults in small and large groups • Apply what they have learned to the real world (i.e., Which material would be most appropriate to construct a house and why?) • Describe objects in the environment using names of shapes, and describe the relative positions of these objects using terms such as above, below, beside, in front of, behind, and next to	**Formative Assessments:** • Teacher observations and conversations • Students' responses to the following discussion questions: o What is a house? o Why do we need houses? o What materials are used to build houses and why are those materials selected for construction? ▪ If you were a house builder, what materials would you use? ▪ What makes this a good material for a house?	1 50-minute session
2	**The Traditional Version of the Three Little Pigs** (by James Marshall): Students listen to and discuss the traditional version of the 'Three Little Pigs' story.	*Students will know:* • How to ask questions • How to classify objects by their attributes • How to identify key details in a text • How to identify characters, settings, and major events in a story • How to compare and contrast experiences of characters in familiar stories *Students will be able to:* • Ask and answer questions about key details in a text • Compare and contrast the adventures and experiences of characters in familiar stories	**Formative Assessments:** • Teacher observations and conversations • Students' responses to the following discussion questions: o What materials did the pigs use to build their houses? o Why do you think they chose straw? …sticks? …bricks?	1 50-minute session

		• Participate in collaborative conversations with diverse partners about kindergarten topics and texts with peers and adults in small and large groups • Identify different technologies • Apply what they have learned to the real world (i.e., Which material would be most appropriate to construct a house and why?)		
3	**The True Story of the Three Little Pigs** (by Jon Scieszka): Students listen to and discuss the story of the Three Little Pigs from the wolf's perspective	*Students will know:* • How to ask questions • How to classify objects by their attributes • How to identify key details in a text • How to identify characters, settings, and major events in a story • How to compare and contrast experiences of characters in familiar stories *Students will be able to:* • Ask and answer questions about key details in a text • Compare and contrast the adventures and experiences of characters in familiar stories • Participate in collaborative conversations with diverse partners about kindergarten topics and texts with peers and adults in small and large groups • Identify different technologies • Apply what they have learned to the real world (i.e., Which material would be most appropriate to construct a house and why?)	**Formative Assessments:** • Teacher observations and conversations • Students' responses to the following discussion questions: o Do you agree with the wolf when he says that the pigs used poor building materials? o Which pigs chose a poor material for building a house? ▪ What makes this poor building material? o What other materials could they have used? (Create a list of ideas.) o If you were going to build a house for the pigs, what materials would you choose? Why?	1 50-minute session
4	**Introduction to the Attributes of Objects and Materials**: Introduction to the Scientific Inquiry Process	*Students will know:* • How to ask questions • How to classify objects by their attributes • Make sense of problems and preserve in solving them • Look for and make use of structure	**Formative Assessments:** • Teacher observations and conversations • Students' responses as they	1 50-minute session

		• How to make a prediction using what they have learned about the real world *Students will be able to:* • Make observations • Identify different technologies • Directly compare two objects with a measureable attribute in common to see which object has 'more of' / 'less of' the attribute, and describe the difference • Apply what they have learned to the real world (i.e., Which material would be most appropriate to construct a house and why?)	predict and explain their reasoning to the following prompt: Which material works best in the design of a strong house that will withstand the windy breath of the big bad wolf?	
5	**Exploring the Attributes of Objects and Materials:** Materials and House Testing Stations	Materials Testing Stations *Students will know:* • The properties and attributes of different materials *Students will be able to:* • Use sight and feeling/touching to observe test materials (straws, sticks, paper, cardstock, plastic cups, and foil) • Compare measureable attributes (strong vs. weak; heavy vs. light; rigid vs. flexible) of test materials • Use data to predict whether the materials will be good as a house building material • Describe measureable attributes of test materials House Testing Stations *Students will know:* • The properties and attributes of different houses *Students will be able to:* • Use sight and feeling/touching to observe sample houses with different attributes (heavy vs. light; tall vs. short; wide vs. thin; windows vs. no windows) • Classify objects by their attributes • Compare objects with common measureable attributes	**Formative Assessments:** • Student Data Recording Sheet (Stations 1 – 10) • Teacher observations and conversations	10 40-minute sessions (one Station per day)

6	**Building Background Knowledge:** Discovery Education resources	*Students will know about:* • Classifying objects by their properties and attributes *Students will be able to:* • Ask questions to build understanding • Identify and apply technology to solve problems • Use a combination of drawing, dictating, and writing to compose informative/explanatory texts in which they name what they are writing about and supply some information about the topic	**Formative Assessments:** • Teacher observations and conversations with students about the skills and concepts discussed in this lesson.	50 minute sessions (as needed)
7	**Engineering Design Process – Build a House for the Fourth Pig:** Students work through each of the six steps (Ask, Imagine, Plan, Create, Experiment, Revise)	**<u>Ask (</u>**Step 1): *Students will know:* • The criteria and constraints for making this tower • Understand all criteria for the "Ask" section of the process *Students will be able to:* • Identify the problem of the performance task • Identify what they are creating • Write further questions they may have about constructing the house for the fourth pig • Share questions with class for teacher to answer **<u>Imagine</u> (Step 2):** *Students will know:* • The criteria for the "Imagine" section of the process *Students will be able to:* • Independently brainstorm ideas for building a Fourth Pig's house and draw or write out ideas in their journal. • Students to discuss their ideas with the rest of the engineering team • Defend their reasons for using specific ideas from their prototype (Ex.: A strong base or foundation is needed to keep the house from blowing away.) • Collaboratively decide on ONE person's design to use or create ONE new hybrid idea incorporating all the differing ideas	**Formative Assessments:** • Observations and conversations as students engage in the design process • Summary and Conclusions: o Teams share results of how they changed and improved their houses, and the reasons for these changes. o Teams make connections to attributes of materials and why it important to know them o Students revisit their initial predictions they made about which types of material would be best for house building. Relate this to what they learned through their investigations.	6-10 50-minute sessions

		<u>Plan</u> (Step 3): *Students will know:* • The criteria for the "Plan" section of the process *Students will be able to:* • Develop a diagram of the team's house prototype • List all possible materials that will be needed to create the prototype **<u>Create</u> (Step 4):** *Students will know:* • The criteria for the "Create" section of the process *Students will be able to:* • Build their prototype following the team plan as closely as possible • Document changes / modifications to the original design if they are modifying their original prototype to make it work • Share their house prototype to the large group, stating what modifications were made to the plan and why **<u>Experiment</u> (Step 5):** Test it out! *Students will be able to:* • Test their prototype house in front of a fan • Collect make observations and record the results in their journals • Measure the distance their house moved away from the starting line using unifix cubes and log this data in journals • Share out their data and the reasons for their results to the class • Understand all the criteria for the "Experiment" section of the process	**Summative Assessments:** • EDP Assessment • Assessment of STEM Competencies (to be conducted by the teacher using the attached rubric)	

		<u>Improve</u> (Step 6): *Students will be able to:* • Review the results of their data • Repeat the EDP to optimize the product • Record the following in their journals o Ask: What worked? What didn't work? Why? o Imagine: Which variables should change to keep the house from falling apart and moving? What's the rationale for the changes? o Plan: Draw the diagram of the team's second prototype. Label the parts. o Create: Build a second prototype following the team's design. o Experiment: - Observe what is happening with their house. Log data onto their journals. - Measure the distance their house moved away from the starting line using unifix cubes. Log data onto journals. - Complete data analysis and explain the results.		
8	**Real World Connection: Jay Schafer – The Tumbleweed Tiny House Company** www.tumbleweedhouses.com/	*Students will know:* • How engineering enables us to solve problems *Students will be able to:* • Make observations about the houses presented in this lesson • Classify them by their attributes • Share their observations in a discussion	• Students discuss the following questions: o What do you observe about all the houses he has created? o Why do you think he created these houses? o Is Jay Shafer an engineer? Why?	1 50-minute session

Unit Title: House for the Fourth Pig Lesson Title: Engineering a House for the Fourth Pig Date Developed/Last Revised: 6/19/2013 Unit Author(s): Lynn Lum, Ryan Saito, Karen Umeda	Lesson #: 1-8 Grade Level: Kindergarten Primary Content Area: Science and Engineering Time Frame: 25 50-minute sessions

PLANNING (Steps 1, 2, & 3)

1. Standards/Benchmarks and Process Skills Assessed in this Lesson:

Science:

- **HCPS.SC.K.1.1** Use the senses to make observations
- **HCPS.SC.K.1.2** Asks questions about the world around them
- **HCPS.SC.K.1.3** Collect data about living and non-living things
- **HCPS.SC.K.2.1** Identify different types of technologies at home, in the classroom, and/or in the world
- **HCPS.SC.K.6.1** Classify objects by their attributes (e.g., physical properties, materials of which they are made)

Engineering and Technology:

- **HCPS.CTE Standard 1:** Design, modify, and apply technology to effectively and efficiently solve problems.

Supporting Mathematical Standards:

- **CCSS.Math.Content.K.MD.A.1** Describe measurable attributes of objects, such as length or weight. Describe several measurable attributes of a single object.
- **CCSS.Math.Content.K.MD.A.2** Directly compare two objects with a measurable attribute in common, to see which object has "more of"/"less of" the attribute, and describe the difference. For example, directly compare the heights of two children and describe one child as taller/shorter.
- **CCSS.Math.Content.K.G.A.1** Describe objects in the environment using names of shapes, and describe the relative positions of these objects using terms such as above, below, beside, in front of, behind, and next to.
- **CCSS.Math.Content.K.G.B.5** Model shapes in the world by building shapes from components (e.g., sticks and clay balls) and drawing shapes.

Supporting Mathematical Practices:

- **CCSS.Math.Practice.MP1** Make sense of problems and persevere in solving them
- **CCSS.Math.Practice.MP2** Reason abstractly and quantitatively
- **CCSS.Math.Practice.MP3** Construct viable arguments and critique the reasoning of others
- **CCSS.Math.Practice.MP4** Model with mathematics
- **CCSS.Math.Practice.MP5** Use appropriate tools strategically
- **CCSS.Math.Practice.MP6** Attend to precision
- **CCSS.Math.Practice.MP7** Look for and make use of structure
- **CCSS.Math.Practice.MP8** Look for and express regularity in repeated reasoning

Supporting Language Arts Standards:

- **CCSS.ELA-Literacy.RL.K.1** With prompting and support, ask and answer questions about key details in a text.
- **CCSS.ELA-Literacy.RL.K.3** With prompting and support, identify characters, settings, and major events in a story.
- **CCSS.ELA-Literacy.RL.K.9** With prompting and support, compare and contrast the adventures and experiences of characters in familiar stories.
- **CCSS.ELA-Literacy.W.K.2** Use a combination of drawing, dictating, and writing to compose informative/explanatory texts in which they name what they are writing about and supply some information about the topic.
- **CCSS.ELA-Literacy.SL.K.1** Participate in collaborative conversations with diverse partners about kindergarten topics and texts with peers and adults in small and larger groups.
  - **a:** Follow agreed-upon rules for discussions (e.g., listening to others and taking turns speaking about the topics and texts under discussion).
  - **b:** Continue a conversation through multiple exchanges.

STEM Competencies:

- **Indicator 2.2:** Collaborates with, helps and encourages others in group situations
- **Indicator 2.5:** Demonstrates responsible and ethical behavior in decision making
- **Indicator 6.4:** Uses the appropriate technologies for communication, collaboration, research, creativity, and problem solving

2A. Criteria- What Students Should Know and Be Able to Do:

Students will know:

- How to make observations
- How to ask questions
- How to collect data about non-living things (i.e., houses, house attributes and materials)
- How to classify objects by their attributes
- Relative positions of objects in the environment (above, below, beside, in front of, behind, next to)
- How to design, modify, and apply technology to effectively and efficiently solve problems

Students will be able to:

- Participate in collaborative conversations with diverse partners about kindergarten topics and texts with peers and adults in small and large groups
- Make observations, ask questions and collect data about non-living things (i.e., houses, house attributes and materials)
- Apply what they have learned to the real world (i.e., Which material would be most appropriate to construct a house and why?)
- Describe objects in the environment using names of shapes, and describe the relative positions of these objects using terms such as above, below, beside, in front of, behind, and next to
- Design, modify, and apply technology to effectively and efficiently solve problems.

2B. Assessment Tools/Evidence:

Formative:

- Discussions (conversations) of concepts
- Observations conducted as participants conduct their investigations, engineer their designs, and share the results of their investigations
- Materials Data Recording Sheet
- EDP Journal (see attached rubric)

Summative:

- Short constructed response to the following prompts:
  - Identify a material we investigated in these lessons and identify an attribute of that material.
  - What materials would you use to make your house and why?
  - Identify two technologies we used in these lessons.

Task Specific Rubric

	4	3	2	1
Identify a material investigated in the lessons and an attribute of that material.	Identifies a material used in the lessons and multiple attributes of that material.	Identifies a material used in the lessons and an attribute of that material.	Identifies a material used in the lessons but is unable to identify an attribute of that material. Or, the attribute identified is incorrect.	Needs prompting from the teacher to identify a material.
Identify materials used to build their house and tells why they were used.	Identifies materials used to their house and gives multiple reasons why they were used.	Identifies materials used to build their house and tells why they were used.	Identifies materials used. Incorrectly tells why they were used, or unable to tell why they were used.	Needs assistance from the teacher to identify materials used to build their home and why they were used.
Identify two technologies	Identifies multiple technologies used in the lessons.	Identifies two technologies used in the lessons.	Identifies one technology used in the lesson.	Needs prompting from the teacher to identify a technology.

- EDP Assessment (Assessment and rubric documents attached)
  - Draw what you did in each step of the Engineering Design Process.
  - How does the Engineering Design Process help us?
- STEM Competencies (To be assessed by the teacher using the attached rubric)

3. Learning Experiences (Lesson Plan)

Note to the teacher**:**

- Students should have some prior experiences with the following concepts and skills:
  - Attributes of objects and materials, and how things can be classified by their attributes.
  - Technology, which is defined here as…To further develop the student's ability to identify different technologies in the classroom, it is recommended at the teacher identify the different technological tools as it is used in the lessons.

Materials:

- *The Three Little Pigs* (by James Marshall)
- *The True Story of the Three Little Pigs* (by Jon Scieszka)
- Straws
- Paper
- Cardstock or index cards
- Plastic cups
- Tape
- Aluminum foil
- Paper Clips
- Post-It Notes
- Craft Sticks
- Sample Houses (heavy, light, tall, short, thin, wide, windows, no windows)
- Fan (table or floor)
- Unifix Cubes
- Computers

Handouts/Other Resources: (copies attached)

- A House for the Fourth Pig Exploration Stations Data Recording Sheet (Note: there are two versions available based on the ability of your students)
- 4th Little Pig EDP Journal
- STEM Careers poster
- EDP Rubric - K1
- STEM Competencies Rubric
- Discovery Education – Science Elementary (see titles in Session 7)
- The Tumbleweed Tiny House Company site (www.tumbleweedhouses.com/)

Procedure:

Lesson 1: Engagement Activity

- Take a short walking tour of the neighborhood or show students pictures of a variety of houses.
- Ask the following questions:
  - What is a house?
  - Why do we need houses?
  - What materials are used to build houses and why are those materials selected for

construction?
- If you were a house builder, what materials would you use?
- What makes this a good material for a house?

- Optional: Show students pictures of houses from around the world and ask students why the homes were constructed that way (environment and the resources available).

Lesson 2: The Traditional Version of *The Three Little Pigs* by James Marshall

- Tell students that you will now read a tale of some other house builders.
- Read the traditional version of *The Three Little Pigs*.
- Consider using the following questions to guide the discussion:
  - What materials did the pigs use to build their houses?
  - Why do you think they chose straw? Sticks? Bricks?

Lesson 3*: The True Story of the Three Little Pigs* by Jon Scieszka

- Say: Let's now hear a tale from the wolf's perspective.
- Read *The True Story of the Three Little Pigs*.
- Consider the following questions to guide the discussion:
  - Do you agree with the wolf when he says that the pigs used poor building materials?
  - Which pigs chose a poor material for building a house?
    - What makes this poor building material?
  - What other materials could they have used? (Create a list of ideas.)
  - If you were going to build a house for the pigs, what materials would you choose?

Lesson 4: Introduction to the Attributes of Objects and Materials

- Introduce the following scenario to the students:

> ***Did you know that there is a fourth little piggy? Well, this fourth little piggy is so afraid that the big bad wolf will find her house, too, and will blow it down! You are the engineer that can save her! Your job is to design a strong house that can withstand the windy breath of the big bad wolf! There are many types of materials available to build your house, but no bricks. Can you design a house that the big bad wolf won't huff and puff away?***

- Say: We have been talking a lot about the materials the three pigs used and what makes a good vs. poor material. Words that describe the materials such as strong, weak, heavy or light are called attributes of a material.
  - Explain that an attribute is a characteristic of a material that helps to identify or classify it.

- Clarify that the Three Little Pigs used materials that were available to them. So the first thing we need to learn is what materials are available for us to use and the attributes they have. Ask: Which material works best in the design of a strong house that will withstand the 'windy breath of the big bad wolf? Why do you think so?

- Introduce the students to the materials that we will be using to help the Fourth Little Pig:
  - 4 Straws
  - Paper
  - Cardstock or index cards
  - 1 plastic cup
  - 1 foot of tape
  - 12-inch piece of aluminum foil
  - 3 Paper Clips

    Note: The amounts represent how much each team of students will receive.

- Ask students to predict which material they think would work best and write their prediction on a Post-It note. Use the notes to create a bar graph and briefly discuss the advantages and disadvantages of each of the materials selected. This bar graph will be used after lesson 7 to re-emphasize material strength. (This is also so the teacher can better facilitate the materials attributes that would help the teams build a better house.)

Lesson 5: Exploring the Attributes of Objects and Materials

- Set up the stations (see below). Station cards are an attachment to this document.
- Just as they would in the real world, assign the students to work in teams.
- Explain that they will now be visiting stations to investigate and learn about the attributes of the materials they will be using.
- Using the Data Recording Sheet as a guide, introduce and provide the instructions for each of the stations the students will be visiting. Be sure students understand the vocabulary to be used at each of the stations.

Materials Testing Stations:

Station 1	Station 2	Station 3	Station 4	Station 5	Station 6
Straws	Craft Sticks	Paper	Cardstock	Plastic Cups	Foil

House Testing Stations:

Station 7	Station 8	Station 9	Station 10
Weight of the house: heavy vs. light	Height of the house: tall vs. short	Width of the house: thin vs. wide	Windows vs. No windows

- Explain that they will be making observations of these materials.
  - Clarify that when making observations, you are using your five senses to describe objects and events around you. But for this investigation you will be using the senses of seeing and

feeling/touching only.

- Have students discuss what they learned from their investigations as a team and then as a class.

Option: If you feel 10 stations at once is overwhelming, consider doing just three to four stations a day and having multiples of each station (i.e., two of Station 1, two of Station 2, etc.) and enabling sufficient materials for all students to be engaged.

Lesson 6: Building Background Knowledge

- Discovery Education>>Science Elementary>>Matter>>Intro to Matter>>*Sorting by Senses* Reading Passage (also available as an eBook)
- Discovery Education>>Science Elementary>>Matter>>Intro to Matter>>*Same and Different* Reading Passage (also available as an eBook)
- Discovery Education>>Science Elementary>>Matter>>Intro to Matter>>*Classifying Objects* Reading Passage (also available as an eBook).
- Discovery Education>>Science Elementary>>Matter>>Intro to Matter>>*Flexible or Rigid* eBook
- Discovery Education>>Science Elementary>>Matter>>Intro to Matter>>*Properties of Matter* eBook

Lesson 7: The Engineering Design Process (6-10 50-minute periods)

Notes to the Teacher: The class will go through each step of the process together. It is important to stop after each step to discuss what the students did and the criteria needed. You may refer to "Engineering Design Rubric" to help guide discussions. Do the amount of steps you feel your students can handle in the time allotted. It may take 1 day or many days to go through and understand these steps. Don't worry… it's the process that's important.

Although students are part of a team, each student is responsible for completing each part of their own engineering design process journal. The team is there to help brainstorm, share ideas, and create one product, but each student must participate and contribute their individual ideas to help the group.

Begin these engineering sessions by saying that they are now ready to build their house for The Fourth Pig. Introduce the "Fourth Pig" that each team will be receiving. You can use any small pig, some examples are as follows:

Next introduce the Engineering Design Process. This process has 6 steps and the first step is to:

Ask (Step 1):

- Show the students sub-standard examples of the 4th Little Pig's house.
- Have students identify:
  - The problem of the performance task.
  - What they are creating.
  - The criteria and constraints for making this tower.
- Show students the materials that are available for them to use. Consider keeping all of the materials on a "materials table" for easy access.
- Have students:
  - Write further questions they may have about constructing the house for the fourth pig.
  - Share questions with class for teacher to answer.
- Stop and go over the criteria for the "Ask" section of the process. Take notes on the Teacher Observation Sheet to monitor student learning.

Imagine (Step 2):

- Instruct students to independently brainstorm ideas for building a Fourth Pig's house and draw or write out ideas in their journal.
- Encourage students to discuss their ideas with the rest of the engineering team. Students must be able to defend their reasons for using specific ideas from their prototype. (Ex.: A strong base or foundation is needed to keep the house from blowing away.)
- Tell students that each engineering team may then decide on ONE person's design to use or create ONE new hybrid idea incorporating all the differing ideas.
- Stop and go over the criteria for the "Imagine" section of the process. Take notes on the Teacher Observation Sheet to monitor student learning.

Plan (Step 3):

- Designate one person to sketch a diagram of the team's house prototype onto a piece of paper. This sketch should include labels for each of the parts and possible measurements. The sketcher must be sure to incorporate all the agreed upon ideas into the design. Students then list all possible materials that will be needed to create the prototype.
- Inform students that when all team members are satisfied with the prototype design, each member should copy this diagram of the house onto their journals.
- Instruct team members to check with each other to see if all drawings and labels are completed and everyone has the same plan to follow.
- Stop and go over the criteria for the "Plan" section of the process. Take notes on the Teacher Observation Sheet to monitor student learning.

Create (Step 4):

- Instruct students to follow their team plan as closely as possible when building their prototype. If they are modifying their original prototype to make it work, guide students to be sure each person writes down and adds that information to their journal diagram plans as well.
- Ask teams to share their house prototype to the large group, stating what modifications were made to the plan and why.
- Stop and go over the criteria for the "Create" section of the process. Take notes on the Teacher Observation Sheet to monitor student learning.

Experiment (Step 5): Test it out!

- Instruct teams to bring their houses to the testing station.
- Students will be placing their houses in front of a fan, behind the starting line. Tell them to imagine it is the wolf huffing and puffing to blow their house down. The house must withstand this force for 1 minute. Did their house withstand the strength of the wolf's wind? Did their house lose any of its materials? If so, what caused it to happen?
- Have students make observations and record the results onto their journals.
- Guide students to measure the distance their house moved away from the starting line using Unifix cubes. Instruct students to log this data onto journals.
- Have teams share out their data and the reasons for their results to the class. Chart the distances that each house moved for all students to see. (Students will be learning from each other and using other people's ideas, as well as their own, as they are improving upon their own prototypes)
- Stop and go over the criteria for the "Experiment" section of the process. Take notes on the Teacher Observation Sheets to monitor student learning.

Improve (Step 6):

- Have each team review the results of their data.
- Repeat the EDP to optimize the product. Students would continue to record the following in their journal…
  - Ask: What worked? What didn't work? Why?
  - Imagine: Which variables will they change to keep the house from falling apart and moving? What's the rationale for the changes?
  - Plan: Draw the diagram of the team's second prototype. Label the parts
  - Create: Build your second prototype following your team's design. Keep to the plan
  - Experiment Procedure:
    - Bring your house up to the fan and place it behind the starting line
    - Teacher turns on the fan
    - Students observe what is happening with their house. Log data onto their journals
    - Students measure the distance their house moved away from the starting line using Unifix

cubes. Log data onto journals

- Analyze the data and explain the results that they find

- Have each team share their results of how they changed and improved their houses, and the reasons for these changes.

Note to the Teacher: You may go through this EDP cycle many times to get an optimized product that is wanted. It all depends on the amount of time you have available.

Summary and Conclusions:

- Have each team share their results of how they changed and improved their houses, and the reasons for these changes. Make connections back to what the attributes of materials are and why it important to know them.
- Revisit the bar graph showing predictions students made about which types of material would be best for house building. Relate this to what they learned through their investigations.

Summative Assessment:

- Short Constructed Response for Science
- EDP Assessment (see attached assessment and rubric documents)
- Teacher assessment of STEM Competencies (see attached rubric)

Lesson 8: Real World Connection: Jay Schafer – The Tumbleweed Tiny House Company

www.tumbleweedhouses.com/

- Project the website so it can be viewed by all students.
- Introduce Jay Schafer and his company.
- Ask the following questions to guide the discussion:
  - What do you observe about all the houses he has created?
  - Why do you think he created these houses?
  - Is Jay Shafer an engineer? Why?
- Explain to students that land is expensive. In some places, like in Hawaii, there is very little land on which to build houses. Jay Shafer saw a need to create homes that needed very little land. That is what engineers do; they help us to solve problems.

TEACHING & ASSESSMENT (Steps 4, 5, 6, &7)
Completed by teacher after instruction has taken place

4. Teaching and Collecting of Evidence of Student Learning:
Teacher Notes:

5. Analysis of Student Products/Performances - Formative:
Teacher Notes:

6. Evaluation of Student Products/Performances – Summative (Not necessary for every lesson): Teacher Notes:
7. Teacher Reflection: Replanning, Reteaching, Next Steps: Teacher Notes:

Name: _____ Date: _____

A House for the Fourth Pig

Exploration Stations Data Recording Sheet

Directions: Circle and tell why

MATERIALS TESTING STATIONS

Station 1: STRAWS

Is it strong or weak?	Is it heavy or light?	Is it rigid or flexible?
Is this a good building material? Yes or No Why or why not? _____ _____ _____		

Station 2: STICKS

Is it strong or weak?	Is it heavy or light?	Is it rigid or flexible?
Is this a good building material? Yes or No Why or why not? _____ _____ _____		

Station 3: PAPER

Is it strong or weak?	Is it heavy or light?	Is it rigid or flexible?
Is this a good building material? Yes or No Why or why not? _____ _____ _____		

Station 4: CARDSTOCK

Is it strong or weak?	Is it heavy or light?	Is it rigid or flexible?
Is this a good building material? Yes or No Why or why not? _____ _____ _____		

Station 5: PLASTIC CUPS

Is it strong or weak?	Is it heavy or light?	Is it rigid or flexible?
Is this a good building material? Yes or No Why or why not? _____ _____ _____		

Station 6: FOIL

Is it strong or weak?	Is it heavy or light?	Is it rigid or flexible?
Is this a good building material? Yes or No Why or why not? _____ _____ _____		

<u>HOUSE TESTING STATIONS</u>

Station 7: Weight of House

Compare the heavy house with the light house. What are your observations?

_____

_____

_____

Station 8: Height of House

Compare the tall house with the short house. What are your observations?

_____
_____
_____
_____

Station 9: Width of House

Compare the thin house with the wide house. What are your observations?

_____
_____
_____
_____

Station 10: Windows vs. No Windows

Compare the house with windows vs. the house with no windows? What are your observations?

_____
_____
_____
_____

Name: _____ Date: _____

A House for the Fourth Pig

Exploration Stations Data Recording Sheet

MATERIALS TESTING STATIONS

Directions: Circle the word in each box that best describes each material.

Station	Material	Strength	Weight	Flexibility
1	Straws	Strong or Weak	Heavy or Light	Rigid or Flexible
2	Sticks	Strong or Weak	Heavy or Light	Rigid or Flexible
3	Paper	Strong or Weak	Heavy or Light	Rigid or Flexible
4	Cardstock	Strong or Weak	Heavy or Light	Rigid or Flexible
5	Plastic Cups	Strong or Weak	Heavy or Light	Rigid or Flexible
6	Foil	Strong or Weak	Heavy or Light	Rigid or Flexible

Which materials would you choose to build your house? Tell why.

_____

_____

_____

_____

_____

_____

HOUSE TESTING STATIONS

Directions: Circle the word that best describes which house did better in the wind.

Station	Attribute	Circle One	
7	Weight	Heavy	Light
8	Height	Tall	Short
9	Width	Thin	Wide

Based on your observations, what kind of house should you build? Tell why.

_____

_____

_____

_____

_____

_____

Name: _____ Date: _____

The 4th Little Pig Engineering Design Process Journal

Performance Task:

Did you know that there is a fourth little piggy? Well, this fourth little piggy is so afraid that the big bad wolf will find her house, too, and will blow it down! You are the engineer that can save her! Your job is to design a strong house that can withstand the windy breath of the big bad wolf! There are many types of materials available to build your house, but no bricks. Can you design a house that the big bad wolf won't huff and puff away?

The criteria/constraints for creating this house:

- There must be enough room for the piggy to stand inside the house.
- There must be an entrance.
- You may use only the materials provided.

Materials:
For each team of students-

- 1 small pig
- 4 straws
- 1 plastic cup
- 1 foot of tape
- 12-inch piece of aluminum foil
- 3 paper clips

Additional materials-

- paper
- cardstock or index cards

Identify:
What is the problem?

_____

_____

_____

What do you need to make?

_____

_____

_____

STEP 1: ASK: What questions do you have about building this house? Write them here.

_____

_____

_____

_____

_____

_____

_____

_____

STEP 2: IMAGINE: Draw pictures of the different ways you could design your house using the materials that were shown to you. Using your background knowledge of what you observed about keeping your house from blowing away, how will you build your house?

My thinking….

STEP 3: PLAN: After hearing the ideas of your teammates, draw a picture of the house that your team will be making. Label each part and the type of material that you will be using. Make sure each person in your team has the same plan here.

Team Plan

STEP 4: CREATE: Build your house following your team's plan.

STEP 5: EXPERIMENT: Test out your house!

Data Table: 4th Piggy's House

	Did your house fall over?	Did your house fall apart?	How far did it fly? (number of Unifix cubes)
House 1	**Yes No**	**Yes No**	
House 2 (After Redesign)	**Yes No**	**Yes No**	

STEP 6: IMPROVE:

- **ASK:** Looking at your data, answer the following questions:
  What worked? What didn't work? What more can I add? **WHY?**

  _____

  _____

  _____

  _____

  _____

- **IMAGINE:** Which variable(s) will you change to keep the house from falling down or moving? Why would you change these variable(s)?

Will you change the…

Weight of the house?	**Too Heavy Too Light Just Right**
Size of the house?	**Too Big Too Small Just Right**

Height of the house?	**Too Tall**	**Too Short**	**Just Right**
Width of the house?	**Too Wide**	**Too Thin**	**Just Right**

- **PLAN:** Draw out a diagram of your team's 2nd prototype. Remember to label your parts, state the materials used and possible measurements.

Team Redesign Plan:

- **CREATE:** Build your prototype following your group's design. Keep to the plan. Use the materials listed as well as the measurements that your group decided on.

- **EXPERIMENT: Write your data on the data table above.**

CONCLUSION (What did we learn): Which house was harder for the wolf to blow? Why?

_____

_____

_____

_____

_____

_____

_____

STEM CAREERS

Job Description	Total job openings 09-19	2009 average hourly wages	Education Level
Management occupations			
Computer and information systems manager	127	$44.08	Degree + work experience
Industrial production manager	11	$36.06	Work experience in related field
Construction manager	23	$34.06	Bachelor's degree
Engineering manager	103	$49.64	Degree + work experience
Natural sciences manager	33	$47.54	Degree + work experience
Business and financial operations occupations			
Cost estimators	28	$32.35	Work experience in related field
Business operation specialist	141	$27.76	Bachelor's degree
Accounts and auditors	192	$21.50	Bachelor's degree
Financial specialist	10	$29.18	Bachelor's degree
Computer and mathematical science occupations			
Computer and information scientist, research	49	$15.73	Doctoral degree
Computer programmers	253	$26.43	Bachelor's degree
Computer software engineers, applications	277	$32.77	Bachelor's degree
Computer software engineers, systems software	186	$35.52	Bachelor's degree
Computer support specialist	269	$20.61	Associate's degree
Computer systems analysis	284	$28.80	Bachelor's degree
Database administrators	51	$27.50	Bachelor's degree
Network and computer systems administrators	221	$29.12	Bachelor's degree
Network systems and data communications analysts	572	$24.98	Bachelor's degree
Computer specialist	98	$31.75	Associate's degree

Source: Hawai`i Technology Workforce: Occupations and Projections Report 2010SOURCE: Economic Modeling Systems, Inc. 1Q 2010 Data Set

Actuaries	10	$38.84	Degree + work experience
Mathematicians	-	$28.87	Doctoral degree
Operations research analysts	18	$33.34	Master's degree
Statisticians	7	$28.22	Master's degree
Agriculture and engineering occupations			
Architects, except landscape and naval	161	$30.51	Bachelor's degree
Surveyors	50	$22.26	Bachelor's degree
Aerospace engineers	6	$30.45	Bachelor's degree
Biomedical engineers	17	$37.15	Bachelor's degree
Chemical engineers	6	$38.76	Bachelor's degree
Computer hardware engineers	43	$31.90	Bachelor's degree
Electrical engineers	108	$35.08	Bachelor's degree
Electronics engineers, except computer	59	$37.22	Bachelor's degree
Environmental engineers	29	$39.98	Bachelor's degree
Health and safety engineers	12	$33.46	Bachelor's degree
Industrial engineers	20	$36.68	Bachelor's degree
Marine engineers and naval architects	11	$33.63	Bachelor's degree
Materials engineers	1	$39.88	Bachelor's degree
Mechanical engineers	91	$39.24	Bachelor's degree
Mining and geological engineers, including mining safety engineers	1	$13.56	Bachelor's degree
Nuclear engineers	27	$25.63	Bachelor's degree
Petroleum engineers	1	$24.69	Bachelor's degree
Engineers, all others	67	$35.01	Bachelor's degree
Architectural and civil drafters	171	$22.16	Post secondary vocational award
Aerospace engineering and operations technicians	-	$23.89	Associate's degree
Civil engineering technicians	20	$21.60	Associate's degree
Electrical and electronic engineering technicians	37	$29.32	Associate's degree
Environmental engineering technicians	13	$20.54	Associate's degree
Industrial engineering technicians	44	$22.90	Associate's degree

Source: Hawai`i Technology Workforce: Occupations and Projections Report 2010SOURCE: Economic Modeling Systems, Inc. 1Q 2010 Data Set

Job Description	Total job openings 09-19	2009 average hourly wages	Education Level
Mechanical engineering technicians	5	$22.57	Associate's degree
Engineering technicians. Except drafters, all others	22	$32.16	Associate's degree
Life, physical, and social science occupations			
Animal scientists	2	$14.98	Bachelor's degree
Food scientist and technologists	8	$27.01	Bachelor's degree
Soil and plant scientists	8	$25.37	Bachelor's degree
Biochemists and biophysicists	39	$32.62	Doctoral degree
Microbiologists	16	$24.29	Doctoral degree
Zoologist and wildlife biologists	8	$29.44	Bachelor's degree
Biological scientists, all other	13	$32.52	Bachelor's degree
Conservation scientists	1	$26.48	Bachelor's degree
Foresters	1	$16.49	Bachelor's degree
Epidemiologists	8	$23.32	Master's degree
Medical scientists, except epidemiologists	95	$28.32	Doctoral degree
Life scientists, all other	7	$32.00	Bachelor's degree
Astronomers	13	$33.99	Doctoral degree
Physicists	14	$42.72	Doctoral degree
Atmospheric and space scientists	8	$30.37	Bachelor's degree
Chemists	26	$28.33	Bachelor's degree
Materials scientists	10	$31.64	Bachelor's degree
Environmental scientists and specialists, including health	85	$30.86	Master's degree
Geoscientists, except hydrologists and geographers	36	$31.78	Master's degree
Hydrologists	10	$24.64	Master's degree
Clinical, counseling, and school psychologists	7	$24.45	Doctoral degree
Industrial-organizational psychologists	8	$18.23	Master's degree
Psychologists, all other	1	$20.13	Master's degree
Anthropologists and archeologists	74	$30.05	Master's degree
Social scientists and related workers, all other	25	$33.24	Master's degree
Agricultural and food science technicians	18	$16.41	Associate's degree
Biological technicians	82	$15.85	Associate's degree

Source: Hawai`i Technology Workforce: Occupations and Projections Report 2010SOURCE: Economic Modeling Systems, Inc. 1Q 2010 Data Set

Chemical technicians	13	$25.14	Associate's degree
Nuclear technicians	9	$25.75	Associate's degree
Environmental science and protection technicians, including health	35	$21.47	Associate's degree
Forest and conservation technicians	2	$17.11	Associate's degree
Life, physical, and social science technicians, all other	37	$23.36	Associate's degree
Arts, design, entertainment, sports, and media occupations			
Graphic designers	50	$20.19	Bachelor's degree
Healthcare practitioners and technical occupations			
Dietitians and nutritionists	2	$24.62	Bachelor's degree
Nuclear medicine technologists	7	$33.69	Associate's degree
Food preparation and serving related occupations			
First-line supervisors/managers of food prep and serving workers	1	$16.43	Work experience in a related field
Cooks, institution and cafeteria	1	$15.61	Moderate-term on-the-job training
Office and administrative support occupations			
Statistical assistants	1	$17.63	Moderate-term on-the-job training
Farming, fishing, and forestry occupations			
Supervisors, farming, fishing, and forestry workers	5	$20.21	Work experience in a related field
Installation, maintenance, and repair occupations			
Avionics technicians	1	$28.33	Post secondary vocational award
Aircraft mechanics and service technicians	1	$26.80	Post secondary vocational award
Automotive service technicians and mechanics	1	$19.18	Post secondary vocational award
Installation, maintenance, and repair workers, all other	5	$21.90	Moderate-term on-the-job training
Production occupations			
Electromechanical equipment assemblers	6	$15.61	Short-term on-the-job training
Numerical tool and process control programmer	2	$23.60	Long-term on-the-job training
Chemical plant and system operators	8	$26.56	Long-term on-the-job training
Chemical equipment operators and tenders	8	$23.20	Moderate-term on-the-job training

Source: Hawai`i Technology Workforce: Occupations and Projections Report 2010SOURCE: Economic Modeling Systems, Inc. 1Q 2010 Data Set

Engineering Design Process Rubric – (K-1)

	Exceeds (5)	Proficient (3)	Novice (1)
ASK	☐ I can clearly tell you the problem with details in my own words. ☐ I can tell you what I can and cannot do with my product and ask more questions to clarify thinking if needed. ☐ I can use what I know to ask thinking questions that help me to gain more information and understanding of a concept.	☐ I can tell you the problem in my own words. ☐ I can tell you what I can and cannot do with my product. (criteria) ☐ I can use what I know to ask questions.	☐ I can tell you parts of the problem. ☐ I can tell you some of what I can and cannot do with my product. ☐ I can ask questions with help (prompting) from the teacher.
IMAGINE	☐ I can think of several ideas to make my product. ☐ My ideas match the problem and are creative and one of a kind.	☐ I can think of an idea to make my product. ☐ My idea matches the problem.	☐ I can think of an idea with my teacher's help. ☐ My own idea does not quite match the problem.
PLAN	☐ I can choose the best possible idea that I know I can do. ☐ I can draw a complete/accurate picture of my idea with labels of all the materials needed to complete this project.	☐ I can choose one idea that I know I can do. ☐ I can draw a picture of my idea with labels of most of the materials needed to complete this project.	☐ I can choose an idea with help from the teacher. ☐ My drawing has several missing parts. ☐ Labels are few or missing or do not match the picture.
CREATE	☐ I can follow all parts of my plan/picture accurately. ☐ My original plan works.	☐ I can follow most of my plan/picture accurately. ☐ I can add and/or change things to my original plan to make my product work.	☐ I can follow some of my plan with help from my teacher. ☐ Changes to my plan are not made even if it does not work.
EXPERIMENT	☐ I can collect and record data correctly. ☐ I can tell you what my data means by comparing patterns and relationships.	☐ I can collect and record data correctly. ☐ I can tell you what my data means.	☐ I can collect and record data with help from the teacher. ☐ Most of the data that I collected are not correct or complete.
IMPROVE	☐ I can tell you what worked and didn't work and think of creative and unique ways to improve my product. ☐ I will go through the EDP process many times to improve my product until my test data shows great improvement.	☐ I can tell you what worked and didn't work and how I can improve my product. ☐ I can work to make an improvement to my product.	☐ I can understand what worked and didn't work with help from the teacher. ☐ I can use suggestions of how to improve my product from the teacher. ☐ I can improve my product with help from the teacher.

STEM Competencies Rubric

	Advanced	Proficient	Developing	Beginning
Indicator 2.2: Collaborates with, helps and encourages others in-group situations (in science and engineering teams).	Student respectfully and effectively contributes ideas and feedback to the team. He/she listens to and encourages others to share their ideas. He/she works collaboratively with others to incorporate STEM process and skills in achieving team goals.	Student positively contributes ideas and feedback to the team. He/she listens to the contributions of others as they share their ideas. He/she works with others to incorporate STEM process and skills in achieving team goals.	Student contributes ideas and/or feedback to the team. He/she sometimes listens to the contributions of others. He/she works with others to incorporate STEM process and skills in achieving team goals but is not always effective or collaborative.	With coaching, student is able to contribute ideas and feedback to the team. He/she is able to work with others to achieve team goals, with support and guidance.
Indicator 2.5 – Demonstrates responsible and ethical behavior in decision making (while making choices for the team's implementation plans).	Student consistently demonstrates safe, ethical, and expert behavior in using equipment, technology, and data to make decisions in developing and implementing their plan. He/she honestly records and reports the results of their investigations.	Student demonstrates responsible and ethical behavior in using equipment, technology, and data to make decisions in developing and implementing their plan. He/she honestly records and reports the results of their investigations.	Student is able to use equipment, technology, and data to make decisions in developing and implementing their plan, but is not always responsible or ethical. He/she may be inconsistent in honestly recording and reporting the results of their investigations.	With coaching, student is able to responsibly use lab equipment, technology, and data to make decisions on developing and implementing their plan. He/she needs guidance to record and honestly report results of their investigations.
Indicator 6.4 Uses the appropriate technologies for communication, collaboration, research, creativity, and problem solving (multi-meter/internet/apps).	Student uses advanced search tools to efficiently gather and communicate relevant information from multiple authoritative print and digital sources. He/she effectively avoids plagiarizing sources and follows a standard citation format.	Student uses basic search tools to gather and communicate relevant information from multiple authoritative print and digital sources. He/she reasonable avoids plagiarism and usually follows a standard citation format.	Student needs some assistance in using basic search tools to gather and communicate relevant information from print and digital sources. He/she requires some guidance to avoid plagiarism and follow a citation format.	With coaching, student gathers and communicates information from limited print or digital sources. He/she requires assistance to avoid plagiarism and follow a citation format.

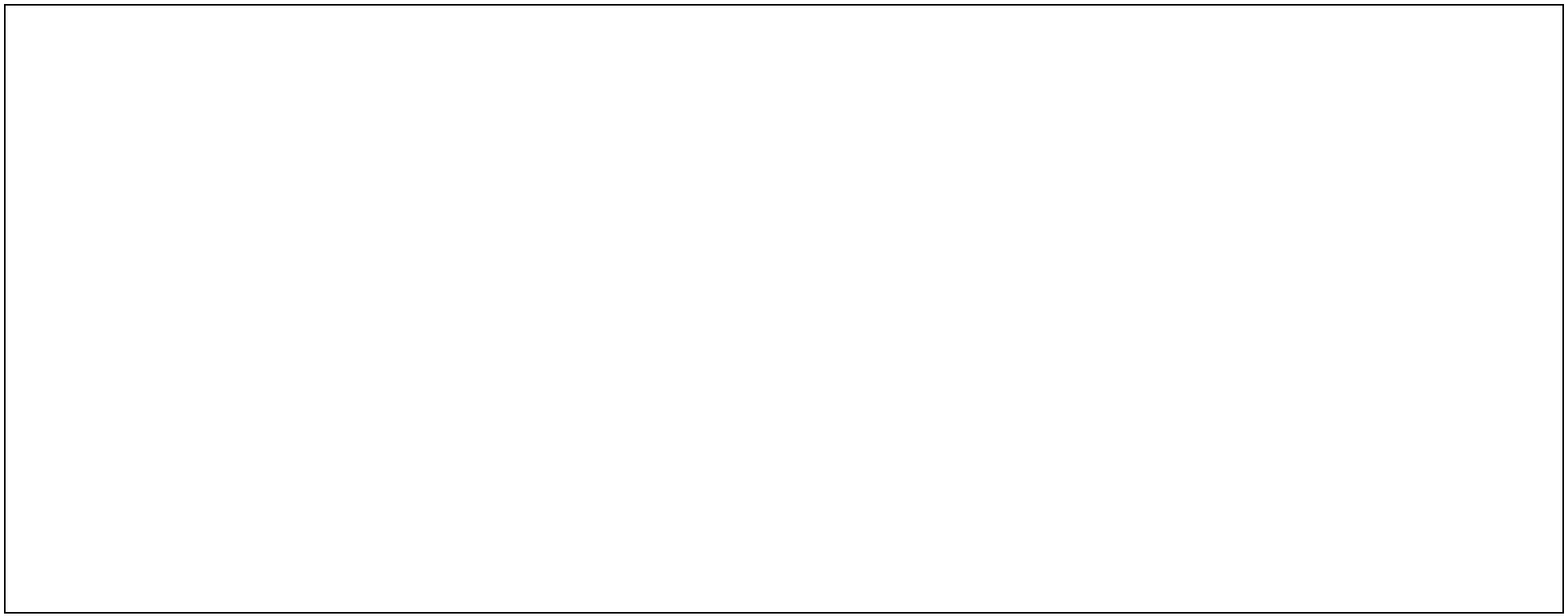
Engineering Design Process Assessment

Directions: Draw or write what you did at each step of the process.

Ask - I asked questions to help me understand what I need to know and do.	Imagine - I thought of different ideas of how to make my product.	Plan - I chose one of my ideas and drew a picture of it.
Create - I followed my plan as I made my product.	Experiment - I tested my product and collected and recorded my data on tables and graphs	Improve - I thought about what worked and didn't work and how I could improve my product.

Engineering Design Process Assessment

Now draw and/or write to tell us how the Engineering Design Process helps us.



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