Lesson Plan		
Subject: Introduction to Technology	Teacher:	Unit: The Design Process
Time frame: 1 – 2 class periods	Lessons 1 and 2: Defining the Problem and Brainstorming	Activity Title: Pumpkin Chunkin’

UNIT/ESSENTIAL QUESTION:	How can we use the design process to solve an engineering problem?
LESSON OBJECTIVE:	Students will BRAINSTORM design solutions to an engineering problem.
STANDARDS:	ITEA, STL 11-M. Identify the design problem to solve and decide whether to address it. ITEA, STL 11-Q. Develop and produce a product or system using a design process. NGSS, HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

KEY POINTS	MATERIALS
As a result of this lesson, students will be able to… • identify and define a design problem • identify the requirements of a design solution • sketch solutions to a defined engineering problem	**For each student:** • Student Handout: Pumpkin Chunkin’ Rule Book • Student Handout: Documentation Scoring Rubric • Student Handout: Design Scoring Rubric (these materials can be downloaded from www.howardcountymd.gov/pumpkinlaunch) **For class:** • Engineering notebooks* ** indicates teacher/student provided*
VOCABULARY	BEFORE CLASS
• Design statement • Problem statement • Brainstorm • Pictorial sketch • Multi-view sketch	N/A

HOMEWORK	If students did not finish brainstorming ideas during the class period, instruct them to finish at least one sketch for next class period

PROCEDURE	
ENGAGE *(5 minute Drill, 3 minute class discussion)*	Post the following question on the board for students to read. Instruct students to silently answer the question in their engineering notebook. Provide each student a copy of the Pumpkin Chunkin’ Rule Book, documentation scoring rubric and design scoring rubric: Review the Pumpkin Chunkin’ Rules and rubrics provided: 1. What is Pumpkin Chunkin’? What is the design challenge that our class will be developing a solution for? 2. What are some of the requirements for our design solution outlined in the rulebook. *Sample Answers: Pumpkin Chunkin’ is a pumpkin launching competition. The design challenge is to build a launcher that can throw a pumpkin a distance of 77ft and a height of 10 feet. The launcher cannot be ballistic, and it must be*

	easily transported and a certain cost. Discuss the Drill ▪ Record students thoughts on the front board.
EXPLORE *(20 minutes)*	▪ Explain to students that over the next few weeks, they will be going through the engineering design process to design a pumpkin launching device that meets the requirements outlined in the rulebook. ▪ Come up with a problem statement for the Pumpkin Chunkin' challenge as a class. Instruct students to record the statement in their engineering notebook. Discuss the difference between a problem statement (problem, need or want) and design statement (how the engineer will take action to solve the problem). ***Example Problem Statement:*** *Robinson Nature Center wants students to have the chance to compete in an engineering competition whose goal is to hit a target with a pumpkin.* ***Example Design Statement:*** *Design a pumpkin launching device that can throw a 4 – 10 lb pumpkin 77ft in distance and 10 fit in height. The device must be easily transported and built within a $100 budget.* ▪ Explain to students that, once engineers have identified the problem, they begin brainstorming solutions. ▪ Provide students the definition for brainstorm. Instruct them to record the definition in their lab notebook. **Brainstorm:** Any technique used by a design team to generate ideas. ▪ Provide students the definitions for pictorial and multi-view sketch. Instruct them to record the definition in their lab notebook. **Pictorial Sketch:** A type of drawing that gives the illusion of three dimensions, by showing an object's height, width and depth in a single view. **Multiview Sketch:** A type of drawing that portrays an object as a series of two or more two-dimensional views arranged in a specific pattern. ▪ Instruct students to sketch ideas they have for a pumpkin launching device in the engineering notebooks. They must draw either pictorial or multi-view sketches to give an idea of the machine in 3D DIRECTIONS: You have 15 minutes to draw a pictorial or multi-view sketch of at least one idea for a pumpkin launching device in your engineering notebook. Be sure to title and date your sketches (example: Pumpkin Chunkin' Launcher Brainstorm, Design #1 Multi-view sketch). Write one complete sentence under your drawing explaining how it works. Label your drawing as either a pictorial or multi-view sketch. CHALLENGE: Label your sketch with possible building materials that could be used to make your design.
EXPLAIN & ELABORATE *(20 minutes)*	▪ When students have finished brainstorming provide them a Post-It note on which to re-draw a simple sketch of their idea. Have students stick their Post-Its to the front board so everyone can see the ideas generated. ▪ Sort the Post-Its into groups with similar design ideas. If possible, encourage students to generate labels for the groups (example: catapults, trebuchets, ballistas, cannons, etc…)

	▪ Explain to students that tomorrow, they will conduct research on launching mechanisms to help inspire new ideas.
WRAP-UP	Wrap-up Key Question: How can we use the design process to solve an engineering problem? • The first step in the design process is "defining the problem." Engineers will identify the most important information about the design project. • Once the design problem has been identified, engineers begin brainstorming solutions.
EVALUATE *(5 minutes)*	Post the following problem on the board for students to read. Instruct students to silently answer the question in their engineering notebook. 1. Which design that either you or a classmate brainstormed in class today, would you be most interested in researching further? Why? *Sample Answers: Answers will vary*

BLOOM'S IN THIS LESSON		
X	Knowledge	arrange, define, duplicate, label, list, memorize, name, order, recognize, relate, recall, repeat, reproduce state
X	Comprehension	classify, describe, discuss, explain, express, identify, indicate, locate, recognize, report, restate, review, select, translate
X	Application	apply, choose, demonstrate, dramatize, employ, illustrate, interpret, operate, practice, schedule, sketch, solve, use, write
X	Analysis	analyze, appraise, calculate, categorize, compare, contrast, criticize, differentiate, discriminate, distinguish, examine, experiment, question, test
	Synthesis	arrange, assemble, collect, compose, construct, create, design, develop, formulate, manage, organize, plan, prepare, propose, set up, write
	Evaluation	appraise, argue, assess, attach, choose compare, defend estimate, judge, predict, rate, core, select, support, value, evaluate

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Lesson Plan		
Subject: Introduction to Technology	Teacher:	Unit: The Design Process
Time frame: 1 – 2 class periods	Lesson 3: Research and Generate Ideas	Activity Title: Pumpkin Chunkin’

UNIT/ESSENTIAL QUESTION:	How can we use the design process to solve an engineering problem?
LESSON OBJECTIVE:	Students will COMPARE different design ideas found through research to generate the best solution for a design problem
STANDARDS:	ITEA, STL 11-M. Identify the design problem to solve and decide whether to address it. ITEA, STL 11-Q. Develop and produce a product or system using a design process. NGSS, HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

KEY POINTS	MATERIALS
As a result of this lesson, students will be able to… • identify and define a design problem • identify the requirements of a design solution • research solutions to a design problem • compare different design options found through research to generate the best solution to a design problem	**For class:** • Access to internet or library* • Engineering notebooks* ** indicates teacher/student provided*
VOCABULARY	BEFORE CLASS
• Research	N/A

HOMEWORK	If students did not finish brainstorming ideas during the class period, instruct them to finish at least one sketch for next class period

PROCEDURE	
ENGAGE *(5 minute Drill, 3 minute class discussion)*	Post the following question on the board for students to read. Instruct students to silently answer the question in their engineering notebook. 1. Why would researching launching devices be beneficial to generating a design solution for the Pumpkin Chunkin’ challenge? *Sample Answers: Answers will vary. Students should recognize seeing many different ideas may inspire them to combine ideas in new ways to generate an even better solution than brainstorming alone.* Discuss the Drill ▪ Record students thoughts on the front board.
EXPLORE *(20 minutes)*	▪ Explain to students that they will be conducting research on several different launching devices to generate new ideas for their Pumpkin Chunkin’ machine. ▪ As a class, generate a list of ideas of launching devices. Record ideas on the board.

	Example launching devices: *catapult, trebuchet, cannon, sling-shot, ballista* ▪ Provide students the definition for research. Instruct them to record the definition in their engineering notebooks for future reference **Research:** The systematic study of materials and sources in order to establish facts and reach new conclusions. ▪ Assign groups of students to research one of the launching devices generated by the class. DIRECTIONS: You and your group have been assigned a specific launching mechanism to research further. Your job it to write a 1-paragraph summary of how the machine works and to draw a simple picture of the machine's design. You must also prepare a "works cited" list, detailing where you found your information in case we want to revisit the source in the future. Be sure to use correct MLA format when citing your sources. Be prepared to share the information you discover with the class. ▪ Provide students ample time to research their launching mechanism.
EXPLAIN & ELABORATE *(20 minutes)*	▪ Have students present their drawing, paragraph and sources to the class. Keep the drawings on the board for the class to examine.
WRAP-UP	Wrap-up Key Question: How can we use the design process to solve an engineering problem? • Engineers conduct research in order to establish facts and reach new conclusions about a design problem
EVALUATE *(5 minutes)*	Post the following problem on the board for students to read. Instruct students to silently answer the question in their engineering notebook. 1. What launching mechanism that was presented in class do you think would be the most successful at launching a pumpkin? Why? 2. What specific components of the mechanism you identified in question one could you incorporate into your pumpkin launcher design? *Sample Answers: Answers will vary*

BLOOM'S IN THIS LESSON		
X	Knowledge	arrange, define, duplicate, label, list, memorize, name, order, recognize, relate, recall, repeat, reproduce state
X	Comprehension	classify, describe, discuss, explain, express, identify, indicate, locate, recognize, report, restate, review, select, translate
X	Application	apply, choose, demonstrate, dramatize, employ, illustrate, interpret, operate, practice, schedule, sketch, solve, use, write
X	Analysis	analyze, appraise, calculate, categorize, compare, contrast, criticize, differentiate, discriminate, distinguish, examine, experiment, question, test
	Synthesis	arrange, assemble, collect, compose, construct, create, design, develop, formulate, manage, organize, plan, prepare, propose, set up, write
	Evaluation	appraise, argue, assess, attach, choose compare, defend estimate, judge, predict, rate, core, select, support, value, evaluate

Lesson Plan		
Subject: Introduction to Technology	Teacher:	Unit: The Design Process
Date: 1 – 2 class periods	Lesson 4: Identifying Criteria and Specifying Constraints	Activity Title: Pumpkin Chunkin’

UNIT/ESSENTIAL QUESTION:	How can we use the design process to solve an engineering problem?
LESSON OBJECTIVE:	Students will WRITE a design brief summarizing the criteria and constraints for a given design problem
STANDARDS:	ITEA, STL 11-M. Identify the design problem to solve and decide whether to address it. ITEA, STL 11-N. Identify criteria and constraints and determine how these will affect the design process. ITEA, STL 11-Q. Develop and produce a product or system using a design process. NGSS, HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. NGSS, HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability and aesthetics as well as possible social, cultural, and environmental impacts.

KEY POINTS	MATERIALS
As a result of this lesson, students will be able to… • define the terms criteria and constraint • identify the criteria and constraints in an engineering problem • write a design brief summarizing the criteria and constraints for a design problem	**For each student:** • Student Handout: Example Design Brief • Student Handout: Create Your Own Design Brief • Rubric: Design Brief **For whole class** • Engineering notebooks* ** indicates teacher/student provided*
VOCABULARY	BEFORE CLASS
• criteria • constraint • design brief	N/A

HOMEWORK	If design briefs are not completed by the end of class time, assign students to complete them for homework.

PROCEDURE	
ENGAGE *(5 minute Drill, 3 minute class discussion)*	Post the following problem on the board for students to read. Instruct students to silently answer the question in their engineering notebook. Imagine you are designing a shoe. You have the following materials to choose from: aluminum foil, canvas, cotton fabric, felt, foam, newspaper, plastic, and rubber. 1. What material(s) would select to build your shoe out of? 2. Why did you choose these materials? IF YOU FINISH EARLY: Draw a sketch of the shoe you would design. Be sure to label what material each part of the shoe is made out of. *Sample Answers: Answer will vary.*

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Discuss the Drill
▪ Encourage students to share their explanations for why they chose a particular material over another. Guide the conversation to a discussion about the function of a shoe and how a design must meet constraints and criteria: <i>The reason students chose a particular material was because they believed it would better suit the function of the shoe they were designing.</i>
Sample Questions:

What were you envisioning the function of your shoe to be? Was it an athletic shoe? A water shoe?
How does this information impact your material choices?
How does your choice of materials relate to the function of a shoe?
Why might you not want to make a shoe out of newspaper?
Would your choice in materials change if I told you the shoe needed to be waterproof? Lightweight? Recyclable/green?

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<td>EXPLORE
<i>(20 minutes)</i></td>
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▪Provide students the following two definitions. Instruct them to record the definitions in their engineering notebook for future reference.

Criteria: Standards by which something may be judged or decided
Constraints: A limit or restriction to a design process

▪ Explain to students that engineers must consider both criteria and constraints when designing a solution to a problem.
▪ Connect the definitions of criteria and constraint to the “drill.” Provide students an example of both a criteria and a constraint, then encourage students to share their own ideas.

<i>Example: Constraint = durability, Criteria = being waterproof</i>

▪ Transition the discussion to identifying criteria and constraints in the Pumpkin Chunkin’ design challenge

DIRECTIONS: You have 5 minutes to identify the criteria and constraints for our Pumpkin Chunkin’ design challenge with a partner. Be sure to record your thoughts in chart or other organized way in your engineering notebook.
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<td>EXPLAIN & ELABORATE
<i>(20 minutes)</i></td>
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Class Discussion
▪ Pause students where they are to discuss the criteria and constraints that they identified with the whole class. Record student responses on the board in a T-chart with the following headings.

<i>Sample responses:</i>

<table>
<tr><th><i>Criteria</i></th><th><i>Constraint</i></th></tr>
<tr><td><i>Must launch a pumpkin 77 ft in distance, 10 feet in height</i></td><td><i>Size</i>
<i>Cost</i></td></tr>
<tr><td><i>Easy transportation</i></td><td><i>Deadline</i></td></tr>
<tr><td><i>Visually attractive</i></td><td><i>No explosives</i></td></tr>
<tr><td><i>Unique</i></td><td></td></tr>
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▪ Encourage students to differentiate between criteria that are vital, strongly desired, marginally desired and unessential. Guide students to the conclusion that resources and time should be allocated efficiently; we must include vital criteria, but there is no need to spend time and money addressing unessential criteria. Encourage students to support their responses with evidence and reasoning
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Sample Questions

- Which criteria would we categorize as vital? Strongly desired? Marginally desired? Unessential? Why?
- Which criteria should we spend the most time and resources developing? Why?

▪ Provide students the definition for design brief. Instruct them to record the definition in their engineering notebook for future reference.

Design brief: A written plan that identifies a problem to be solved, its criteria and constraints.

▪ Explain to students that design briefs are important because they encourage thinking about all aspects of the problem to be solved before a solution is attempted.
▪ Show students the example of a design brief, Student Handout: Example Design Brief. Then, instruct them to write a design brief with their partner for the Pumpkin Chunkin' Challenge.

DIRECTIONS: You have 15 minutes to write a design brief for the Pumpkin Chunkin' design challenge. Before beginning, review the grading rubric to ensure you understand how you are being evaluated and that you include all components of the assignment.

WRAP-UP

Wrap-up
Key Question: How can we use the design process to solve an engineering problem?

- When solving an engineering challenge, engineers must make sure they've thought about all aspects of a problem
- This involves identifying the criteria and constraints associated with the problem
- It is important to determine which criteria are vital, strongly desired and unessential to ensure resources are allocated appropriately
- Engineers use design briefs to clearly and concisely record the criteria and constraints of a given problem, so that they are able to refer to the decisions they've made at any time

EVALUATE
(5 minutes)

Post the following problem on the board for students to read. Instruct students to silently answer the question in their engineering notebook.

1. Consider our shoe design problem from the beginning of class. Identify the criteria and constraints you would consider if you were designing the shoe

Sample Answers: Answer will vary. Possible examples

Criteria	***Constraint***
Waterproof	*Size*
Light-weight	*Cost*
Attractive design	
Made of recyclable materials	

BLOOM'S IN THIS LESSON		
X	Knowledge	arrange, define, duplicate, label, list, memorize, name, order, recognize, relate, recall, repeat, reproduce state
X	Comprehension	classify, describe, discuss, explain, express, identify, indicate, locate, recognize, report, restate, review, select, translate
X	Application	apply, choose, demonstrate, dramatize, employ, illustrate, interpret, operate, practice, schedule, sketch, solve, use, write
X	Analysis	analyze, appraise, calculate, categorize, compare, contrast, criticize, differentiate, discriminate, distinguish, examine, experiment, question, test
X	Synthesis	arrange, assemble, collect, compose, construct, create, design, develop, formulate, manage, organize, plan, prepare, propose, set up, write
	Evaluation	appraise, argue, assess, attach, choose compare, defend estimate, judge, predict, rate, core, select, support, value, evaluate

Name: Date: Period:

HANDOUT 1. DESIGN BRIEF EXAMPLE:

DIRECTIONS: Examine the design brief for a phone case outlined below. While reading, consider the elements contained in each section of the report. *What are the components of a "good" design brief? How can you incorporate these elements when writing your own design brief?*

DESIGN BRIEF

CLIENT:	Fancy Phones, LLC
DESIGNER:	Malik Johnson
PROBLEM STATEMENT:	Phones are at a high risk for damage including scratches to the screen and backing, cracks and shattering of the screen, water damage, etc. While many of the cases sold in today's market place offer protection against impact and water damage, their bulky design impairs the performance of speakers and touch screen functions. Additionally, the designs are not visually appealing to consumers.
DESIGN STATEMENT:	Design, model and test a prototype cell phone case for a phone of our choosing that provides impact protection and prevents water damage, amplifies external speaker performance, keeps ports accessible and has a sleek, visually appealing design.
CONSTRAINTS:	(i) 2-mo. Design and prototype, (ii) $15 max. manufacturing cost (qty of 100,000), (iii) must fit your chosen phone's dimensions (WxHxD) (iv) 40 g max. weight
DELIVERABLES:	(i) sketches showing breadth of ideas, (ii) design journal, (iii) technical drawings, (iv) mfg. cost estimates, (v) development schedule and cost estimates, (vi) prototype

Name: Date: Period:

HANDOUT 2. CREATE YOUR OWN DESIGN BRIEF:

DIRECTIONS: Write a design brief that identifies the criteria and constraints associated with the Pumpkin Chunkin' design problem. Consult Handout 1. Design Brief Example as a reference if you have difficulty identifying what belongs in each section. When you are finished, highlight the design criteria you've identified in YELLOW. Highlight the design constraints you've identified in BLUE.

CLIENT:	
DESIGNER:	
PROBLEM STATEMENT:	
DESIGN STATEMENT:	
CONSTRAINTS:	
DELIVERABLES:	

HANDOUT 3. DESIGN BRIEF GRADING RUBRIC

Name: Period:

DESIGN BRIEF GRADING RUBRIC

	MEETING EXPECTAIONS (3 points)	APPROACHING EXPECTATIONS (2 points)	BELOW EXPECTATIONS (1 point)
1. ORGANIZATION	All sections of the design brief are completed fully. Student correctly identifies what information should be included in particular sections of the report.	At least 4 of the sections of the design brief are completed fully. Student correctly identifies what information should be included in particular sections of the report most of the time.	Fewer than 4 of the sections of the design brief are completed fully. Student rarely identifies the correct information that should be included in each section.
2. PROBLEM STATEMENT	Student accurately and concisely summarizes the design problem they are creating a solution for.	Student attempts to summarize the design problem they are creating a solution for, but is missing some information OR includes erroneous information that detracts from the report.	Student's summary of the problem is missing key information, is unintelligible OR student summarizes a different problem than the one for which they are designing a solution.
3. DESIGN STATEMENT	Student accurately and concisely summarizes the criteria their design will meet.	Student attempts to summarize the criteria their design will meet, but is missing one or two criteria.	Student attempts to summarize the criteria their design will meet, but is missing more than two of the criteria, OR student confuses constraints with criteria.
4. CONSTRAINTS	Student accurately identifies all of the constraints their design must meet.	Student identifies most of the constraints their design must meet.	Student identifies few, if any, of the constraints their design must meet, OR student confuses constraints with criteria.
5. DELIVERABLES	Student accurately identifies all of the deliverables they will produce.	Student identifies most of the deliverables they will produce.	Student identifies few, if any, of the deliverables they will produce.

TOTAL SCORE: _____/15

JAMES & ANNE Robinson NATURE CENTER
Howard County RECREATION & PARKS

Lesson Plan		
Subject: Introduction to Technology	Teacher:	Unit: The Design Process
Timeframe: 1 – 2 class periods	Lesson 5: Exploring Possibilities	Activity Title: Pumpkin Chunkin’

UNIT/ESSENTIAL QUESTION:	How can we use the design process to solve an engineering problem?
LESSON OBJECTIVE:	Students will DESIGN solutions that meet the criteria and constraints in an engineering problem
STANDARDS:	ITEA, STL 11-N. Identify criteria and constraints and determine how these will affect the design process. ITEA, STL 11-P. Evaluate the design solution using conceptual, physical, and mathematical models at various intervals of the design process in order to check for proper design and to note areas where improvements are needed. ITEA, STL 11-Q. Develop and produce a product or system using a design process. NGSS, HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. NGSS, HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability and aesthetics as well as possible social, cultural, and environmental impacts.

KEY POINTS	MATERIALS
As a result of this lesson, students will be able to… • identify the criteria and constraints in an engineering problem • design solutions that meet the criteria and constraints in an engineering problem • differentiate between pictorial and multi-view sketches • argue whether a particular design is better represented as a pictorial or multi-view sketch • compare design solutions to an engineering problem and synthesize ideas to create an even better solution	**For each student:** • Post-It Notes* • Scratch paper* **For whole class:** • Engineering notebooks* ** indicates teacher/student provided*
VOCABULARY	BEFORE CLASS
• criteria • constraint • pictorial sketch • mult-iview sketch • stepladder method of brainstorming	N/A

HOMEWORK	

PROCEDURE	
ENGAGE *(5 minute Drill, 3 minute class discussion)*	Post the following question on the board for students to read. Instruct students to silently answer the question in their engineering notebook.

	Look through your engineering notebook and find the sketches you made during our first Pumpkin Chunkin' brainstorming session. Review the criteria and constraints we identified for this engineering problem during class yesterday. 1. Which of your drawings best meets the design criteria and constraints that we've identified? Why? 2. What could you change about this design to make it better meet the design criteria and constraints that we've identified? How would these changes accomplish this goal? IF YOU FINISH EARLY: Begin sketching your design included the new elements you identified in question 2 in your engineering notebook. *Sample Answers: Answer will vary.* Discuss the Drill ▪ Review the criteria and constraints you identified as a class, record them on the front board so all students can see. Encourage students to share their drawing that best meets the design criteria and constraints and how they would modify their design to make it better. Encourage students to think back to the research they conducted about launching devices earlier in the design process. How can they use this research to better their designs? Sample Questions: • What are the criteria we identified for our Pumpkin Chunkin' launcher? The constraints? • How does your design meet these criteria/constraints? • What criteria/constraints does your design not address? • Have you uncovered any ideas through the research we conducted that you could add to your design to better meet the criteria and constraints? • What could you change about your design to make it better meet the criteria and constraints we've identified?
EXPLORE *(20 minutes)*	▪Provide students 7 minutes to redraw their pumpkin launcher design with the modifications they identified in question #2 from the drill. ▪Pause students after the allotted time to review the two types of sketching discussed during Lessons 1 and 2. Defining the Problem and Brainstorm. Ask students: *What are the two types of sketching we discussed during Lesson 2. Brainstorm?* ▪If students don't remember the definitions, provide them again. **Pictorial Sketch:** A type of drawing that gives the illusion of three dimensions, by showing an object's height, width and depth in a single view. **Multi-view Sketch:** A type of drawing that portrays an object as a series of two or more two-dimensional views arranged in a specific pattern. ▪ Instruct students to identify if the sketch(es) they've been working on are pictorial, multi-view or something else. Have them label the type of sketch they've drawn accordingly. Ask students: *Do you think the design you're working on is better captured in a pictorial sketch or a multi-view sketch? Why?* ▪ Encourage students to share their thoughts to the question posed. Answers will vary depending upon what the student is drawing. Focus on the argument behind a student's answer as opposed to confirming whether there is a right or wrong answer. Encourage students to support their thoughts with specific evidence. ▪ If students need more time to finish their drawings at this point, provide it.

	It not, transition students to “exploring the possibilities” DIRECTIONS: Today we are going to use the “stepladder method” of brainstorming to generate design ideas. This process is particularly useful for groups that have a mix of both introverts and extroverts and guarantees that everyone’s ideas are heard. We’ve already completed the first two steps. **Step 1.** Clearly define the problem and criteria **Step 2.** Allow group members time to create ideas individually **Step 3.** Two group members come together and share their ideas and brainstorm new ideas that develop as a result of the sharing process. **Step 4.** A third member is added who presents his or her ideas to the other two members and then listens to the ideas from the original two members. After all of the ideas have been shared, time is allowed to brainstorm new ideas. **Step 5.** Repeat step 4 by adding one new group member at a time until all members have joined and shared ideas. ▪ Have students complete “Step 3.” Pair students with a member from their tables and provide them 6 minutes to share and brainstorm new ideas. RECOMMENDATION: display a timer to allow students to monitor their progress through this step. ▪ Have students complete a modified “Step 4.” Group pairs of students together. Have all students share their ideas and have students brainstorm new ideas as a result of the sharing. Provide students approximately 15 minutes to do this. Inform students that their group will be presenting their “final” sketch from the results of their brainstorming at the end of this time period. RECOMMENDATION: It’s best to have at least 6 groups of students when moving on to the next step. Adjust your groupings accordingly.
EXPLAIN & ELABORATE *(20 minutes)*	Class Discussion ▪ Allow groups to present the “final” sketch they came up with as a result of their stepladder brainstorm. Have students explain their drawing and ideas and tape their sketch to the front board. ▪ Encourage students to ask questions, voice opinions and share constructive criticism. RECOMMENDATION: it may be useful to review classroom norms for sharing opinions before this step. ▪ When all groups have finished sharing, provide each student with three sticky notes. DIRECTIONS: You have been given three sticky notes. When I say go, quietly and respectfully place a sticky note on the three designs you think best meet the design criteria and constraints we’ve established. We will evaluate these ideas more thoroughly tomorrow. ▪ Note the three designs with the most student votes. Save the sketches for next class period.
WRAP-UP	Wrap-up Key Question: How can we use the design process to solve an engineering problem? • When solving an engineering challenge, engineers revisit solution ideas they generated earlier in the design process and build upon them • At this point in the design process, it’s important to consider the criteria and constraints of the problem when generating and modifying ideas.

	• The stepladder method is a useful brainstorming technique when exploring the possibilities because it allows team members to express, expand, combine and twist ideas generated by the group to come to an even better design
EVALUATE *(5 minutes)*	Post the following problem on the board for students to read. Instruct students to silently answer the question in their engineering notebook. 1. Which design presented by a group today do you think best meets the design criteria and constraints your class identified? Why (support your answer with specific evidence)? *Sample Answers: Answer will vary.*

BLOOM'S IN THIS LESSON		
X	Knowledge	arrange, define, duplicate, label, list, memorize, name, order, recognize, relate, recall, repeat, reproduce state
X	Comprehension	classify, describe, discuss, explain, express, identify, indicate, locate, recognize, report, restate, review, select, translate
X	Application	apply, choose, demonstrate, dramatize, employ, illustrate, interpret, operate, practice, schedule, sketch, solve, use, write
X	Analysis	analyze, appraise, calculate, categorize, compare, contrast, criticize, differentiate, discriminate, distinguish, examine, experiment, question, test
X	Synthesis	arrange, assemble, collect, compose, construct, create, design, develop, formulate, manage, organize, plan, prepare, propose, set up, write
X	Evaluation	appraise, argue, assess, attach, choose compare, defend estimate, judge, predict, rate, core, select, support, value, evaluate

Lesson Plan		
Subject: Introduction to Technology	Teacher:	Unit: The Design Process
Time frame: 2 – 3 class periods	Lesson 6: Select an Approach	Activity Title: Pumpkin Chunkin’

UNIT/ESSENTIAL QUESTION:	How can we use the design process to solve an engineering problem?
LESSON OBJECTIVE:	Students will EVALUATE design solutions to an engineering problem using a decision matrix
STANDARDS:	ITEA, STL 11-N. Identify criteria and constraints and determine how these will affect the design process. ITEA, STL 11-P. Evaluate the design solution using conceptual, physical, and mathematical models at various intervals of the design process in order to check for proper design and to note areas where improvements are needed. ITEA, STL 11-Q. Develop and produce a product or system using a design process. NGSS, HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. NGSS, HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability and aesthetics as well as possible social, cultural, and environmental impacts.

KEY POINTS	MATERIALS
As a result of this lesson, students will be able to… • identify the criteria and constraints in an engineering problem • compare design solutions to an engineering problem and synthesize ideas to create an even better solution • identify the considerations that should be included in a decision matrix • create a decision matrix • evaluate design solutions to an engineering problem using a decision matrix	**For each student:** • Student Handout: Decision Matrix Example • Student Handout: Decision Matrix Template **For whole class:** • Scratch paper* • Computers with Excel application (optional)* • Engineering notebooks* ** indicates teacher/student provided*
VOCABULARY	**BEFORE CLASS**
• criteria • constraint • considerations • decision matrix	N/A

HOMEWORK	

PROCEDURE	
ENGAGE *(5 minute Drill, 3 minute class discussion)*	Post the following question on the board for students to read. Instruct students to silently answer the question in their engineering notebook. Think back to the phone case design brief you read during Lesson 4. Identifying Criteria and Constraints. 1. If you were comparing several different cell phone case designs, how would you decide which solution was the best?

	Sample Answers: Answer will vary. Discuss the Drill ▪ Have a student summarize the phone case design brief for the class as a reminder. Encourage students to share their responses to the drill. Sample Questions: • What were the criteria and constraints identified in the design brief? • How might criteria and constraints relate to determining the best design solution? • Are there other considerations besides criteria and constraints that we can use to determine which design solution is the best? What are they?
EXPLORE *(20 minutes)*	▪Introduce the concept of a decision matrix. Explain to students that a decision matrix is used to help engineers decide which solution to a design problem is the best. It's a tool that prevents us from being "married to an idea" and biased in our decision-making. ▪Instruct students to record the definition for decision matrix in their engineering notebooks. **Decision Matrix:** A chart used by engineers to quantify their opinions of two or more design ideas by assessing each idea according to a series of important considerations. ▪ Provide students Handout 1. Decision Matrix Example. Model how to annotate the handout (example: drawing lines and making comments) to answer the questions posed in the directions: DIRECTIONS: Examine the decision matrix comparing several phone case design solutions pictured below. Consider the following questions while reading: *What are the considerations used to compare the designs? How are the design solutions scored? What is the difference between points awarded using a variable scale versus a binary scale? How can we tell which design idea is the best?*
EXPLAIN & ELABORATE *(20 minutes)*	Class Discussion ▪ Discuss students' answers to the questions posed in the directions. ▪ Provide students information about variable and binary number scales: "Two number scales may be used to evaluate solution ideas in a decision matrix: a variable scale and a binary scale. The variable scale can include a range of values that is more than two. Ideas can be ranked based on how well they meet an important consideration. A binary scale is used when an idea is evaluated based on a specific criteria or a question. Zero indicates "No" and one indicates "Yes." If a team decides a particular consideration is more important than another, for example the functionality is twice as important as the visual appeal, a multiplier may be used to give weight to the more important category." ▪ As a class, generate ideas for the "considerations" pumpkin-launching devices should be evaluated by. DIRECTIONS: You have 5 minutes to brainstorm at least three "considerations" by which you think we should evaluate our pumpkin-launching devices. Two of your considerations should be able to be judged

	on a **variable scale**. One of your considerations should be able to be judged on a **binary scale**. ▪ "Wrap around share" students' ideas; each person shares one idea they came up with followed by the person next to them until everyone has shared. Write the responses on the front board for all students to see. If a student only generated ideas that the class has already come up with, ask them to select the idea they think is best and to put a check mark next to that "consideration" on the board. ▪ Have students explain why their suggestion should be scored using a variable or binary scale as they share. ▪ After everyone has shared, ask if any students still have ideas that are not on the front board. ▪ Have students eliminate "considerations" that are very similar to other ones on the boards. ▪ Explain to students that they must vote to determine which "considerations" should be included in the decision matrix. Try to limit the number of "considerations" to 6 variable and 3 binary scored options or fewer. DIRECTIONS: We must now agree on which "considerations" we will include in our decision matrix. Which "considerations" should we definitely include? Why? Which ones can we eliminate? Why? ▪ When the class has reached consensus on the decision matrix "considerations," create the design matrix. It may be helpful to make the decision matrix in Excel to make tabulating easier. ▪ Have all students fill out the decision matrix to determine a total point score for each preliminary idea. Average the totals from each team member's decision matrix to determine the idea with the highest score.
WRAP-UP	Wrap-up Key Question: How can we use the design process to solve an engineering problem? • When solving an engineering challenge, engineers must determine which design solution they've developed is best. • A useful tool for objectively evaluating design solutions is a decision matrix. • A decision matrix is a chart engineers use to quantify their opinions of two or more design ideas by evaluating each idea according to a series of important considerations. • Decision matrixes allow engineers to come to consensus about which idea has the greatest potential for development into a successful working solution.
EVALUATE *(5 minutes)*	Post the following problem on the board for students to read. Instruct students to silently answer the question in their engineering notebook. 1. Do you believe that the pumpkin launching mechanism design with the highest score from the decision matrix has the greatest potential for development into a successful working solution? Why or why not? *Sample Answers: Answer will vary.*

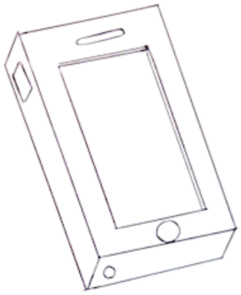
BLOOM'S IN THIS LESSON		
X	Knowledge	arrange, define, duplicate, label, list, memorize, name, order, recognize, relate, recall, repeat, reproduce state
X	Comprehension	classify, describe, discuss, explain, express, identify, indicate, locate, recognize, report, restate, review, select, translate
X	Application	apply, choose, demonstrate, dramatize, employ, illustrate, interpret, operate, practice, schedule, sketch, solve, use, write
X	Analysis	analyze, appraise, calculate, categorize, compare, contrast, criticize, differentiate, discriminate, distinguish, examine, experiment, question, test
X	Synthesis	arrange, assemble, collect, compose, construct, create, design, develop, formulate, manage, organize, plan, prepare, propose, set up, write
X	Evaluation	appraise, argue, assess, attach, choose compare, defend estimate, judge, predict, rate, core, select, support, value, evaluate

JAMES & ANNE Robinson
NATURE CENTER
Howard County
RECREATION & PARKS

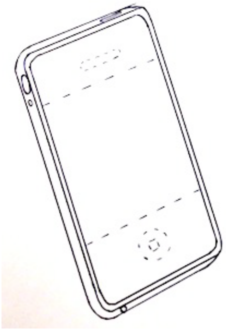
Name: Date: Period:

HANDOUT 1. DECISION MATRIX EXAMPLE

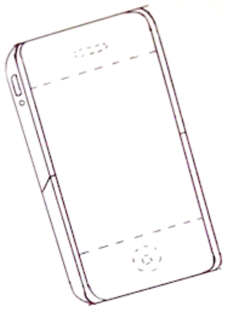
DIRECTIONS: Examine the decision matrix comparing several phone case design solutions pictured below. Annotate the answers to the following questions on your handout while reading: *What are the considerations used to compare the designs? How are the design solutions scored? What is the difference between points awarded using a variable scale versus a binary scale? How can we tell which design idea is the best?*



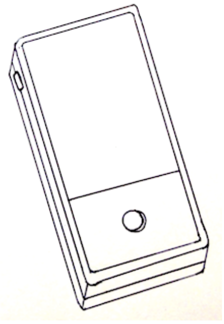
IDEA #1



IDEA #2



IDEA #3



IDEA #4

Preliminary Ideas Decision Matrix

	DESIGN & MANUFACTURING CONSIDERATIONS						
SOLUTONS	Functionality	Visual Appeal	Manufacturing Cost	Complexity	Is it waterproof?	Are all ports accessible?	TOTAL
IDEA #1	4	1	3	3	0	1	12
IDEA #2	3	4	2	4	1	1	15
IDEA #3	2	3	1	1	1	1	9
IDEA #4	1	2	4	2	0	0	9

VARIABLE SCALE			
4	3	2	1
BEST			WORST

BINARY SCALE		
1		0
YES		NO

Name: Date: Period:

HANDOUT 2. DECISION MATRIX TEMPLATE

DIRECTIONS: Draw a rough sketch of, or describe, each of the pumpkin launching design ideas being compared in the space provided below. Once your class comes to a consensus about which considerations should be included in your decision matrix, fill in the considerations and complete the decision matrix below.

SKETCHES

IDEA #1	IDEA #2	IDEA #3	IDEA #4

Preliminary Ideas Decision Matrix

	DESIGN & MANUFACTURING CONSIDERATIONS								
SOLUTONS									TOTAL
IDEA #1									
IDEA #2									
IDEA #3									
IDEA #4									

VARIABLE SCALE			
4	3	2	1
BEST			WORST

BINARY SCALE		
1		0
YES		NO

Lesson Plan		
Subject: Introduction to Technology	Teacher:	Unit: The Design Process
Time frame: 2 – 3 class periods	Lesson 7: Develop a Design Solution	Activity Title: Pumpkin Chunkin’

UNIT/ESSENTIAL QUESTION:	How can we use the design process to solve an engineering problem?
LESSON OBJECTIVE:	Students will CREATE a design proposal for an engineering problem consisting of CAD drawings, text descriptions and/or hand drawings
STANDARDS:	ITEA, STL 11-O. Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of the final product. ITEA, STL 11-Q. Develop and produce a product or system using a design process. ITEA, STL 11-R. Evaluate final solutions and communicate observations, processes, and results of the entire design process, using verbal, graphic, quantitative, virtual, and written means, in addition to three-dimensional models. NGSS, HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

KEY POINTS	MATERIALS
As a result of this lesson, students will be able to… • specify the materials, dimensions and process to be used in the construction of a prototype or model • create a design proposal consisting of CAD drawings, text descriptions and/or hand drawings	**For each student:** • Student Handout: Design Proposal Grading Rubric • Graph paper* • Rulers* **For whole class:** • Computers with CAD (optional)* • Engineering notebooks* **Modifications** • Student Handout: Writing a Design Proposal (MOD) ** indicates teacher/student provided*
VOCABULARY	BEFORE CLASS
• Design proposal • Computer assisted drawing (CAD)	N/A

HOMEWORK	If students are not able to finish their design proposal in class, and you are short on time, consider assigning it for homework.

PROCEDURE	
ENGAGE *(5 minute Drill, 3 minute class discussion)*	Post the following question on the board for students to read. Instruct students to silently answer the question in their engineering notebook. Imagine you just bought an Ikea bookshelf. It requires assembly. 1. What would the manufacturer provide you to help you assemble your bookcase? 2. What information is included in the document you identified in question 1? *Sample Answers: Answer will vary. Most students will recognize the manufacturer would provide you with a schematic or drawing showing how parts are put together. This document may have dimensions, specific materials to be used in each step, etc…*

	Discuss the Drill ▪ Encourage students to share their responses to the drill. Sample Questions • How might a manufacturer present assembly information? • What type of information (visual, text, etc) would be most helpful to you if you were assembling a bookcase? Why? • Why would dimensions be helpful if you are assembling a bookcase? Would they be important if you were manufacturing one?
EXPLORE *(20 minutes)*	▪ Explain to students that, at this point in the design process, they need to complete the preparations to build a prototype or model of their chosen design. DIRECTIONS: At this point, you have selected a design solution. Before building a prototype or model, a clear, documented description of the design is required. Engineers document this information in a "design proposal." ▪ Provide students the following definition for design proposal. Encourage them to record the definition in their lab notebook for future reference. **Design proposal:** A written document that clearly specifies how to build a model, prototype of final design. The design proposal should include documents that specify (1) materials, (2) dimensions and (3) processes used in the construction.
EXPLAIN & ELABORATE *(20 minutes)*	▪ If you have CAD software available and enough computers, this is a great opportunity to (re)introduce students to CAD modeling. ▪ If you do not have CAD software available, provide students graph paper and rulers to assist them in their drawing process. ▪ Before letting students loose to begin their design proposal, be sure to review the rubric and assignment expectations as a class. ▪ Students will probably need over an hour of time to complete this assignment. If you are trying to save on class time, you can assign whatever is not completed in class as homework. DIRECTIONS: You have the rest of the class period to begin working on your design proposal. Be sure to consult the rubric as you work to ensure you're meeting all expectations! ▪ When students have completed their design proposals, review them as a class. Now is the time to analyze designs and make decisions about materials, size, and other items that were inconsequential during the earlier parts of the design process. ▪ Select the best design proposal written, and use the information contained in it to purchase supplies for your build next class.
WRAP-UP	Wrap-up Key Question: How can we use the design process to solve an engineering problem? • When solving an engineering challenge, engineers must complete the preparations to build a prototype or model of their chosen design. • Engineers document how to build their prototype or model in a "design proposal." • A design proposal should include documents that specify (1) materials, (2) dimensions and (3) processes used in the construction.

EVALUATE *(5 minutes)*	Post the following problem on the board for students to read. Provide each student a copy of the design proposal rubric. Instruct students to silently answer the question in their engineering notebook. 1. Compare your design proposal to the grading rubric. If you were grading your design proposal, what grade would you give yourself? Why? *Sample Answers: Answer will vary.*

BLOOM'S IN THIS LESSON		
X	Knowledge	arrange, define, duplicate, label, list, memorize, name, order, recognize, relate, recall, repeat, reproduce state
X	Comprehension	classify, describe, discuss, explain, express, identify, indicate, locate, recognize, report, restate, review, select, translate
X	Application	apply, choose, demonstrate, dramatize, employ, illustrate, interpret, operate, practice, schedule, sketch, solve, use, write
X	Analysis	analyze, appraise, calculate, categorize, compare, contrast, criticize, differentiate, discriminate, distinguish, examine, experiment, question, test
X	Synthesis	arrange, assemble, collect, compose, construct, create, design, develop, formulate, manage, organize, plan, prepare, propose, set up, write
	Evaluation	appraise, argue, assess, attach, choose compare, defend estimate, judge, predict, rate, core, select, support, value, evaluate

JAMES & ANNE Robinson NATURE CENTER
Howard County RECREATION & PARKS

HANDOUT 1. DESIGN PROPOSAL GRADING RUBRIC

Name: Period:

DESIGN PROPOSAL GRADING RUBRIC

	MEETING EXPECTAIONS (3 points)	APPROACHING EXPECTATIONS (2 points)	BELOW EXPECTATIONS (1 point)
1. ORGANIZATION	The report is clean, legible and easy to understand.	The report meets two of the following expectations: clean, legible and easy to understand	The report meets one or fewer of the following expectations: clean, legible and easy to understand
2. DRAWING	Student accurately captures the design in a multi-view or pictorial drawing.	Student imprecisely captures the design in a multi-view or pictorial drawing OR captures the drawing in a format other than multi-view of pictorial that does not provide 3D information.	The student's drawing is difficult to understand. The idea is not captured in 3D.
3. MATERIALS	Student selects appropriate building materials for the design. All materials are specified in the drawing or text.	Student selects mostly appropriate building materials for the design. Most materials are specified in the drawing or text.	Student selects mostly inappropriate building materials for the design. Few materials are specified in the drawing or text.
4. DIMENSIONS	Student specifies appropriate dimensions for all components of the design idea.	Student specifies dimensions for all components of the design idea. Some dimensions may be inappropriate.	Student specifies dimensions for few, if any, components of the design idea.
5. PROCESS	Student logically describes/shows the assembly/construction process for their design in text or image.	Student describes/shows the assembly/construction process for their design in text or image. Some steps may be unclear or missing.	Student attempts to describe/show the assembly/construction process for their design in text or image. Most steps are unclear or missing.

TOTAL SCORE: _____/15

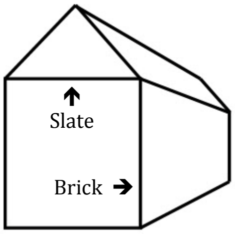
HANDOUT 2. WRITING A DESIGN PROPOSAL (MOD)

Name: Period:

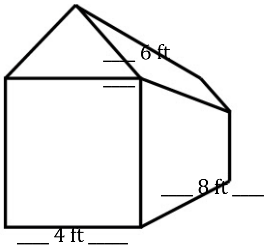
1. In the space provided below, <u>DRAW</u> a picture of the Pumpkin Chunkin' launcher designed by your class. Be sure to draw a **pictorial** or **multi-view sketch**.

2. Is the drawing you completed above a **pictorial** or **multi-view sketch** (CIRCLE ONE)?

   PICTORIAL SKETCH MULTI-VIEW SKETCH



3. <u>LABEL</u> your drawing in step 1 with the materials you plan to build each part of your machine out of (i.e. wood)



4. <u>LABEL</u> your drawing in step 1 with the approximate dimensions (i.e. lengths, widths and heights) for each part of your design. BE SURE TO INCLUDE UNITS (i.e. feet, meters)

5. <u>WRITE</u> a step-by-step procedure that explains how to build your pumpkin launcher.

   1. First, ______________________________

      ____

   2. Next, ______________________________

      ____

   3. Then, ______________________________

      ____

Lesson Plan		
Subject: Introduction to Technology	Teacher:	Unit: The Design Process
Time frame: 3 – 5 class periods	Lesson 8: Making a Model or Prototype	Activity Title: Pumpkin Chunkin’

UNIT/ESSENTIAL QUESTION:	How can we use the design process to solve an engineering problem?
LESSON OBJECTIVE:	Students will BUILD the design solution they outlined in their design proposal
STANDARDS:	ITEA, STL 11-O. Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of the final product. ITEA, STL 11-P. Evaluate the design solution using conceptual, physical, and mathematical models at various intervals of the design process in order to check for proper design and to note areas where improvements are needed. ITEA, STL 11-Q. Develop and produce a product or system using a design process. NGSS, HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

KEY POINTS	MATERIALS
As a result of this lesson, students will be able to… • identify the materials best suited to building a design solution • follow a construction plan outlined in a design proposal • build a design solution	**For whole class:** • Materials for build outlined in design proposals created by the class* • Legos (optional)* • Engineering notebooks* ** indicates teacher/student provided*
VOCABULARY	**BEFORE CLASS**
• prototype • model	You need to procure the materials your class has chosen to use for building their launching device prior to this lesson. Please contact Robinson Nature Center at 41-313-0400 with any questions regarding in-kind materials donated to teams by the Columbia Home Depot store.

HOMEWORK	

PROCEDURE	
ENGAGE *(5 minute Drill, 3 minute class discussion)*	Post the following question on the board for students to read. Instruct students to silently answer the question in their engineering notebook. Today we will begin building our model/prototype pumpkin launching device. 1. What safety protocol should we follow to ensure we have a safe classroom environment? *Sample Answers: Answer will vary. Most students will recognize the need for using goggles, gloves, etc. Be sure to discuss being aware of other people in the room around you, especially if students will be using saws, etc.* Discuss the Drill ▪ Encourage students to share their responses to the drill.

	Sample Questions: • What safety equipment should we wear to protect our bodies and clothing? • Why is it important to be aware of space when working in a shop? • What should you do if there is an accident or someone becomes injured?
EXPLORE *(20 minutes)*	▪ Explain to students that at this point in the design process, they will begin building a model or prototype of their pumpkin launching device. ▪ Decide whether you want students to build a model of the launching mechanism before building a prototype. If so, consider using Legos or small wood pieces to build models. ▪ Provide students the following definition for model and prototype. **Model:** A detailed three dimensional representation of a design that is used to communicate, explore or test an idea. Models may be scaled down or scaled up from the intended size, and they may be made from different materials than the final product. **Prototype:** A one-of-a-kind working model of a solution that is developed for testing purposes. A prototype is manufactured according to the information contained in the design proposal. ▪ Allow students time to build their model or prototype. ▪ If necessary, model the use of specific equipment students may need to utilize in the design process. ▪ Circulate the room looking for safety concerns, behavior concerns and to answer questions and make suggestions.
EXPLAIN & ELABORATE *(20 minutes)*	▪ If you've chosen to build a model before progressing to a full scale prototype, consider having students complete Lesson 9: Test and Evaluate, with their model and then returning to this lesson to build a prototype after initial modifications have been specified.
WRAP-UP	Wrap-up Key Question: How can we use the design process to solve an engineering problem? • When solving an engineering challenge, engineers may create models of the solution to communicate, test or explore a design idea. • Engineers may also choose to build a prototype using the specification outlined in the design proposal to test their design solution.
EVALUATE *(5 minutes)*	Post the following problem on the board for students to read. Provide each student a copy of the design proposal rubric. Instruct students to silently answer the question in their engineering notebook. 1. Why might it be useful/practical to build a model before building a prototype of a design solution? What are the benefits? What are the trade-offs? *Sample Answers: Answer will vary. Students should recognize a model may save on cost and resources because it can be made from different materials and may be a smaller size than the end product. A trade-off could be not being able to assess whether the materials the design solution is supposed to be made from are appropriate.*

BLOOM’S IN THIS LESSON		
X	Knowledge	arrange, define, duplicate, label, list, memorize, name, order, recognize, relate, recall, repeat, reproduce state
X	Comprehension	classify, describe, discuss, explain, express, identify, indicate, locate, recognize, report, restate, review, select, translate
X	Application	apply, choose, demonstrate, dramatize, employ, illustrate, interpret, operate, practice, schedule, sketch, solve, use, write
	Analysis	analyze, appraise, calculate, categorize, compare, contrast, criticize, differentiate, discriminate, distinguish, examine, experiment, question, test
	Synthesis	arrange, assemble, collect, compose, construct, create, design, develop, formulate, manage, organize, plan, prepare, propose, set up, write
	Evaluation	appraise, argue, assess, attach, choose compare, defend estimate, judge, predict, rate, core, select, support, value, evaluate

James & Anne Robinson Nature Center
Howard County Recreation & Parks

Lesson Plan		
Subject: Introduction to Technology	Teacher:	Unit: The Design Process
Time frame: 1 – 3 class periods	Lesson 9: Test and Evaluate	Activity Title: Pumpkin Chunkin’

UNIT/ESSENTIAL QUESTION:	How can we use the design process to solve an engineering problem?
LESSON OBJECTIVE:	Students will COLLECT and effectively DISPLAY data that can be used to evaluate the quality of their design solution and make improvements based on evidence collected from testing
STANDARDS:	ITEA, STL 11-O. Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of the final product. ITEA, STL 11-Q. Develop and produce a product or system using a design process. NGSS, HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. NGSS, HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

KEY POINTS	MATERIALS
As a result of this lesson, students will be able to… • determine what data would be most useful for making design improvements • design spreadsheets to collect data • analyze data collected to make suggestions for design improvement • display data in meaningful ways EXTENSION • calculate standard deviation for their machine’s distance and height data • use standard deviation to compare their machines precision before and after modifications have been made.	**For each student:** • Student Handout: Data Table Grading Rubric **For whole class:** • Pumpkins (4 – 10 lbs)* • Prototype of pumpkin launching device • Engineering notebooks* **Modifications:** • Student Handout: Data Table (MOD) • Student Handout: Data Table Grading Rubric (MOD) ** indicates teacher/student provided*
VOCABULARY	BEFORE CLASS
• Standard deviation • Accuracy • Precision	A full size prototype of the pumpkin launching device should be built before beginning this lesson.

HOMEWORK	

PROCEDURE	
ENGAGE *(5 minute Drill, 3 minute class discussion)*	Post the following question on the board for students to read. Instruct students to silently answer the question in their engineering notebook. Look back at your “Rules and Regulations” packet for Pumpkin Chunkin’. 1. How is your pumpkin launching mechanism going to be evaluated on competition day? 2. Which criteria can you evaluate and refine through testing? 3. How can you evaluate how well your machine meets this criteria?

Sample Answers: Students will be evaluated on accuracy, consistency/precision, design and documentation on competition day. Student should suggest accuracy and consistency/precision can be evaluated and refined through testing. Students may suggest a variety of ways for evaluating how well the machine meets these criteria. Some may suggest measuring the distance and/or height the launcher throws the pumpkin (accuracy). Some may suggest evaluating the clustering of pumpkin tosses (consistency/ precision)

Discuss the Drill

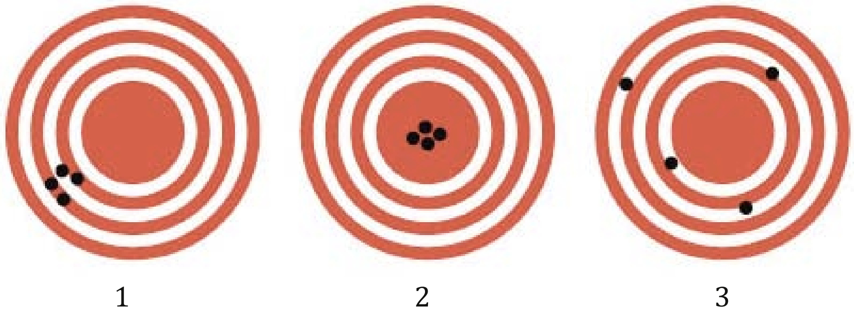
▪ Encourage students to share their responses to the drill.

Sample Questions:

- What are the four categories your machine will be evaluated on?
- Which categories require testing to refine?
- What is the difference between accuracy and consistency/precision?

EXPLORE
(20 minutes)

▪ Draw/display the following pictures on the board



▪ Ask students the following questions:

1. *Which picture shows the target from the best archer? How do you know?*
2. *How would you describe what's going on in picture 1? Picture 3? Picture 2?*

▪ Provide students the following definitions for accuracy and precision

Accuracy: A measurement of how close you are to the actual value.

Precision: The ability of a measurement to be consistently reproduced.

▪ Ask students the following questions:

1. *Which picture shows a target with high accuracy, but low precision? (3)*
2. *Which picture shows a target with high precision but low accuracy? (1)*
3. *Which picture shows a target with both high precision and accuracy? (2)*

▪ Explain to students that they will need to measure both accuracy and precision when testing their launching mechanism.

▪ Brainstorm ways to measure accuracy and precision for your pumpkin launcher. Record suggestions on front board and vote to decide which suggestion is best and will be utilized.

SUGGESTIONS:

- *It may be easiest for students to simplify this questions into two separate 1D problems, rather than approaching it in 2D*
- *The height of the target for competition day is ten feet off the ground, the same height as a standard field goal on a football field. To evaluate height of throw, students can estimate how far above or below the field goal post the shot is.*

	• *Students can tally how many times the pumpkin goes above as compared to below the field goal as well as estimate how high above, or how low below, the pumpkin is thrown to measure precision in the "y" plane.* • *The distance of the target from the launching are on competition day is 77ft. Students can use a tape measure to determine the distance the pumpkin is launched in the "x" plane.* • *Students can use a tape measure to determine how far each pumpkin landing point is from a set distance (like the goal post) or from each other point to determine precision (standard deviation).* • *If students are stuck, review how judges are scoring these items on competition day. This may provide inspiration to students.*
EXPLAIN & ELABORATE *(20 minutes)*	▪ When students have determined how they will evaluate accuracy and precision, have them create a table in their engineering notebooks in which they can record their data. RECOMMENDATION: Provide students Handout 1. Table Grading Rubric, to help them incorporate all necessary components of a good table into their notebooks. ▪ Allow students ample time to collect data. ▪ If time and resources allow, consider having students input their data into an Excel spreadsheet. ▪ When students have finished collecting data in their charts, provide them time to analyze their data. ▪ Ask students the following questions: 1. *What can we conclude from the data we collected?* 2. *Was our launcher accurate? Why or why not?* 3. *Was our launcher precise? Why or why not?* MATH EXTENSION: Standard Deviation ▪ Ask students "How can we determine how precise our machine is?" ▪ Students with a stronger background in mathematics or statistics may suggest standard deviation. ▪ Provide students the definition for standard deviation. Instruct them to record the definition in their engineering notebooks for future reference. **Standard deviation:** A measurement of how spread out a set of numbers is. A standard deviation close to zero, indicates the data points are very close to the mean of the set, whereas a high standard deviation indicates the data points are spread out over a wide range of values. ▪ Explain to students that we can calculate **standard deviation** for the distance and height data we collected. This will give you an idea of how **consistent** your machine is, meaning how likely it is to hit the same spot on the target every time it's fired. The closer the standard deviation you calculate is to zero, the more consistent your machine is! ▪ Introduce students to the formula for standard deviation. Explain that you will break this complicated equation down into simple steps, so they can easily solve the problem! $\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - \mu)^2}$ σ = standard deviation

N = number of data points
Σ = for each value x, complete the computation in parentheses and then take the sum of the values
x_i = individual data points
μ = mean (average) of the data points

▪ Provide students the following “name the steps” procedure for calculating standard deviation. Instruct students to record the steps in their engineering notebook for future reference.

For the following problem lets pretend we have the following distance data:

TRIAL	DISTANCE
1	70 m
2	90 m
3	50 m

HOW TO: Calculating Standard Deviation

STEP	WHAT IT LOOKS LIKE
1. Calculate the mean (average) of your data points	(70m + 90m + 50m)/3 = 70m
2. Subtract the mean from each data point	70m – 70m = 0m 90m – 70m = 20m 50m – 70m = -20m
3. Square each number you calculated in step 2	$(0m)^2 = 0\ m^2$ $(20m)^2 = 400\ m^2$ $(-20m)^2 = 400\ m^2$
4. Calculate the mean of the squared numbers you determined in step 3	$(0\ m^2 + 400\ m^2 + 400\ m^2)/3 = 266.6m^2$
5. Take the square root of the mean you calculated in step 4. This is the standard deviation of your data.	$\sqrt{}266.6m^2 = 16.3m$

▪ Have students calculate the standard deviation for their distance and height data respectively.

▪ Explain to students that they can compare their standard deviations for distance and height data that they calculate for their first round of testing, to standard deviations calculated from future data after the machine has been modified. This information will allow them to determine if their modification made their machine more or less consistent (if future standard deviations are closer to zero, their consistency/precision has improved and vice versa).

WRAP-UP

Wrap-up
Key Question: How can we use the design process to solve an engineering problem?

- When solving an engineering challenge, engineers test prototypes they’ve built to evaluate how well their design solution solves the problem
- It may be useful to measure accuracy and precision when evaluating a design solution

EVALUATE
(5 minutes)

Post the following problem on the board for students to read. Provide each student a copy of the design proposal rubric. Instruct students to silently answer the question in their engineering notebook.

	1. Is our pumpkin launcher accurate and/or precise? Why or why not? 2. What could we change about our launcher's design to improve its accuracy and precision? You may draw or write your response to this question. *Sample Answers: Answer will vary. If time allows, you may want students to share their answers to question 2 with the class to begin generating ideas for the "Refining the Design" step.*

BLOOM'S IN THIS LESSON		
X	Knowledge	arrange, define, duplicate, label, list, memorize, name, order, recognize, relate, recall, repeat, reproduce state
X	Comprehension	classify, describe, discuss, explain, express, identify, indicate, locate, recognize, report, restate, review, select, translate
X	Application	apply, choose, demonstrate, dramatize, employ, illustrate, interpret, operate, practice, schedule, sketch, solve, use, write
X	Analysis	analyze, appraise, calculate, categorize, compare, contrast, criticize, differentiate, discriminate, distinguish, examine, experiment, question, test
X	Synthesis	arrange, assemble, collect, compose, construct, create, design, develop, formulate, manage, organize, plan, prepare, propose, set up, write
X	Evaluation	appraise, argue, assess, attach, choose compare, defend estimate, judge, predict, rate, core, select, support, value, evaluate

HANDOUT 1. DATA TABLE GRADING RUBRIC

Name: Period:

DATA TABLE GRADING RUBRIC

	MEETING EXPECTATIONS (2 pts)	**APPROACHING EXPECTATIONS (1 pt)**	**BELOW EXPECATIONS (0 pts)**
TITLE	Title concisely summarizes what data was collected and is displayed in table	Title's relationship to data is vague or unclear	Title is unrelated to data collected or is missing entirely
LABELS	Column or row labels accurately and clearly identify contents	Columns and rows are labeled, some labels may be vague	Some or all columns and rows are missing labels.
UNITS	Correct units are specified in column headings where appropriate	Correct units are specified for most headings	Units are missing or inaccurate.
DATA	Data collected is useful for evaluating the launching mechanism. Tables are accurate, suitable for the data, focused and clear for the intended audience. All applicable statistical analysis of data is provided in chart (e.g. mean, standard deviation)	Data collected is useful for evaluating the launching mechanism. Tables are accurate. Some statistical analysis of data is provided in chart (e.g. mean)	Data collected is not useful for the intended purpose of collection. Tables may be inaccurate. Statistical analysis of data is missing.
FORMATTING	Lines of demarcation are used to set title, headers, data, and footnotes apart from one another.	Formatting is somewhat appropriate for the data and somewhat inadequate for the intended audience	Formatting is not appropriate for the data or is not present

TOTAL SCORE: ____/10

HANDOUT 2. DATA TABLE (MOD)

Name: Period:

DIRECTIONS: Fill in the boxes with the information asked to complete your data table.

PART 1:

1. Before you begin, create a title for your chart that describes the information you will be recording. (HINT: Look at the labels at the top of each column. What sort of data are you collecting?)
2. Determine what units you will be collecting your data in (example: feet). Record the unit in the space provided above each column.
3. Fill in the distance the pumpkin is thrown and the approximate height the pumpkin reaches for each trial (each time the pumpkin is launched).
4. Once you have collect all of your data, determine the average distance and average height your machine launches pumpkins. **To determine the average**, add all of the numbers in the column together and divide by the number of trials you completed.

INSERT TITLE HERE:

TRIAL	DISTANCE (unit: ______)	HEIGHT (unit:______)
1		
2		
3		
4		
5		
AVERAGE		

PART 2: In this section, you will be calculating **standard deviation,** which is a measurement of how spread out your numbers are for distance and height respectively. This will give you an idea of how **consistent** your machine is, meaning how likely it is to hit the same spot on the target every time it's fired. The closer the standard deviation you calculate is to zero, the more consistent your machine is!

DISTANCE

CALCULATING STANDARD DEVIATION: DISTANCE			
TRIAL (same as chart on previous page)	DISTANCE (same as chart on previous page)	DISTANCE – AVERAGE (subtract the distance of the individual trial from the average distance determined in the chart on the previous page.)	(DISTANCE – AVERAGE)^2 (square [multiply by itself] the number determined in the previous column)
1			
2			
3			
4			
5			

1. Add the numbers in the last column (DISTANCE – AVERAGE)^2 together. Record your result here: ________________

2. Divide your answer from step 2 by the total number of trials you completed. Record your result here: __________

3. Take the square root of the number you calculated in step 3. This is the **standard deviation for your distance data**. Record your result here: ________________

HEIGHT

CALCULATING STANDARD DEVIATION: HEIGHT			
TRIAL (same as chart on previous page)	HEIGHT (same as chart on previous page)	HEIGHT – AVERAGE (subtract the height of the individual trial from the average height determined in the chart on the previous page.)	(HEIGHT – AVERAGE)^2 (square [multiply by itself] the number determined in the previous column)
1			
2			
3			
4			
5			

1. Add the numbers in the last column (HEIGHT – AVERAGE)^2 together. Record your result here: ________________

2. Divide your answer from step 2 by the total number of trials you completed. Record your result here: __________

3. Take the square root of the number you calculated in step 3. This is the **standard deviation for your height data**. Record your result here: ________________

HANDOUT 1. DATA TABLE GRADING RUBRIC (MOD)

Name: Period:

DATA TABLE GRADING RUBRIC

	MEETING EXPECTATIONS (2 pts)	**APPROACHING EXPECTATIONS (1 pt)**	**BELOW EXPECATIONS (0 pts)**
TITLE	Title concisely summarizes what data was collected and is displayed in table	Title's relationship to data is vague or unclear	Title is unrelated to data collected or is missing entirely
UNITS	Correct units are specified in column headings where appropriate	Correct units are specified for most headings	Units are missing or inaccurate.
DATA	Data collected is accurate, suitable for the table and clear for the intended audience.	Data collected may not be appropriate for the table OR data is not accurate	Data is incomplete
STATISTIC	All applicable statistical analysis of data is calculated (e.g. mean, standard deviation)	Some statistical analysis of data is provided (e.g. mean)	Statistical analysis of data is missing.
FORMATTING	Information is recorded in correct locations and is complete	Information is complete but may not always be recorded in the correct location.	Charts are incomplete.

TOTAL SCORE: ____/10

Lesson Plan		
Subject: Introduction to Technology	Teacher:	Unit: The Design Process
Time frame: 1 – 3 class periods	Lessons 10 and 11: Refining the Design and Creating or Making the Final Design Solution	Activity Title: Pumpkin Chunkin’

UNIT/ESSENTIAL QUESTION:	How can we use the design process to solve an engineering problem?
LESSON OBJECTIVE:	Students will EVALUATE the quality of their design solution and make improvements based on evidence collected from testing
STANDARDS:	ITEA, STL 11-O. Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of the final product. ITEA, STL 11-Q. Develop and produce a product or system using a design process. NGSS, HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. NGSS, HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

KEY POINTS	MATERIALS
As a result of this lesson, students will be able to… • determine what data would be most useful for making design improvements • identify short comings in their design • update existing technical drawings to include refinements • argue why changes are necessary to the original design	**For each student:** • Photocopies of the pumpkin launcher design from the design proposal created by the class (enough for each student to have one)* **For whole class:** • Pumpkins (4 – 10 lbs)* • Prototype of pumpkin launching device* • Building materials to modify machine* • Engineering notebooks* **Modifications:** • Student Handout: Refining the Design (MOD) ** indicates teacher/student provided*
VOCABULARY	BEFORE CLASS
• Refinements	A full size prototype of the pumpkin launching device should be built before beginning this lesson.

HOMEWORK	

PROCEDURE	
ENGAGE *(5 minute Drill, 3 minute class discussion)*	Post the following question on the board for students to read. Instruct students to silently answer the question in their engineering notebook. Review the data you collected during the “Testing and Evaluating” phase of the design process. 1. Does our testing and evaluation indicate that all of the criteria and specifications have been satisfied? Why or why not? 2. What aspects of our design should we consider tweaking? Why?

	Sample Answers: Answers will vary depending upon how your testing phase went. Perhaps the machine was not able to launch the pumpkin the specified distance or height. Discuss the Drill ▪ Encourage students to share their responses to the drill. Sample Questions • What are the criteria and constraints our design is being evaluated by? • What criteria or constraints are we still failing to meet with our design? • What problems have arisen with our design? • What ideas do we have to improve our launching machine?
EXPLORE *(20 minutes)*	▪ Have students brainstorm design solutions that address the shortcomings that testing has revealed about the machine. Record students' thoughts on the board. ▪ Provide students a copy of the schematic drawings from the design proposal. Have student draw modifications directly on the image, or draw modifications to the device in their engineering notebooks. DIRECTIONS: Using the copy of the schematic drawings from the design proposal provided, add modifications to our design to ensure our machine better meets the criteria and constraints we've identified. When you are finished drawing, write a paragraph explaining what modifications you've made and why they are necessary. ▪ Have students share ideas they've developed and the paragraph they wrote with the class. ▪ Decide which modifications will be made to the pumpkin launching device ▪ Modify the pumpkin launching device ▪ Retest your launching device using the same tests you agreed upon for the "Testing and Evaluating" phase of the design process. Instruct students to once again collect data in tables in their engineering notebook.
EXPLAIN & ELABORATE *(20 minutes)*	▪ After testing, have students compare their data for the modified machine, to the original machine's data. ▪If you had student calculate standard deviation in lesson 9, have them calculate it for their new data. Have students compare their initial standard deviations for height and distance to the new calculations. Ask students "*Has our consistency/precision improved*?" If the newer standard deviations are closer to zero, the consistency/precision has improved. If the new standard deviations are farther from zero, the consistency/precisions has decreased. ▪Have them reflect about whether the modifications improved the machine. DIRECTIONS: Compare your data for our modified pumpkin launcher, to the data we originally collected. Did our modifications improve our machine? Are we better meeting the design criteria and constraints? Why or why not? ▪ Have students share ideas they've developed and the paragraph they wrote with the class. ▪ Ask students if the machine requires further "tweaking." Encourage them to support their thoughts with specific evidence from testing. ▪ If student decide the machine requires further refinement, repeat the process outlined in this lesson plan until the machine is meeting the design criteria and constraints or until the deadline is passed.

WRAP-UP	Wrap-up Key Question: How can we use the design process to solve an engineering problem? • It's rare that design projects are successful on the first try. • When solving an engineering challenge, engineers must evaluate data from testing to make informed decisions about refining their design. • Engineer's will continue refining a design until all of the criteria or specification have been satisfied, at which point they "create or make" the mature product.
EVALUATE *(5 minutes)*	Post the following problem on the board for students to read. Provide each student a copy of the design proposal rubric. Instruct students to silently answer the question in their engineering notebook. After refining a design solution, engineers proceed to the next step in the design process "Creating or Making." At this phase, a product may be commercially fabricated. There are two generally categories for commercial production: mass production and custom production. 1. What do you think the difference between mass and custom production is? 2. Do you think our build was more similar to mass or custom production? Why? *Sample Answers: Students should recognize mass production creates much larger quantities of a product than custom production. Our design process is much more similar to custom production because we only made one machine.*

BLOOM'S IN THIS LESSON		
X	Knowledge	arrange, define, duplicate, label, list, memorize, name, order, recognize, relate, recall, repeat, reproduce state
X	Comprehension	classify, describe, discuss, explain, express, identify, indicate, locate, recognize, report, restate, review, select, translate
X	Application	apply, choose, demonstrate, dramatize, employ, illustrate, interpret, operate, practice, schedule, sketch, solve, use, write
X	Analysis	analyze, appraise, calculate, categorize, compare, contrast, criticize, differentiate, discriminate, distinguish, examine, experiment, question, test
X	Synthesis	arrange, assemble, collect, compose, construct, create, design, develop, formulate, manage, organize, plan, prepare, propose, set up, write
X	Evaluation	appraise, argue, assess, attach, choose compare, defend estimate, judge, predict, rate, core, select, support, value, evaluate

JAMES & ANNE
Robinson
NATURE CENTER

Howard County
RECREATION & PARKS

HANDOUT 1. REFINING THE DESIGN (MOD)

Name: Period:

DIRECTIONS: <u>DRAW</u> modifications (changes) for the pumpkin launcher directly on the copy of the image your teacher provided you. Use this worksheet to help explain why you made the changes you did to the design. When you are finished, attach your modified image to this worksheet for grading.

MODIFICATIONS I MADE TO THE PUMPKIN LAUNCHING DEVICE

The first change I made to the pumpkin launcher design was: ______________________________

____

I made this change to the design because: ______________________________

____

I believe this change will make our pumpkin launcher better because: ______________________

____

A second modification I made to the pumpkin launcher design was: ______________________

____

I made this change to the design because: ______________________________

____

I believe this change will make our pumpkin launcher better because: ______________________

____

Another change I made to the pumpkin launcher design was: ______________________________

____

I made this change to the design because: ______________________________

____

I believe this change will make our pumpkin launcher better because: ______________________

____

Lesson Plan		
Subject: Introduction to Technology	Teacher:	Unit: The Design Process
Time frame: 1 – 3 class periods	Lesson 12: Communicating Process and Results	Activity Title: Pumpkin Chunkin’

UNIT/ESSENTIAL QUESTION:	How can we use the design process to solve an engineering problem?
LESSON OBJECTIVE:	Students will PRODUCE a final design document that effectively communicates design decisions
STANDARDS:	ITEA, STL 11-O. Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of the final product. ITEA, STL 11-Q. Develop and produce a product or system using a design process. NGSS, HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. NGSS, HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

KEY POINTS	MATERIALS
As a result of this lesson, students will be able to… • identify design criteria and constraints • argue why a particular design solution was chosen over another • argue why changes made to the original design were necessary to better meet criteria and constraints	**For each student:** • Student Handout: Documentation Scoring Rubric (available online at www.howardcountymd.gov/pumpkinlaunch) • Student Handout: HCPSS Teach Ed SLO Rubric (optional)* **For class:** • Access to computers with word processing and/or web page development software (optional)* • Video camera (optional)* • Engineering notebooks* ** indicates teacher/student provided*
VOCABULARY	BEFORE CLASS
• Criteria • Constraints • Final design document	N/A

HOMEWORK	

PROCEDURE	
ENGAGE *(5 minute Drill, 3 minute class discussion)*	Post the following question on the board for students to read. Instruct students to silently answer the question in their engineering notebook. Provide each student a copy of the documentation scoring rubric: Review the Pumpkin Chunkin’ documentation scoring rubric: 1. Look through your engineering notebook. “Dog-ear” pages where you can find information required for documentation. 2. The final documentation may be presented as a website or video. If given the option, which documentation form would you prefer?

	Sample Answers: Answers will vary. Discuss the Drill ▪ Tally students' responses to the second drill question on the front board. Either have students create the documentation in the form that earned the most votes OR break the class into two or more groups based on what type of documentation they want to create.
EXPLORE *(20 minutes)*	▪ Explain to students that, when a design solution is complete, engineers communicate the details of their design in a final design document. Robinson Nature Center has requested that the final design document be presented in a particular form. ▪ Provide students the definition for final design document. Instruct them to record the definition in the engineering notebooks for future reference. **Final design document:** A complete set of design documentation prepared at the final stages of the design process. The final design documentation communicates clearly and completely what the design is and how well the design solves the problem. Final documentation should include all of the necessary charts, graphs, calculations, CAD drawings, modeling, simulations and text descriptions that, taken as a whole, represent the final design. ▪ Review the documentation rubric as a class. Encourage students to ask questions about particular indicators on the rubric. Explain to students that judges will be assessing them on whether a component was present or not. ▪ To save time, consider assigning groups of students a particular indicator to develop for a) the website, or B) the script for the video. ▪ Provide students time to complete the documentation portion of the project.
EXPLAIN & ELABORATE *(20 minutes)*	▪ When documentation is complete, evaluate the final product using the scoring rubric. Ask students: *1. Does our documentation contain all of the components outlined in the scoring rubric? If not, what is missing?* *2. Is our documentation concise? Clear? Logically presented? If not, how can we improve it?* ▪ If editing/improvements are necessary, provide students time to complete the assignment in class.
WRAP-UP	Wrap-up Key Question: How can we use the design process to solve an engineering problem? • When a design solution is complete, engineers communicate the details of their design in a final design document • Final documentation should include all of the necessary charts, graphs, calculations, CAD drawings, modeling, simulations and text descriptions that, taken as a whole, represent the final design.
EVALUATE *(5 minutes)*	Post the following problem on the board for students to read. Provide each student a copy of the design proposal rubric. Instruct students to silently answer the question in their engineering notebook. Compare your final design document to the rubric(s) provided. 1. If you were evaluating your (contribution to the) project, what score would you give yourself? Why? *Sample Answers: Answers will vary.*

BLOOM'S IN THIS LESSON		
X	Knowledge	arrange, define, duplicate, label, list, memorize, name, order, recognize, relate, recall, repeat, reproduce state
X	Comprehension	classify, describe, discuss, explain, express, identify, indicate, locate, recognize, report, restate, review, select, translate
X	Application	apply, choose, demonstrate, dramatize, employ, illustrate, interpret, operate, practice, schedule, sketch, solve, use, write
X	Analysis	analyze, appraise, calculate, categorize, compare, contrast, criticize, differentiate, discriminate, distinguish, examine, experiment, question, test
X	Synthesis	arrange, assemble, collect, compose, construct, create, design, develop, formulate, manage, organize, plan, prepare, propose, set up, write
X	Evaluation	appraise, argue, assess, attach, choose compare, defend estimate, judge, predict, rate, core, select, support, value, evaluate