

Prototyping PIP: An Engineering Design Challenge Mission Brief

**Subject: Engineering
Design Process**

**Grade: Kindergarten
through 8th Grade**

**Time: Three 90-
minute sessions****

Learning Objectives:

- Utilize the resources and tools available in the makerspace to design and construct a robotic pig-inspired creation.
- Encourage creativity, problem-solving, and collaboration while incorporating various materials and techniques found in the makerspace.

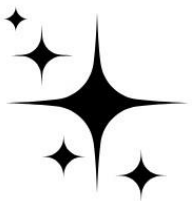
Standards and Competencies:

NGSS Elementary (K-5)

- 3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
- 3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
- 3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

NGSS Middle School (6-8)

- MS-ESS1-3. Analyze and interpret data to determine scale properties of objects in the solar system.
- MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
- MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
- MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
- MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.



Background Knowledge:

- Read the book “PIP Goes Incredibly Fast”
- Review the [Engineering Design Process](#), as needed, using your preferred steps.
- Review the description of PIP, the Robotic Pig using the text below:
 - “Imagine a robotic space pig with a sleek metallic body that glistens in the light. Its body is shaped like a pig, complete with a snout, round body, and a curly robotic tail. The pig's body is adorned with various mechanical components and sensors that assist it in navigating and exploring space. The robotic space pig has four sturdy legs with flexible joints, allowing it to move gracefully in zero gravity environments. Each leg ends with a specialized robotic hoof equipped with sensors for enhanced traction and stability. Its eyes are large and expressive, resembling shiny camera lenses, allowing the space pig to capture and analyze its surroundings. On top of its head, it has a pair of antenna-like ears that serve as communication devices, enabling it to send and receive messages across vast distances. At the back of the space pig, there are multiple compartments that open to reveal storage spaces for tools, equipment, and scientific instruments. These compartments are designed to keep everything secure during space missions. The robotic space pig has a friendly and playful demeanor. It emits soft beeping sounds and occasionally oinks in a robotic tone. Its purpose is to assist in various space exploration tasks, such as collecting samples, conducting experiments, and navigating challenging terrains on celestial bodies. Although it may appear whimsical with its pig-like appearance, the robotic space pig is a highly capable and intelligent explorer, contributing to scientific discoveries in the vastness of space.”

Materials:

- “PIP Goes Incredibly Fast” Storybook
- Makerspace materials (cardboard, craft supplies, recyclable materials, etc.)
- Maker tools and equipment (scissors, glue, markers, rulers, etc.)
- Optional electronic components, including sensors

Procedure:

Session 1: Design and Build

Introduction (10 minutes)

- Introduce the design challenge to the students: creating a robotic pig-inspired creation using the makerspace and based on a specific description.
- Explain the learning objectives and the importance of creativity and problem-solving in the design process.

Brainstorming and Design (20 minutes)

- Review the description of PIP the robotic pig from the Background Information.
- Feel free to use your imagination to add any additional features or details to your robotic space pig!
- Discuss the main characteristics and features of PIP the robotic pig, such as our sturdy legs, flexible joints, large eyes, antennae-like ears, snouts, curly tails, and storage compartments.
- Encourage students to brainstorm ideas and sketch their robotic pig-inspired designs, considering size, shape, and available materials.
- Remind students to think about functionality, aesthetics, and the use of different materials to bring their designs to life.

Material Selection and Planning (30 minutes)

- Provide students with an array of maker space materials and tools.
- Instruct students to select the materials they will use for their pig creation based on their design sketches. For an additional challenge, you can limit the number of different materials.
- Guide students in planning the construction process, including the order of assembly and how different materials will be incorporated.
- Instruct students to create a planning sketch with labels of materials.

Construction (60 minutes)

- Allow students to begin constructing their pig creations using the chosen materials and tools from the planning sketch.
- Encourage students to collaborate, share ideas, and assist each other during the construction process.
- Provide support and guidance as needed, ensuring students are using the tools safely and effectively.

Session 2: Refining and Enhancing

Reflection and Evaluation (10 minutes)

- Facilitate a class discussion on the progress of the robotic pig creations.
- Encourage students to reflect on the challenges they faced during construction and brainstorm solutions to improve their designs.

Refining and Enhancing (60 minutes)

- Instruct students to refine and enhance their robotic pig creations based on their reflections and evaluations.
- Encourage experimentation with additional materials, colors, textures, or decorative elements to add personality and detail to their robotic pigs, making sure to display a friendly and playful demeanor, as mentioned in the description.
- Promote problem-solving skills by addressing any design flaws or structural weaknesses.

Presentation Preparation (20 minutes)

- Instruct students to prepare a short presentation showcasing their robotic pig creations.
- Encourage students to think about the story or inspiration behind their designs and practice describing their construction process.

Assessment:

Session 3: Presentations and Reflection

Presentations (30 minutes)

- Allocate time for students to present their robotic pig creations to the class.
- Each student or group should explain their design choices, materials used, and any unique features of their robotic pig creations.
- Encourage classmates to ask questions and provide positive feedback to their peers.

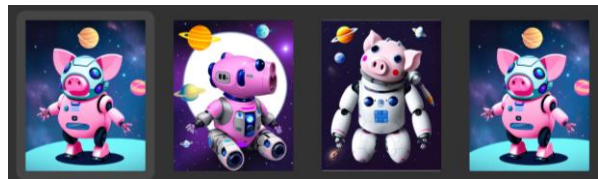
Reflection and Discussion (20 minutes)

- Lead a reflection discussion, allowing students to share their experiences, challenges, and successes during the design and construction process.
- Discuss how the makerspace resources and tools contributed to the realization of their robotic pig creations.
- Highlight the importance of creativity, collaboration, and perseverance in the design and making process.

Additional Resources:

Extension Activities

- Organize a gallery walk where students can showcase their robotic pig creations to the school community or other classrooms.
- Integrate technology by using microcontrollers or sensors to add interactive features to the pig creations.
 - For example, you could use an Arduino and a distance sensor as P.I.P.'s robotic eyes.
 - [P.I.P. Arduino Sensor \(Robot Eyes\)](#)
- Collaborate with an art or literature class to create a multidisciplinary project, where students write stories or create artwork inspired by their robotic pig creations.
- Utilize AI art generators to give students ideas for their prototypes
 - [DALL-E 2](#), [Bing](#), [NightCafe](#), [Jasper](#), [Deep AI](#), [Fotor](#), [Picsart](#), [CF Spark Art](#)



****Note:** The duration and complexity of the design challenge can be adjusted based on the students' age, skill level, available materials, and time constraints.