FUTURE U.

Zero Waste Challenge

Materials Store:

- Cardboard, cut into 1in x 1in squares
- Paper, cut into 1in x 1in squares
- Tape, divided into 1-inch sections
- Modeling clay
- Straws
- Glue
- Scale
- Ruler or measuring tape
- Scissors
- **In addition:** Each team will need one paper bag.

Example Team Roster	
Finance manager	
Materials manager	
Additive Manufacturing Engineer	
Additive Manufacturing Engineer #2	
Mechanic	

Overview

In this challenge, students will explore how waste is reduced in additive manufacturing. After teams are presented with a set of materials, they will be instructed to build a model airplane with as little waste as possible—using additive (*not* subtractive) manufacturing. Any waste that they create will be weighed and subtracted from their score!

Educator Prep

- Review the Introduction Video.
- Review the other pages included in this activity packet.
- Complete the classroom setup below prior to the session.

Classroom Set Up

1. Set up and review the Materials Store. Ensure there is enough of each item for each team.
2. Set up the Teams Tables with the following items:
    - Team Roles and Salaries sheet
    - Role handouts
    - Engineering Planning Guide
3. Divide students into teams of four people. If some teams have five people, a second engineer can be added. Distribute one paper bag to each team.

Student Introduction

As you learned during the site tour video, the process of additive manufacturing builds objects layer by layer using a 3D computer design. Many forms of construction use a subtractive process, which means they begin with materials that are larger than needed. Additive manufacturing begins with nothing and adds material little by little so only exactly what is needed is used.

Today, you will simulate the process of additive manufacturing in order to design and build your own model airplane! Each team member will have a role to play as you construct your model according to the design specifications. Any waste that you produce must be saved in your paper bag. It will then be weighed, and its weight in grams will be subtracted from your final score.

Once you have had about 25 minutes to design, build, and perform your roles, you will share your model with the rest of the class and weigh the waste you have produced!

Team Roles and Salaries

Finance Manager: $2,500

Responsible for the budget

Materials Manager: $2,500

Responsible for the purchasing and inventory of the supplies

Additive Design Engineer: $3,500

Leads the group through completing the Engineering Design Planning Guide

Mechanic: $2,500

Constructs the model

Materials Manager: Cost Sheet

Items	Cost
Cardboard	$1,000 per 1-inch square
Paper	$800 per 1-inch square
Tape	$500 per 1-inch piece
Modeling clay	$100 per 10 grams
Straws	$300 per straw
Glue	FREE
Ruler or measuring tape	FREE
Scissors	$500

Finance Manager: Budget Sheet

Items	Starting Budget: $35,000
Finance manager salary	$2,500
Materials manager salary	$2,500
Additive Design Engineer salary	$3,500
Additive Design Engineer #2 salary	
Mechanic salary	$2,500
Cardboard	
Paper	
Tape	
Modeling clay	
Straws	
Glue	FREE
Ruler or measuring tape	FREE
Scissors	
Ending Balance:	**$_____**

Additive Manufacturing Engineer Instruction Sheet

Additive manufacturing is the process of creating an object by building it one layer at a time. Today, you and your team will use additive manufacturing to create a model 737 airplane model that adheres to the design specifications shared with the mechanic.

Your role is to lead your team through completing the Engineering Design Planning Guide. You will work with your team members to select the materials and build an airplane model that meets the design specifications. The goal of the challenge is two fold: 1) To create a model that meets the specifications, and 2) To create as little waste as possible.

You may use any of the materials available to you as long as they are within your budget.

Mechanic Instructions Sheet

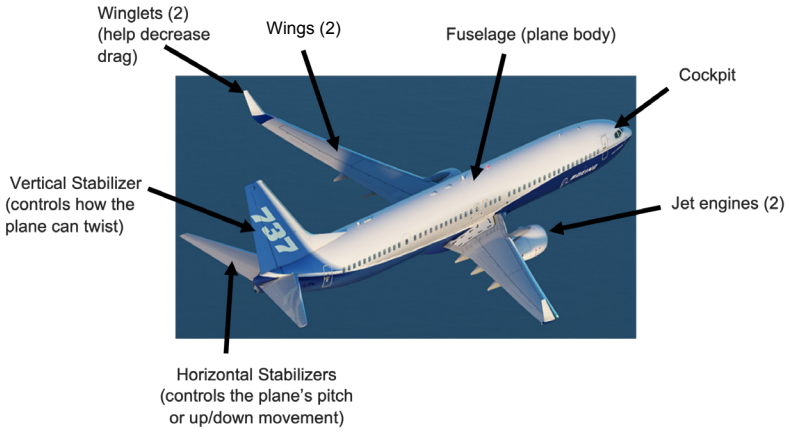
Work with your teammates to use additive manufacturing to create a model 737 airplane model that meets the design specifications listed below, while creating as little waste as possible. It is your job to lead the construction of this model.

Remember: Any waste produced must be kept in the paper bag provided to your team!

Specifications

Your model plane must:

- Be one foot long from front to back
- Contain the following parts:
  - Cockpit
  - Fuselage
  - Jet Engines (2)
  - Wings (2)
  - Winglets (2)
  - Vertical Stabilizer
  - Horizonal Stabilizers (2)



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STUDENT HANDOUT

Directions: Follow the steps below to prepare for the Zero Waste Challenge. Make notes as you discuss your answers together.

- **Ask:** What is the problem we are trying to solve?

_____

_____

- **Imagine:** How can we solve this problem? Brainstorm solutions.

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- **Plan:** Select one solution you think will work best and explain how it will solve the problem.

_____

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- **Create:** Design and build your model.

- **Test:** Ensure that your model meets all of the design specifications.

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- **Improve:** How could you make your design better? Make these changes.

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- **Share:** Be ready to discuss what you have learned!

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Scoring/Judging Guide

Each group of students is unique. In addition to which airplane model(s) contain all of the required specifications as well as deducting points equivalent to the weight of waste (in grams) that each team produced, you may also choose other ways to judge your groups based on their grade level, your learning focus areas, and the resources available.

Additional judging criteria may include the following:

___ correctly completed math on the Budget Sheet

___ highest flight

___ most detailed or realistic airplane model

___ least amount of money spent

___ completion of the Engineering Design Planning Guide

___ _____

___ _____

___ _____

Once you have selected multiple judging criteria, assign one point to each item above to see which group(s) has the highest number of points.

Final Discussion Question Guide

Directions: Conclude with a discussion around some, or all, of the following questions to wrap up the session:

- How did your design ideas differ from one another? How were they similar?
- How did your manufacturing ideas differ from one another? How were they similar?
- Which manufacturing method produced the least waste? Why was this more effective than the other methods?
- What factors did your team have to keep in mind in order to produce the least possible amount of waste?
- What are the benefits of additive manufacturing? What are the downsides?
- NASA and other companies that focus on space exploration are investing in additive manufacturing equipment to use in space. Why may additive manufacturing be useful in places such as on the Moon or on Mars?