



FUTURE U.

Virtual Field Trip | Manufacturing the Future of Aviation

Objectives

Students will:

- **Identify** the skills and responsibilities associated with STEM careers that interest them.
- **Discuss** the intersection of mechatronics, robotics, and ergonomics as it relates to manufacturing and the world at large.
- **Create** a mechanical arm that can grasp a variety of materials and evaluate how it could be enhanced with robotics.
- **Connect** the concept of ergonomics to their own lives and design a prototype of an ergonomically-enhanced item.

Overview

The *Manufacturing the Future of Aviation* Virtual Field Trip takes students on a special tour of three Boeing manufacturing centers in different regions of the United States. Students will have the opportunity to learn about a variety of careers as they meet some of the people who build Boeing's airplanes, helicopters, rockets, and satellites. They will discover the fields of mechatronics, robotics, and ergonomics as they watch employees work alongside robots and machines, and they will consider how each field plays an important role in the future of aviation manufacturing.

The pre-field trip activity in this companion guide is designed to introduce students to the topics they will learn about during the VFT. The activities designed for completion during and post viewership connect and extend student learning to classroom concepts.

Time Frame

Two to three class periods

National Standards

Next Generation Science Standards

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.

Common Core State Standards: Mathematics

7.RP.A.2 Recognize and represent proportional relationships between quantities.

ITEEA Standards for Technological Literacy

Standard 1: Scope of Technology

- F. New products and systems can be developed to solve problems or to help do things that could not be done without the help of technology.
- H. Technology is closely linked to creativity, which has resulted in innovation.

Common Core State Standards: English Language Arts

CCSS.ELA-LITERACY.CCRA.SL1: Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.

Pre-Virtual Field Trip Activity

Materials

- Device with the ability to project, one for the educator
- Digital Collage handout, to project
- Pre-Viewing Graphic Organizer, one per student

Distribute one Pre-Viewing Graphic Organizer to each student and project the Digital Collage images. Encourage students to independently observe the images and give them two minutes to jot down a list of their observations on the handout.

Then instruct students to review their notes with a partner and circle any observations that apply to more than one image. Encourage the class to share these observations.

Go on to explain that these images are snapshots from a Virtual Field Trip in which the students are about to participate! With this in mind, have them work with their partner to jot down three predictions they have about the Virtual Field Trip, as well as two or three questions that the images spur. Be sure to share that they will return to these notes after they participate in the Virtual Field Trip.

During the Virtual Field Trip

Materials

- *Career Profile* handout, one per student

Share the Career Profile handout with students and review the directions provided. As they meet Boeing professionals during the *Manufacturing the Future of Aviation* Virtual Field Trip, encourage them to choose two or three careers that interest them and fill out the career profile blurbs. Encourage students to think about skills and responsibilities related to STEM as well as the 4Cs (critical thinking, creativity, collaboration, and communication).

Post Virtual Field Trip Activities

Take a moment to recap the Virtual Field Trip with a discussion around the careers that were highlighted. Also provide students an opportunity to share any questions they developed during the pre-activity that were answered, as well as questions they may still have. Once this recap is complete, move on to one or both of the activities below!

Activity 1: Robo-Lifter

Materials:

For groups of 2–4 students:

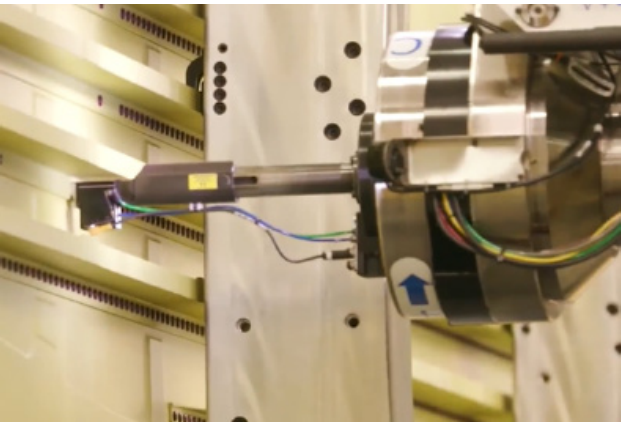
- tape
 - popsicle sticks
 - rubber bands
 - string
 - dowels or skewers
 - straws
 - pipe cleaners
 - paper clips or brass fasteners
 - one coin
 - one marble
 - cup
 - one device with internet access
1. Begin by reviewing the meaning of mechatronics as it was presented in the Virtual Field Trip. Be sure students understand that mechatronics is a branch of engineering that focuses on creating products that have both mechanical and electronic components.
 2. Explain that students will begin today by building their own mechanical arms. They will then consider the enhancements they could make based on what they learned from the Virtual Field Trip!
 3. Divide students into groups of three and distribute one Mechanical Arm handout to each group. Review the directions, show students where they can find their materials, and then encourage groups to begin.
 4. Once groups' designs are complete, ask each group to demonstrate how their arms function.
 5. Wrap up by discussing as a class:
 - How could the students' designs be enhanced with electronics, robotics, and/or artificial intelligence?
 - Once enhanced, could their innovated arms be used in the field of manufacturing? Why or why not?
 - How could these innovated arms help the world in other ways?

Activity 2: Ergonomic Improvements

Materials:

- Ergonomics handout, one per student
 - A variety of prototype materials for the class to share, which could include:
 - clay or playdough
 - paper and cardboard
 - toothpicks
 - blocks, LEGOs, and other building materials
 - aluminum foil
 - tape and glue
1. Begin by discussing the way in which Boeing combines ergonomics with mechatronics and robotics to manufacture its fleet. Questions to discuss may include:
 - What is ergonomics? (Answer: *Ergon* means work and *nomos* means law, so ergonomics essentially means “laws of work.” Ergonomics is the study of people’s safety and efficiency in the workplace. It uses devices, tools, and other technology to help fit a job to a worker.)
 - What examples of ergonomics did you see Boeing use in the manufacturing process?
 - How does ergonomics benefit both the company and the people who work there?
 2. Guide students in connecting the study of ergonomics to their own lives:
 - Explain that though students likely don’t think about it often, the field of ergonomics ensures that many things they use are safe, comfortable, and effective.
 - Hold up a pencil and encourage students to think about the ergonomic choices behind its design. Can students imagine what writing would be like if pencils were shorter, thinner, or heavier?
 - Then invite students to identify other classroom products that have likely been designed with ergonomics in mind.
 3. Now tell the class that they are about to consider how they could use the concept of ergonomics to make something safer, more comfortable, and more efficient. Pair students together and pass out one Ergonomics handout to each student. After reviewing the directions, encourage pairs to begin!
 4. When there are about fifteen minutes left in the session, bring the class back together and ask pairs to share their design ideas. Challenge students to offer feedback on their peers’ designs—including which design elements they think would work well as well as anything that could be improved upon.
 5. Finally, wrap up with discussion around the following question: We already discussed the role that ergonomics plays in the workplace. Now consider “What role does (or should it) play in other parts of people’s lives?”

<p>Image Observations</p>	<p>3 Predictions</p>
	<p>2-3 Questions</p>



Directions: When you watch the *Manufacturing the Future of Aviation* Virtual Field Trip, you'll meet several different people who work at Boeing. As you do, choose three careers that you find the most interesting and fill out the profiles below. It's okay to infer (or make an educated guess based on the information you learn) some of the responsibilities and skills!

Career: _____	
Responsibilities:	Skills needed:
•	•
•	•
•	•
•	•

Career: _____	
Responsibilities:	Skills needed:
•	•
•	•
•	•
•	•

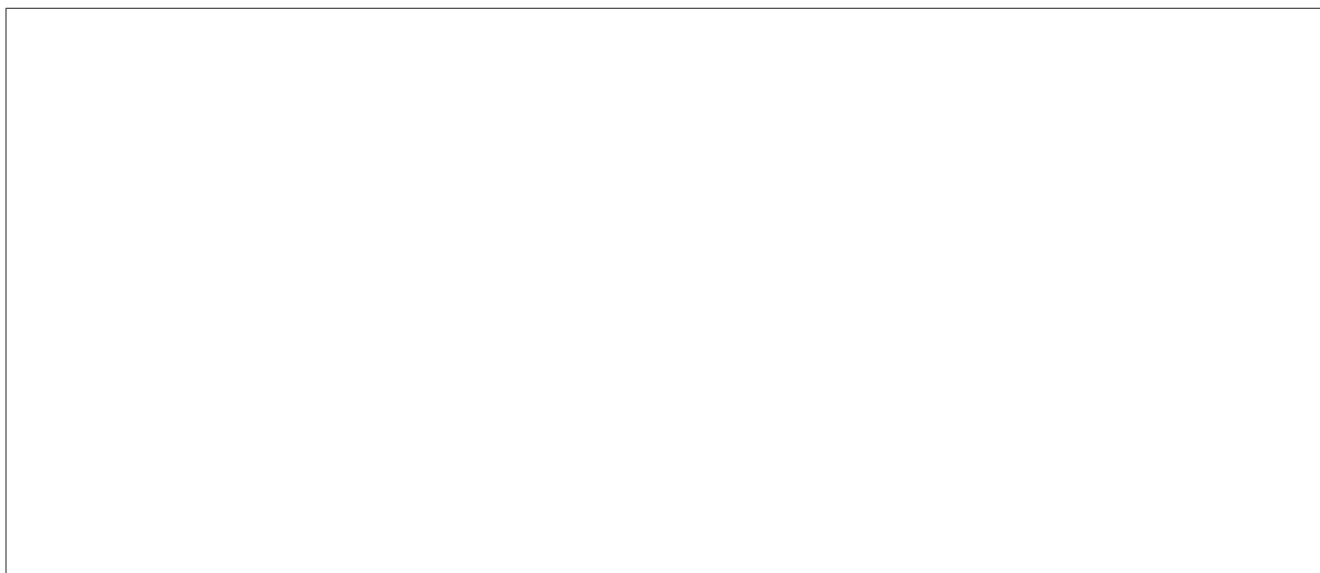
Career: _____	
Responsibilities:	Skills needed:
•	•
•	•
•	•
•	•

Step 1: Take turns picking up a marble, a straw, and a coin with one hand. How is picking up these objects similar? How is it different to pick up each item?

Step 2: Your challenge is to create a mechanical arm with a hand that can open, close, and pick up these three objects. Discuss:

- What type of design could it have?
- How may it open and close?
- How could you use the materials available to you to create this design?

Step 3: Use the box below to sketch your ideas. Be sure your design idea includes both a hand and an arm. The arm should allow you to be at least one foot away from the objects.



Step 4: Watch the *Design a Robotic Arm* video available at youtu.be/diX2FvMt2xo. Compare the video's ideas to your own and consider which ideas could make your own design even better. Revise your sketch as needed.

Step 5: Build your mechanical arm! Stop and consult your sketch and/or rewatch the video as needed.

Step 6: Continually test your arm as you build it. If there are any additional materials that you think could help your design, add them now.

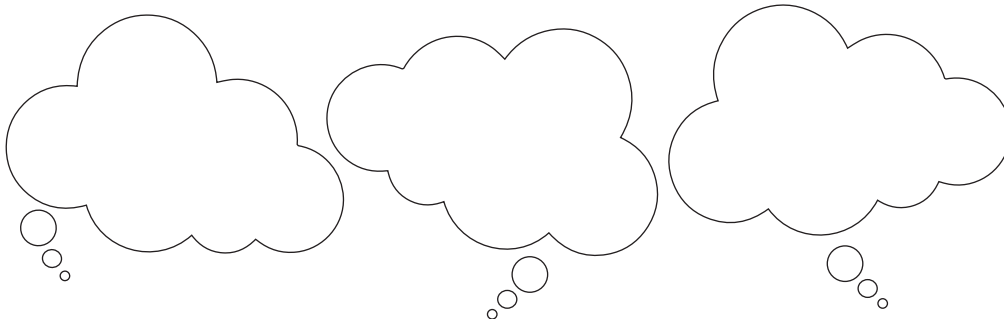
Step 7: Be ready to demonstrate your mechanical arm to the class!

Did you know that the tools, products, machines, and systems that we use every day have likely been reviewed to ensure that they are safe, comfortable, and effective for us to use? This is thanks to the field of ergonomics—which is the study of designing devices and environments so they can be easily used by humans. Think like an ergonomist as you follow the steps below.

Step 1: Observe the world around you. What do you use every day at school that has been designed with you in mind? Record the items and the features about it that make it easy (or easier) to use.

Item	Design Decisions

Step 2: Identify problems. What do you use at school that could be designed better? Think about tools, materials, and equipment that could be modified to be safer, more comfortable, or more efficient for you and your peers to use. Record them in the thought bubbles below.



Tip: Think about EVERYTHING you use! From your desk and chair to your toothbrush, pencil, headphones, and more!

Step 3: Brainstorm solutions. Select one product from above that you would like to make more ergonomic. In the space below, brainstorm *how* this object could be improved so that it is safer, more comfortable, and/or more effective for people to use. Be sure to consider the user *and* the space where it will be used.

Currently, this product is:

It could be improved by:

Step 4: Design Solutions

Sketch your design in the space below. Then use the materials available to create a prototype. As you create your prototype, be sure to:

- Consider its size. Depending on the size of your product, your model may need to be scaled (or made proportionally smaller or larger).
- Label the parts you have changed!

**Step 5: Share and Evaluate**

Be ready to share your redesigned product with your peers. As you and your classmates share, evaluate each other's designs and provide feedback for improvement.