



FUTURE U.

Topic Series: Flight Path

Objectives

Students will be able to:

- **Research** the concept of drag and understand its effect on flight
- **Participate** in the design process to create an innovative airplane design with minimal drag

Episode 1

Concept—What are we trying to solve?

Materials

- Device with projection capabilities, one for the instructor
- Boeing 777X, to project
- Concepting & Design video to project
- Design Process handout, one per student
- Devices with Internet access, at least enough for half the class
- Airplane Design handout, one per student
- Grid Design Paper (3 copies per student) or enough devices for half the class to access an online design software such as [Tinkercad](#)*

Note: Decide in advance whether students will use graph paper or design software to create their design during the Apply section. Students may also be allowed to make their own choice.

Timing

45–60 minutes

National Standards

Next Generation Science Standards

Engineering Design

- 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.

ITEEA Standards for Technological Literacy

Standard 8: The Attributes of Design

To realize the attributes of design, students should learn that:

- F. Design involves a set of steps, which can be performed in different sequences and repeated as needed.

Standard 9: Engineering Design: To comprehend engineering design, students should learn that:

- F. Design involves a set of steps, which can be performed in different sequences and repeated as needed.
- H. Modeling, testing, evaluating, and modifying are used to transform ideas into practical solutions.

Engage

- Begin by projecting this image of the Boeing [777X](#). Ask students: If you were to describe this plane to someone who has never seen it, what might you say?
- Then encourage students to turn to a partner and brainstorm: As this plane travels from one destination to the next, what might it encounter that makes it more difficult to fly? If needed, prompt students to think about wind, low visibility, etc.
- Introduce the idea of drag to students. Explain that drag is a force that slows you down as you move through air or a liquid.

Encourage students to think about what happens if they [put their hand outside a moving vehicle](#). What do they feel? This is drag!

Point to the Boeing 77X image and explain that as an object, like this plane, moves forward and pushes the air around it out of the way, the air also pushes back on the plane and creates resistance. This affects how quickly the plane can move. Drag increases as the object's speed increases.

Investigate & View

- Explain that students will be challenged to develop innovative airplane designs for Boeing that minimize drag as much as possible. By reducing drag, the plane will become more fuel-efficient—and subsequently more sustainable and environmentally friendly.
- Tell the class that before they begin their designs, they are going to watch a video that shows how Boeing solves problems. They will then follow a similar process as they create their designs.
- Distribute a Design Process handout to each student and review the directions provided.
- Tell students that the first time they watch the video, they should jot different steps in the design process in each box. The second time they watch the video, they should draw lines or arrows to show how the process flows.
- When the video is complete, discuss:
 - How would students describe Boeing's design process?
 - Was it easy to create a simple diagram illustrating this process? Why or why not?
 - Why is it important for the design process to be iterative and maybe even messy?

Apply

- Instruct students to form groups of four, and distribute an Airplane Design handout to each student.
- Explain that students will now work in these teams to develop airplane designs that minimize drag. Explain that groups will first perform additional research, and they will then begin the design process. Review each of the steps provided before students begin.*

*For Step 2, be sure to explain whether students will be using Graph Design Paper or design software to create their designs. Then distribute the appropriate materials.

- When five minutes are remaining in the class session, bring the class back together for a quick closing discussion around their impression of the design process. Suggested questions include:
 - What problem were you trying to solve?
 - How did research help you solve this problem?
 - Why is it important to have many people involved in the design process?
 - If you were to continue developing your plane, what step may come next and why?
- Be sure the students store their designs in a safe place so they can be used again with the *Concepting & Design* video #2!

Directions: The design process takes time and requires collaboration. There are many different ways to solve a problem. As you learn more about how Boeing approaches the design process, take notes on each step in the squares below. Then draw arrows to show how the process progresses.

Remember: It may get messy and likely won't go in a straight line!

Step 1: Before you begin your design, perform background research using the links below. As you read through each website, record one or two facts that could help you design a plane with minimal drag.

<p>Forces of Flight howthingsfly.si.edu/forces-flight/four-forces</p> <ul style="list-style-type: none">••	<p>Pressure Drag howthingsfly.si.edu/aerodynamics/pressure-drag</p> <ul style="list-style-type: none">••
<p>Friction Drag howthingsfly.si.edu/aerodynamics/friction-drag</p> <ul style="list-style-type: none">••	<p>Vortex Drag howthingsfly.si.edu/aerodynamics/vortex-drag</p> <ul style="list-style-type: none">••

Step 2: Divide your team into two groups: Wings and Fuselage (or plane body). Using what you now know about drag, brainstorm and create at least **three** different 2-D designs that would reduce drag for the plane section you have been assigned.

Step 3: Share your designs with the rest of your group and explain your design decisions. Work together to come up with at least one optimization (or improvement) for each design.

Step 4: Then collaborate to decide which combinations of wings and fuselages may work best together. Work with your group to create at least **two** full plane designs, complete with a fuselage and wings.

Tip: Don't forget that the design process can be messy! If your designs don't work well together, you may also decide to make edits or create a new design before you select designs to combine.

