

# FUTURE U.

## Cabin Redesign

### Objectives

Students will be able to:

- **Research** and **summarize** how illnesses can be transmitted
- **Analyze** where transmission may occur aboard an airplane
- **Redesign** an airplane cabin to minimize this transmission, while considering various constraints
- **Review** and **evaluate** the design proposal of their peers

### Overview

In this lesson, students imagine they are hired by Boeing as design engineers brought in to update airplane cabins in response to learnings from the COVID-19 pandemic. Students will research how different diseases spread, and they will explore how airplane cabins are currently designed. Based on the technical specs of a Boeing plane and their understanding of disease transmission, students will design an upgraded airline cabin that further protects passengers from infectious diseases. They will ultimately share their plans with their peers and collaborate to optimize their designs.

### This lesson focuses on

Engineering Design Process

- Defining the Problem
- Designing Solutions
- Creating or Prototyping

### 21st Century Skills

- Communication
- Collaboration
- Critical thinking
- Creativity

### Timing

Two 60-minute class periods

### Materials

#### Day 1

- Devices with Internet access, at least enough for half the class
- Handout 1: Disease Transmission Research, one per student
- “How to Stop Disease Spread on Airplanes and Ships” [article](#) (airplane section only), one per student

## DAY 2

- Devices with Internet access, at least enough for half the class
- Handouts from Day 1
- Handout 2: Redesign Mockup (3 pages), enough for half the class

## Have you ever wondered...

### **What feature(s) are already available aboard aircraft to reduce disease transmission?**

Since the outbreak of COVID-19, major airlines now mandate that passengers wear masks aboard, and they also disinfect cabins following each flight. Some airlines are also choosing to leave middle seats open in order to maintain social distancing measures. Aside from behavioral changes, the most important feature installed on most planes to reduce the spread of disease are high-efficiency particulate air (HEPA) filters. These filters act similarly to those used in hospital rooms, and they can trap more than 99.990% of small particles, including bacteria and viruses. As air flows through these filters, it is combined with air that is brought in through the airplane's engines. It then re-enters the aircraft as a mixture of 50% fresh air and 50% recirculated air. This can occur as often as every two to three seconds.<sup>1</sup> Boeing has advised airlines to keep this system running as passengers board and disembark planes, which was a practice not commonly used before COVID-19.<sup>2</sup>

### **In light of COVID-19, are airline manufacturers looking into how to further minimize disease transmission aboard aircrafts?**

Yes! Boeing is partnering with medical experts, engineers, and academics to research new ways to prevent disease transmission aboard planes.<sup>2</sup> Boeing is investigating new materials that could kill viruses that land on them—such as antimicrobial coatings. These could potentially be installed in airplane bathrooms as well as on other highly-touched surfaces. Boeing is also in the process of developing a portable ultraviolet disinfectant (which would look like a backpack and a wand) that staff could wave over certain areas to kill viruses within seconds.<sup>2</sup>

### Make Connections

#### How does this connect to students?

COVID-19 has dramatically changed the daily lives of children, teenagers, and adults around the world. Many schools have shifted to online learning, and social contact with those outside their families has been extremely limited. People are also home much more than ever before, and families' travel habits have evolved.

A recent article in The New York Times equated travel during the summer of 2020 to the summer of 1965—in which road trips were the main form of travel. Unlike air travel, which decreased sharply this past year, road trips continued at a steady pace. According to one AAA estimate, there was only a three percent decrease in road trips this past summer,<sup>4</sup> whereas airline travel is now down 43% compared to last year.<sup>5</sup>

In order for domestic and international airline travel to make a comeback, additional safeguards and systems may need to be put in place. This lesson will therefore challenge students to consider what could help Americans safely ease back into airline travel.

#### How does this connect to careers?

##### **Aircraft Design Engineer:**

Aircraft design engineers can design, construct, and test aircrafts. They may be responsible for the structural design of the overall aircraft, and they also create the designs for aircraft interiors in order to ensure that they meet quality standards and requirements from the Federal Aviation Administration.

**Epidemiologist:** Epidemiologists are “disease detectives” or public health professionals who study disease outbreaks in order to treat current diseases and prevent future outbreaks from happening. While their day-to-day duties depend on their employer, they always collect and analyze data to understand how the disease outbreak began, how it is transmitted among populations, how to stop transmission, and how it can be treated.

**Exposure Scientist:** Exposure science is the “study of our contact, such as by swallowing, breathing, or touching, with environmental factors and their effects on the human body.” During COVID-19, exposure scientists have been called on to help identify vulnerable populations, design interventions, and communicate exposure risks in order to minimize the disease’s impact.<sup>6</sup>

#### How does this connect to our world?

While COVID-19 disrupted many individual travel plans, its ripple effects are much larger. The dramatic drop in travel and tourism will also have a huge impact on countries whose economies rely on tourism.

Around the world, Greece, Morocco, Costa Rica, Portugal, and Thailand are projected to be among the hardest hit due to reduced tourism. Their overall losses are projected to be higher than three percent of their GDP.<sup>7</sup>

Until international travel is again possible, some airlines are offering experiences to help passengers who miss flying! Australia’s Qantas Airways, for example, is offering “flights to nowhere” in low-risk areas that give passengers the experience of flight without taking them to a new destination.<sup>8</sup>

As people around the world begin to travel again, it will be essential to maintain health and safety throughout the flying experience. For this reason, airline manufacturers like Boeing are investing in research to find new ways to avoid disease transmission aboard airplanes.

## Sources

- <sup>1</sup> "How Clean is the Air on Planes?" Condé Naste Traveler. [cntraveler.com/story/how-clean-and-safe-is-a-planes-cabin-air](http://cntraveler.com/story/how-clean-and-safe-is-a-planes-cabin-air).
- <sup>2</sup> "Boeing and Airbus Study How Coronavirus Behaves During Air Travel." The Wall Street Journal. [wsj.com/articles/boeing-and-airbus-study-how-coronavirus-behaves-during-air-travel-11590498000](http://wsj.com/articles/boeing-and-airbus-study-how-coronavirus-behaves-during-air-travel-11590498000).
- <sup>3</sup> "How Safe is Air Travel During the Pandemic?" Financial Times. [ft.com/content/b6a40987-4272-4b51-addb-f30c8066ce2c](http://ft.com/content/b6a40987-4272-4b51-addb-f30c8066ce2c).
- <sup>4</sup> "To Many Travelers, 2020 Was the Summer of 1965." The New York Times. [nytimes.com/2020/09/04/travel/to-many-travelers-2020-was-the-summer-of-1965.html](http://nytimes.com/2020/09/04/travel/to-many-travelers-2020-was-the-summer-of-1965.html)
- <sup>5</sup> "5 Things We Know About Flying Right Now." The New York Times. [nytimes.com/2020/08/20/travel/airplanes-coronavirus.html](http://nytimes.com/2020/08/20/travel/airplanes-coronavirus.html).
- <sup>6</sup> "The COVID-19 pandemic: a moment for exposure science." Journal of Exposure Science & Environmental Epidemiology. [nature.com/articles/s41370-020-0225-3](http://nature.com/articles/s41370-020-0225-3).
- <sup>7</sup> "This chart shows how COVID -19 is harming tourism around the world." World Economic Forum. [weforum.org/agenda/2020/08/covid19-coronavirus-tourism-economy-gdp/](http://weforum.org/agenda/2020/08/covid19-coronavirus-tourism-economy-gdp/).
- <sup>8</sup> "Qantas Seven Hour Flight to Nowhere." CNN. [edition.cnn.com/travel/article/flights-to-nowhere-qantas/index.html](http://edition.cnn.com/travel/article/flights-to-nowhere-qantas/index.html).

## Blueprint for Discovery

### DAY 1

1. Kick off by asking students to brainstorm: What do YOU do to stay healthy and avoid getting sick? Keep a list on the board as students share.
2. Review the list and explain that there are some personal actions, such as getting enough sleep, exercising, and eating well, that are beneficial to our overall health.

There are also specific actions and precautions that can specifically reduce our risk of getting sick from different illnesses—which is what the class is going to focus on today!

Elaborate and explain that students are about to imagine they have been hired by Boeing as design engineers brought in to update airplane cabins. They will be updating these cabins to promote safe and healthy air travel in response to learnings from the COVID-19 pandemic and other illnesses.

3. To begin the design process, tell the class that they will research how different diseases spread.
 

Divide students into pairs, and distribute one *Handout 1: Disease Transmission* Research to each student. Review the directions provided and answer any student questions before encouraging them to get to work.
4. After about 20 minutes have passed or most pairs have finished their research, bring the class back together and encourage students to briefly share what they recorded in each of the categories. Students who are missing notes or key points may use this opportunity to add to their charts.
5. Then explain that airlines do already have systems and protocols in place to protect passengers from illness.
 

Distribute one "How to Stop Disease Spread on Airplanes and Ships" article to each student, and instruct students to read independently or in pairs until the "Ships are Incubators" section of the article. As they read, ask them to annotate (highlight or underline) for:

  - What airplanes currently have in place to manage disease transmission
  - What airline manufacturers and companies are considering putting in place to further manage disease transmission
6. Wrap up the day's session by bringing the students back together for a short debrief. Ask:

- What safety procedures or systems are already in place aboard airplanes?
  - What additional procedures or systems are airline manufacturers looking into?
  - Does opportunity exist to lower the risk of disease transmission aboard flights even further?
7. Conclude by explaining that, even though experts believe airline travel is safer than many other public spaces, students will spend the next class session exploring how to redesign aircrafts to lower the risk even more!

Before you leave, be sure to either collect students' work or ask them to keep it in a safe place until the next session.

### DAY 2

1. Begin the second-class session by asking students to look over their work from the previous session and share where they believe the biggest risks for disease transmission exists aboard airplanes.  
  
Then tell the class that now that they have a background in disease transmission, they are ready to begin their work as Boeing design engineers!
2. Pass out one *Handout 2: Redesign Mockup* to each student. Review the directions and each of the steps, and explain that students should work with their partner from the first session to complete this redesign.  
  
Explain that they don't need to redesign the entire cabin interior; they can maintain any elements that they believe work well. They should also be creative and try to brainstorm technology or inventions that may not yet exist.
3. Take a moment to answer student questions and then encourage them to begin! Deduct 10–15 minutes from the end of the class session and explain that they will have this much time to complete their work.
4. When there are about 10–15 minutes left in class, instruct pairs to partner with another pair. They should then take turns presenting their redesigns to each other, being sure to explain the rationale behind their design decisions. As students listen, challenge them to ask each other questions and provide at least one design critique or suggestion for improvement. In addition to safety, also encourage students to review their peers' designs for potential costs. For instance: Was any weight added to the plane that would increase the amount of fuel needed to fly? Were any seats taken away that would decrease the number of paying passengers?
5. Then wrap up by thanking students for their hard work and innovative designs. Explain that it's because of creative minds like theirs that air travel will be able to continue to safely transport passengers around the world!

### Extend

Students can apply what they learned to a mode of transportation that they use during their daily lives. For instance: How could they redesign the interior of a school bus, the subway, their family car, or a city bus to reduce the risk of disease transmission?

## 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.

### National Health Standards

Standard 1: Students will comprehend concepts related to health promotion and disease prevention to enhance health.

- 1.8.3: Analyze how the environment affects personal health.

**Directions:**

1. Explore each of the websites listed in the Illness column below.
2. As you read about how each illness spreads, take notes in the second column.
3. Then go to [boeing.com/commercial/777](http://boeing.com/commercial/777) and scroll halfway down the page until you get to the *777 Award Winning Interior Video*. As you watch and learn more about the interior of airplanes, answer the question listed in the third column.

Illness	How does this illness spread?	Where and/or how could this transmission occur aboard an airplane?
<p><b>Common Cold</b>  <a href="http://cdc.gov/features/rhinoviruses/index.html">cdc.gov/features/rhinoviruses/index.html</a></p>		
<p><b>Influenza</b>  <a href="http://cdc.gov/flu/about/disease/spread.htm">cdc.gov/flu/about/disease/spread.htm</a></p>		
<p><b>Norovirus</b>                      (“stomach bug”)  <a href="http://cdc.gov/norovirus/about/transmission.html">cdc.gov/norovirus/about/transmission.html</a></p>		
<p><b>COVID-19</b>  <a href="http://cdc.gov/coronavirus/2019-ncov/index.html">cdc.gov/coronavirus/2019-ncov/index.html</a></p>		

**Your Challenge:** Boeing’s 787 Dreamliner planes entered service in 2011. They now fly more than 1,900 different routes around the world for dozens of airlines. One-hundred and fifty-eight 787s were produced by Boeing in 2019 alone!

Since you already understand how diseases are transmitted, and you identified where risk for transmission may occur aboard flights, you are ready to begin redesigning the interior of Boeing’s 787 planes.

Follow the steps below to complete your redesign.

**Step 1:** Review the airplane’s basic specs:

- Length: 229 feet
- Interior Width: 18 feet
- Seating: 318 passengers
  - 44 passengers in first class with 20.5-inch-wide seats
  - 274 passengers in various economy classes with 17.3-inch-wide seats
- Airplane Layout:
  - First class: Window—1 seat—Aisle—2 seats—Aisle—1 seat—Window
  - Economy: Window—3 seats—Aisle—3 seats—Aisle—3 seats—Window

**Step 2:** Visit [tinyurl.com/787planetour](http://tinyurl.com/787planetour) and tour the Boeing 787 Dreamliner in 3D. After observing the seat map and overall layout of the airplane, scroll down to see a 3D view of each of the seating sections.

**Step 3:** After you read the questions in the chart below, review your completed Handout 1 as well as your “How to Stop Disease Spread on Airplanes and Ships” article annotations. Then jot notes and ideas to answer the questions below. Be creative!

Where may disease transmission occur aboard this 787?	How could this plane be redesigned to lessen this risk?
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**Step 4:** Create a mock-up of your upgraded, redesigned plane on the following page, keeping the following constraints in mind:

- The primary goal of the airplane redesign is to maintain health onboard and prevent disease transmission.
- The secondary goal of the airplane redesign is to continue to safely transport as many people as possible
- The length and width of the airplane, as well as the number of airline seats, should remain the same.
- There must remain room for at least 9 restrooms, 2 exit rows, and several galleys (where food is prepared).
- Be aware of the amount of weight you add to the airplane, as this increases the amount of fuel needed to fly.

As you sketch your new design, label each of the design changes. Then use the space below to further explain these design decisions.

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