

EDUCATOR GUIDE

TOPIC

Designed for Service

KEY LEARNING OBJECTIVES

Students will be able to:

- Describe how aviation can be used to positively impact the world
- Design or modify an existing aircraft that revolutionizes how we address critical need areas such as humanitarian aid or disaster relief

LESSON OVERVIEW

At Lockheed Martin, Skunk Works® teams utilize collaboration and teamwork to develop highly secretive and innovative designs. The Skunk Works® team remains connected to founder Kelly Johnson's vision of a place where small empowered teams create powerful solutions.

In this lesson, students will begin by working together in small Skunk Works® teams of approximately four- five students (with different roles assigned to each student) to design or modify an aircraft for humanitarian aid or disaster relief, each requiring remote area access. Each team will address a unique real-world scenario that teaches students how to empathize with those around them as they build skills for innovating. Using critical-thinking and collaboration, each team will follow the engineering design cycle to address the challenge.

The accompanying presentation was created with PowerPoint so that it can be used in a variety of classrooms. If you are using a laptop with an LCD projector, simply progress through the PowerPoint by clicking to advance. All the interactive aspects of the presentation are set to occur on click. If you are using an interactive whiteboard, tap on each slide with your finger or stylus to activate the interactive aspects of the presentation. It does not matter where you tap, but you can make it appear as if you are making certain things happen by tapping them. In the notes for each slide there will be information on how to proceed.

CONTENT AREAS

Engineering and Technology

ACTIVITY DURATION

3-4 class sessions (45 minutes each)

GRADE LEVEL

Grades 9-12

NATIONAL STANDARDS

Next Generation Science Standards (NGSS)

HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

HS-ETS1.B: Developing Possible Solutions

There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem.

ITEEA Standards for Technological Literacy

Standard 2: Core Concepts of Technology—Students will develop an understanding of the core concepts of technology.

W: Systems thinking applies logic and creativity with appropriate compromises in complex real-life problems.

BB: Optimization is an ongoing process or methodology of designing or making a product and is dependent on criteria and constraints.

Standard 8: Attributes of Design—Students will develop an understanding of the attributes of design.

E. Design is a creative planning process that leads to products and systems.

Standard 11: Apply Design Processes—Students will develop the abilities to apply the design process.

J. Make two-dimensional and three-dimensional representations of the designed solution.

ESSENTIAL QUESTIONS

1. How can we use aviation to change the world?
2. How does empathy drive innovative solutions?
3. How does the engineering design cycle guide Skunk Works® teams through a process of meeting real-world challenges of different humanitarian aid or disaster relief scenarios?

MATERIALS

- Computers connected to the Internet
- Copies of "Think-Pair-Share Capture Sheet"
- Copies of "Student Mission" Handout
- Copies of the "Extension: Writing Prompt"
- Optional for 3D Model: wire, wire cutters, clay, aluminum foil

BACKGROUND INFO

Every day, all around the world, governments and nongovernmental organizations must respond to human-made and natural disasters confronting vulnerable populations. Whether it be delivering medication to remote locations, or providing food and supplies to flood victims and dealing with environmental damage after a hurricane, innovative aviation has an important role to play in making sure these needed resources get to hard-to-reach locations in a cost-effective and efficient manner. For example, an autonomous design may be best suited for deliveries in dangerous areas, while hover technology may work most effectively in an area with challenging weather conditions or limited landing space.

During the lesson, students will begin by working together in Skunk Works teams of approximately four to five students (with different roles assigned to each student) to design or modify an aircraft for humanitarian aid/disaster relief, each requiring remote area access.

Tell students that they will be working together in teams similar to how Lockheed Martin Skunk Works® is structured. The Skunk Works® team remains connected to founder Kelly Johnson's vision of a place where small empowered teams create powerful solutions. At Skunk Works®, individuals and teams are given the freedom to work on advanced or secret projects with limited constraints. This provides people the opportunity to try out radical ideas that may lead to breakthroughs in invention and innovation. Your group will include approximately four to five students (with different roles assumed by each student) to design or modify an aircraft for humanitarian aid/disaster relief, each requiring remote area access. Each team will address a unique real-world scenario that teaches students how to empathize with those around them as they build skills for innovating. Using critical-thinking, collaboration, and open minds, each team will use design thinking to address the challenge.

PROCEDURE

Day 1 (Slides 1–6)

Engage

Slide 1

- Begin class with an "Empathy" graffiti board. On an empty board in your classroom, or on a long sheet of bulletin board paper, write the questions: *What is empathy? When have YOU shown empathy for others?* As students enter the room, encourage them to fill the board with words, phrases, or pictures that answer these questions.
- Allow a couple minutes for students to share their thoughts. Make sure students understand that empathy is the ability to understand the feelings and actions of another person by putting themselves in that person's shoes.
- Explain to students that design thinking is an approach that starts with empathy. A designer will first put themselves into the perspective of an issue or challenge other people are facing. They will then create designs that meet their needs. In this lesson, students will be investigating how empathy drives innovative solutions in aerospace.

Slide 2

- Introduce students to how they can combine their passion for helping others to innovations in aerospace using an academic vocabulary strategy to unpack the mission!
- Guide individual students to use a scrap piece of paper and rip it into seven pieces. Ask them to write a vocabulary word on each piece: pressure, leak, humanitarian aid, disaster relief, remote transportation, hybrid airship, autonomous robot. Students should then be directed to mix them up.
- In small groups of 3–4, have students discuss which words are familiar and share their understanding of the meanings.

- As a whole group, briefly have students share and review the words and their meanings.
- Next, ask small groups to predict what their STEM challenge might be about.
- Explain to students that, as they watch the STEM challenge video, they will work with a partner to place the vocabulary words in order as they are heard in the segment.
- Play the Designed for Service video.
- After the video segment concludes, have students discuss the sequence of topics from the segment, using the order identified for the vocabulary words. Then, ask them to discuss how the terms and concepts might be used to solve the challenge introduced in the video.

Explore

Slide 3

- Tell students that they will be working together in teams similar to how Lockheed Martin Skunk Works® are structured. The idea of a Skunk Works® is typically defined as a group of people in an organization that are given the freedom to work on advanced or secret projects with limited constraints. This provides people the opportunity to try out radical ideas that may lead to breakthroughs in invention and innovation. Your group will include approximately four-five students (with different roles assumed by each student) to design or modify an aircraft for humanitarian aid/disaster relief, each requiring remote area access. Each team will address a unique real-world scenario that teaches students how to empathize with those around them as they build skills for innovating. Using critical-thinking, collaboration, and open minds, each team will use design thinking to address the challenge.
- **Skunk Works Teamster Tip!** The best brainstorming is done when no idea is shot down, and teammates are accepting of every suggestion, feasible or not.

Slide 4

- Place students into groups and share the different group roles and responsibilities below. (Either pre-assign students their roles or allow them to choose at the beginning of the activity.)
 - Engineering Manager—acts as group leader and time keeper, responsible for coordinating and directing the efforts of the group and keeping everyone on task
 - Aeronautical Engineer—leads the assessment of the humanitarian aid/disaster relief scenario and existing aeronautical designs to develop a list of constraints and requirements for their design
 - Aircraft Designer—executes the technical scale drawings to meet the requirements of the engineering assessment
 - Data Analyst—identifies safety considerations and testing protocols for the prototyped design
 - Project Manager—keeps the group on task, assures work is done by all, and makes sure all have opportunity to participate and learn.
- Instruct students to write down the roles for each member of their group, as well as the responsibilities for their own assigned/chosen role. Answer any questions students may have about the roles/responsibilities.

Slide 5

- Pass out copies of the “Student Mission” handout to each group. Have student groups randomly select one of the three humanitarian aid/disaster relief scenarios to ensure that no more than two groups have selected the same scenario. Review the scenarios:

- A virus outbreak has occurred in a small province but is spreading quickly to neighboring countries. It is reported people are experiencing fevers, headaches, and muscle pain. The outbreak site is on the edge of a dry lake bed that has soft sand. Response teams need access to the site to contain the virus. They will bring with them medicine to immunize enough people so that the virus cannot spread. They will also need to setup rehydration stations, provide shelter to care for patients, and be able to decontaminate surfaces and equipment.
- A five-hundred-year flood has just hit a state in the U.S. The most heavily impacted regions are still feet underwater over a week after the rain event that caused the flooding. Though the immediate search and rescue effort has ended, victims of the flooding need food and supplies. In addition, the environmental impacts are just now beginning to be felt and dealt with. The State Department of Environmental Quality is grappling with how to remediate toxic material, like coal ash and farm waste, that is flowing into waterways and prevent this from happening in future severe flood events.
- A major earthquake has just hit a dense, metropolitan area of nearly 10 million people. Dozens of buildings and other structures were completely destroyed, including the international airport, while hundreds of others continue to pose a risk to rescue workers and residents. Engineers and architects need to inspect thousands of structures around the city, but those with severe structural damage may be unsafe to enter. Survivors of the quake need tents, tarps, blankets and other supplies that will allow them to shelter outdoors until their homes can be determined safe to re-enter.
Ask students to define the goals of the mission and summarize what their solution must, could, and should include to be successful using the "Student Mission" handout.

Slide 6

- Each team's design should draw upon at least one of the technologies developed by Lockheed Martin—i.e. Hovercraft Technology on the Hybrid Airship, the Sikorsky Firehawk® helicopter, the Stalker unmanned aerial system or Indago unmanned aerial system (UAS)

Day 2 (Slides 7–8)

Explore

Slide 7

Invite students to review their notes and determine what they could create to help people in their provided scenario. Students should go through and underline capabilities and features that are relevant to their mission.

Slide 8

- Next, ask students to consider, "What would be really unique or different to include in our design?" Skunk Works teams are empowered to think out of the box and try unconventional methods when brainstorming and designing solutions. Guide students to revisit their career roles and share how each of their perspectives can help advise designing their aviation solution. Encourage students to sketch radical ways to help using the grid paper provided in their "Student Mission" handout.
- **Skunk Works Teamster Tip!** It's important to point out to students the reason behind developing their design in both 2D and 3D space. Prototypes in different forms serve to see and solve problems that would otherwise go undiscovered if only on paper or only CAD modeled. Some problems aren't even revealed until first flight!
- If time allows, invite students to turn their 2D sketch into a 3D model using clay or playdoh. It's usually best to start with wires to create a rough shape of your design. Then, aluminum foil can be added to build out the shape. The clay will then be placed around the rough outline they've created. Students should smooth the clay and then sculpt defining features. They may want to add additional equipment or accessories that demonstrate different features of their design. It is okay for students to use existing aerospace designs to help create their model.

Day 3 (Slide 9–10)

Explain

Slide 9

- Empathy not only can help humanize innovations and why we design, but can also contribute to effective communication. When you explain an innovative idea, empathy can help tell the story of your design by including who will directly benefit from your idea. Work with your group to develop a brief 30-second message that sums up your idea in a compelling way. Your message should answer the following questions:
 - What is the meaning of your solution?
 - How did thinking of other people drive your design?
 - Provide time for students to share their solution summary with their peers.

Evaluate

Slide 10:

- Pass out the “Extension: Writing Prompt.” As a summary to the lesson, students will complete a writing prompt in which they explain and comment on the following premise using evidence from their scenario and design:

“We are defined not by the technologies we create, but the process in which we create them.”
—KELLY JOHNSON
- It is recommended that students spend a short amount of time for pre-writing activities (such as brainstorming, listing, free writing, clustering, mapping, or drawing). After they finish their prewriting activity, they should write their short response in the provided space on their “Student Mission” handout. Remind students that a well-structured summary includes smooth transition between ideas, precise language, and relevant details and examples from their research.

What is an airship?

It's similar to a blimp, but in the shape of a giant wing. That means it flies partly because it floats, and partly because it soars. Airships use helium to balance their weight, allowing the aircraft to operate efficiently when carrying heavy cargo. Its Air Cushion Landing pads operate like a Hovercraft, using air flow to either grip the ground in suction or hover over a cushion of air created from a downward blast. This unusual landing system can also operate on nearly any terrain, including land, water and ice.

How can it help people?

More than two-thirds of the world's land area and more than half of the world's population do not have direct access to paved roads or runways. This lack of infrastructure presents numerous challenges for worldwide humanitarian relief, natural resource extraction and heavy cargo operations. In most cases, developing these areas to accommodate roads or airways is not an option, so for centuries they've remained isolated.

To combat these challenges, the Skunk Works® team developed a one-of-a-kind Hybrid Airship that offers large cargo capacity with significant reductions in fuel consumption compared to other air vehicles, thus allowing long-range missions. All while remaining faster than land and sea transportation systems.



<https://www.lockheedmartin.com/en-us/news/features/2016/hovercraft-technology-help-people-remote-parts-of-world.html>

What is a multi-mission helicopter?

The Sikorsky S-70 FIREHAWK® not only has firefighting capabilities but also acts as an aerial ambulance providing disaster and humanitarian relief.

How can it help people?

These aircraft deliver personnel and equipment to a specific fire site; they also provide evacuation and medical support, as needed. For example, this Sikorsky S-70 FIREHAWK® is a multi-mission helicopter equipped with a 3,785-liter (1,000-gallon) water tank, retractable snorkel attached to the belly of the aircraft, and an extended main landing gear.

Helicopters like this one also include a rescue hoist and a medically-configured interior to support the extraction and medical needs of people trapped within a fire zone. The Sikorsky FIREHAWK helicopter enables firefighters to attack wildland fires with large volumes of water, especially when the effort is coordinated closely with firefighters attacking the same fire from the ground.



What is an unmanned aerial vehicle?

They are aircraft without a human pilot aboard, also known as a drone. A human will program or control the vehicle remotely.

How can it help people?

It provides a quick aerial reconnaissance capability in crowded areas unreachable by fixed-wing unmanned aircraft. The Indago has a payload system for a variety of different applications including: precision agriculture, mapping, surveying and inspection, and reconnaissance. Following natural or manmade disasters, Indago provides mapping and terrain data in areas with no roads and environmental challenges. After a fire, an accident or in hazardous search-and-rescue operations, first responders need to quickly assess the situation and determine how to assist or find people in dangerous situations.



What is an unmanned aerial system?

They are aircraft without a human pilot aboard. The Stalker XE is a small, silent, Unmanned Aerial System (UAS) that provides long-endurance imaging capability.

How can it help people?

The Stalker XE can provide intelligence, surveillance, and reconnaissance data. During natural disasters and other emergencies, it is able to provide geolocation and data to deploy response and rescue units.

It has a wingspan of 12ft and can carry payloads up to 2lbs. It flies at a maximum speed of 45mph and can operate at an altitude of 15,000ft. The Stalker XE has long-endurance imaging capability and is an all-weather system. Its flexibility allows it to support many different types of missions.

