

GENERATION BEYOND

GRADES
9-12

Virtual Field Trip Educator Guide

Skunk Works®

Exploring Top Secret Projects
with Lockheed Martin



OVERVIEW

For more than 75 years, Lockheed Martin's Skunk Works® has created revolutionary aircraft and technologies that push the boundaries of what is possible. Join us live in Palmdale, California at the Lockheed Martin Facility and explore the unique Skunk Works® approach to innovation and design, including examples of successful collaboration and teamwork on highly secretive projects. These include:

- **"Nature Inspired Design": Biomimicry**
Explore solutions to aviation design challenges by emulating nature's patterns and strategies.
- **"The Ultimate Renewable Power": Lockheed Martin Compact Fusion Reactor (CFR)**
Imagine a reactor the size of a large truck that could power a city of 80,000 homes!
- **"Lowering the Boom": Supersonic Air Travel**
What's stopping us from travelling from New York to San Francisco in only 3 hours? The disruptive sonic boom planes create. The Lockheed Martin X-59 QueSST aircraft demonstrator will silence the boom and enable a speedy transportation future.
- **"From Design to Flight": Designing Aircraft**
From concept development through design, fabrication and flight test, learn about the variety of STEM technologies that scientists consider in designing aircraft.
- **"Flying Drones": Autonomous Aircraft**
Learn about the history of drones and some of the new advancements in the industry that will make improvements in analyzing weather behavior, surveillance, mapping and more.

The pre-field trip activities in this companion guide are designed to introduce students to the topics they will learn about. The virtual field trip and post-field trip activities are designed to connect and extend student learning to hands-on challenges in the classroom.

OBJECTIVES

Students will:

- Identify STEM careers that match their skills, interests and experiences.
- Describe how scientists must be able to identify problems, create solutions, think critically, effectively communicate as part of a team, and apply new technologies and skills.
- Explain the role technology plays in solving real-world problems by reconstructing existing and creating their own Skunk Works® innovation case studies.

MATERIALS

- Copies of the Skunk Works® [Case Studies](#), two per case study (each placed in one of six folders marked "Key"): Hybrid Airship, Polecat, ACCA (Copy and paste each case study into a separate documents for printing)
- Two Copies of *Case Studies: Engage Cards*, 30 cards cut and shuffled for random distribution
- Pieces of chart paper, posted around the classroom, one per group
- Tape
- Copies of *Careers in Top Secret Design and Innovation* capture sheet (one per student)
- Internet Access
- *Career Profile Research* handout (one per student)
- Copies of *Skunk Works® Innovations 2030* capture sheet, one per student

ENGAGE

1. Before class, write the headings for each of the three case studies ("Hybrid Airship", "Polecat", and "ACCA"), as well as the subheadings ("Challenge", "Approach", and "Results") on poster paper. Repeat the process so that you have two sets of posters, for a total of six. Print two copies of the *Case Studies: Engage Cards* for a total of 30 cards. Cut along dotted lines and shuffle for random distribution. The Engage activity is designed for six groups—two for each case study—with five students in each. Reduce the number of case studies or give students more than one card for smaller class sizes.
2. Begin class by handing each student a unique section of one of the three Skunk Works® Case Studies.
3. Prior to beginning the activity, provide some background information on the Skunk Works® approach to innovation and design by showing the following video: (3:36 min.) <https://www.youtube.com/watch?v=pmeQ0T4VyeU>
4. Tell students that they will be reviewing the case studies of particular Skunk Works® innovations as a warm-up to the VFT and later, creating case studies for their own designs.
5. Instruct students to read their card and find the heading for the corresponding real-life case study on the poster paper hanging somewhere in the room. (NOTE: Case Study Codes are in the top right corner if students need help with matching.)
6. Once they've located the correct case study, they should work with the other students at that poster (their group) to place their cards in the correct order and tape them under the appropriate headings to complete the case study.
7. Once they think they have the cards in the correct order, direct students to check the full case study in the folder marked "Key" next to the poster. (NOTE: Tell students that their case study text on the poster will be shorter than the complete case study, but they should still endeavor to get their text in the same order as it appears in the actual case study.)
8. Engage students in a short de-brief discussion to synthesize key points they learned about Skunk Works® and introduce the VFT. Leave the posters up for Activity #2 (below).

DURING THE VIRTUAL FIELD TRIP

1. Distribute the *Careers in Top Secret Design and Innovation* capture sheet to students and review the background information.
2. Direct students to watch the "Skunk Works®—Exploring Top Secret Projects with Lockheed Martin" Virtual Field Trip. While they watch, they should list two background experiences/training opportunities that each professional highlighted as influential or helpful in their current career.
3. Then, students should look to match some of their personal background and training opportunities with the careers featured in the presentation and answer the other questions on the capture sheet.

AFTER THE VIRTUAL FIELD TRIP

Two activity options are available for students to apply and summarize their learning.

Activity #1 (Career Investigation)

1. Remind students that during the VFT, they met many professionals who are dedicated to successful collaboration and teamwork on highly secretive design and innovation projects. From aeronautical engineers and plasma physicists, to data analysts and aircraft designers, each career plays a unique role in addressing national security and consumer air travelers' needs by identifying problems, creating solutions, thinking critically, effectively communicating as part of a team, and applying new technologies and skills.
2. The VFT highlighted several of these careers. Ask students to share what they remember about these jobs:
 - Aeronautical Engineer
 - Plasma Physicist
 - Data Analyst
 - Aircraft Designer
3. Then, challenge students to learn more about one of the two careers they listed on the back of their *Careers in Top Secret Design and Innovation* capture sheet. Pass out the *Career Profile*, direct them to conduct a web search, and invite them to record their research.

4. Once research is completed, invite students to identify a gap in their school's course offerings and write a persuasive letter to the principal asking that the school offer more opportunities in this area, either directly or through partnership with outside groups.

Activity #2 (Design Your Own Skunk Works® Innovation)

1. Distribute copies of the *Skunk Works® Innovations 2030* capture sheet to each student.
2. Explain that for this activity, they are to imagine that the year is 2030 and they each have been hired recently by the Skunk Works® team. Tell them that they will get into their group of five from the Engage activity to brainstorm ideas for their own Skunk Works® innovation.
3. Instruct students to engage in a Gallery Walk around the classroom to use the real case studies posted from the Engage Activity for inspiration. They can also draw upon solutions they learned about during the VFT.
4. Individually, they should complete the capture sheet, using their group's collective ideas.

HS NATIONAL STANDARDS

Next Generation Science Standards (NGSS)

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.

International Technology Education Association (ITEA)

Standards for Technological Literacy (STL)

Standard 2: 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.

Case Study Code KEY: **HA**—Hybrid Airship, **P**—Polecat, **AC**—ACCA
 (Print two copies for six groups)

<p>HA</p> <p>This technology can carry heavy cargo affordably to and from remote locations thanks to an air cushion landing system (ACLS) and its unique shape, allowing it to carry a wider range of payloads for increased flexibility.</p>	<p>P</p> <p>This is a high-altitude unmanned aircraft technology showing Skunk Works® ability to decrease development time and costs.</p>
<p>HA</p> <ul style="list-style-type: none"> • Build a half-scale prototype airship • Small integrated design/build/test team 	<p>P</p> <ul style="list-style-type: none"> • Limit the technical requirements • Small build team empowered to execute the task
<p>HA</p> <ul style="list-style-type: none"> • Identify key performance parameters • Design the airship for the lowest operating cost 	<p>P</p> <ul style="list-style-type: none"> • Concentrate on quick operational time frame • Stabilize program funding
<p>HA</p> <ul style="list-style-type: none"> • Thirteen months from program start to successful first flight test • The half-scale prototype successfully demonstrated the technologies required for an operational hybrid airship 	<p>P</p> <ul style="list-style-type: none"> • Conceived of and built in 18 months • 50 percent cost improvement over other prototypes • 98 percent composite structure
<p>HA</p> <ul style="list-style-type: none"> • Provided momentum for the commercial sales campaign in the oil and gas, and mining industries 	<p>P</p> <ul style="list-style-type: none"> • Revolutionary production techniques achieved a 50 percent reduction in touch labor, the elimination of 8,000 fasteners and a 3x reduction in tooling costs

Case Study Code KEY: **HA**—Hybrid Airship, **P**—Polecat, **AC**—ACCA
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AC

The X-55 Advanced Composite Cargo Aircraft program was designed to improve multiple technologies needed for the next generation of airlift aircraft

AC

- Modify an existing aircraft structure
- Small, co-located team to efficiently execute task at hand

AC

- Utilize advanced composite technologies and inventive structural approaches
- Reduce aircraft weight to reduce fuel use and part count while increasing structural durability

AC

- Conceived and built in 15 months
- 50 percent estimated cost reduction of a conventional design of the same size

AC

- Used 90% fewer metallic parts and mechanical fasteners, significantly reducing tooling costs and assembly labor

CAREERS IN TOP SECRET DESIGN AND INNOVATION

(To be completed during the virtual field trip)

Explore the unique Skunk Works® approach to innovation and design, including examples of successful collaboration and teamwork on highly secretive projects. These include:

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While watching the Lockheed Martin Skunk Works® Virtual Field Trip, complete the table:

List **two** background experiences/training opportunities each professional highlighted as influential.

Aeronautical Engineer	1.	2.
Plasma Physicist	1.	2.
Data Analyst	1.	2.
Aircraft Designer	1.	2.

Now, match your own background/opportunities to the careers highlighted.

Which background experiences of yours mirror any that you heard during the video? List two or three below.

Have you heard of any of the high school courses or training opportunities mentioned by any of the professionals as being available at your school? If yes, list them below.

If not, which courses or opportunities would you be interested in exploring further to see if they could be offered at your school or through an extension/partnership program?

List **two** careers from the Virtual Field Trip that are most interesting to you based on your background and the training opportunities available to you.

How do these careers increase the sustainability of national security and/or consumer air travel?

CAREER PROFILE RESEARCH

Directions: Conduct internet research to further explore a career that you learned about in the Virtual Field Trip. Record your notes below.

CAREER NAME	_____
Brief Description	
Training & Skills Required	
Salary Range	
Related Careers	
Current Job Openings, (If Available)	
Current Classes I am Taking that Impact this Career	
How this career matches my interests/skills/strengths	
Training opportunities I would need in the future to pursue this career	

SKUNK WORKS® INNOVATIONS 2030

Directions: Complete a Gallery Walk of the posters around the room and a brainstorm session with your fellow group members. Imagine and name your own Skunk Works® design of the future and describe the challenge your client faces, the approach, and the results of your plan.

Name: _____

Challenge: _____

Approach: _____

Results: _____

