National Aeronautics and Space Administration

X-Plane Glider

Engineering Design Challenge — Suggested Grades: 4-8

Activity Overview

In this activity, students will apply the engineering design process (EDP) to design an X-plane Glider that meets specific design criteria and constraints.

Steps

1. Prior to starting the activity prepare a flight zone for testing. Using tape clearly identify a flight zone with a specific starting point and flight distances (see Figure 1, page 1 for example).
2. Review with students the engineering design process and how NASA engineers use the engineering design process to solve problems (Figure 2, page 2).
3. Discuss the X-59 Quiet SuperSonic Technology (QueSST) aircraft and how NASA engineers design aircraft.
    a. Optional: Watch How Sound Travels and the X-59 to learn how NASA engineers purposefully designed the X-59 to reduce the sound of a sonic boom. https://youtu.be/IRUoL4SBIjM
4. Divide students into teams of 2-3 and assign job duties. Suggestions include, but are not limited to:
    a. Project Manager – Oversees the design, ensuring design parameters are followed; keeps track of time; coordinates decision-making.
    b. Lead Engineer – Leads the building of the devices, and works with the Test Engineer to achieve a quality build.
    c. Test Engineer – Takes measurements, assesses and tests devices for defects, notes any issues with first test and records any new measurements and adjustments made.
5. Review with students the list of Glider Criteria and Constraints. Remember to clearly define each constraint.
6. Have students discuss their glider design within their team. Teams will then sketch their design in the worksheet (page 3) labeling all materials they plan to use. Remind students to use the engineering design process and determined job duties.
7. Teams should receive NASA approval (educator approval) prior to building their designs.
8. Once ready teams should complete their first test (Trials 1-3), recording all data in the worksheet (page 3). Using this data teams should continue through the engineering design process, improving their design and retesting for test two (page 4, Trials 1-3).
9. Wrap-up the activity by asking teams to report out to the group their final results and answering the provided discussion questions (page 4). Engage the students in a discussion of how the engineering design process contributed to their glider designs and how this process contributes to NASA missions.

Time: 2 hours

Materials:

- Cardboard Tube 3.12” x 3.12” x 9.19” (ex. 5.2 oz Potato Chip Can)
- Assorted classroom supplies (ex. tissue paper, cardboard, balsa wood, etc.)
- Safety Goggles
- Meter Stick
- Scissors
- Tape or Glue
- Student Worksheet & Discussion Questions

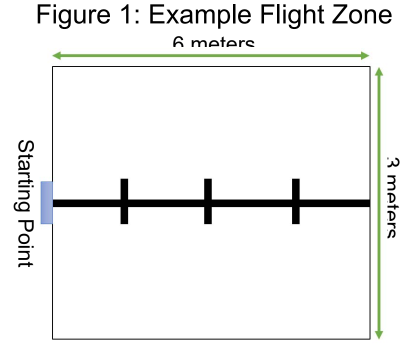
NEXT GENERATION SCIENCE STANDARDS

- 3-5-ETS1-1
- 3-5-ETS1-2
- 3-5-ETS1-3
- MS-ETS1-1
- MS-ETS1-2
- MS-ETS1-3
- MS-ETS1-4

For more information:

- www.nasa.gov/X59
- www.nasa.gov/stem/nextgenstem/aeronaut-x/
- www.nasa.gov/aeroresearch

Figure 1: Example Flight Zone



Glider Criteria

- The glider must move forward a minimum distance of 3 meters.
- The glider must remain intact upon landing.

Glider Constraints

- The glider must include an intact cardboard tube.
- The building and testing must occur within a teacher-set time limit.
- The glider may be constructed using only the provided materials.
- The glider must be no larger than 18" x 18".

X-59 Quiet SuperSonic Technology aircraft

What if you could fly a supersonic airplane that didn't produce loud sonic booms? What if, for those on the ground below, those sonic booms were quiet enough not to be an annoyance, or perhaps not heard at all?

That's what the X-59 is going to help find out.

Based on decades of research into supersonic flight that included work in wind tunnels, testing concepts on aircraft in flight, and using powerful supercomputers to run simulations, NASA's aeronautical innovators think they've come up with a solution.

By carefully designing the aircraft's shape and overall configuration, engineers have found a way to manipulate the shockwaves coming off an airplane flying supersonic so they don't produce sonic booms as intense as those the public is wary of.

It will be the X-59's job to validate those theories, and once that's done the airplane will go on the road, so to speak, and be flown over several U.S. communities (yet to be selected) so residents below can provide reactions to what they might or might not hear.

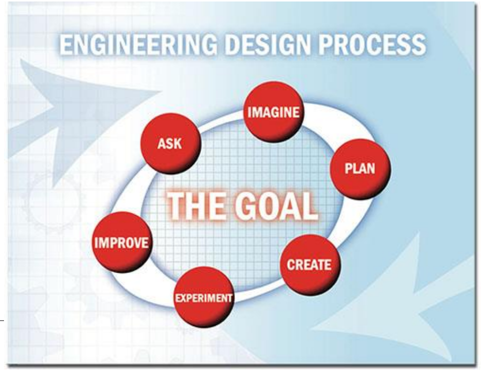
That data will then be passed on to the FAA and international regulators who, it is hoped, will use that information to help rewrite the rules so that supersonic flight over land is regulated based on noise levels and not the arbitrary speed of Mach 1.

When that happens, a major hurdle will be cleared for the nation's aviation community to move forward in establishing a new market for commercial supersonic flight over land, where people and packages can get to their destinations in half the time.

For more information, please visit the following website: https://www.nasa.gov/aero/nasa-supersonic-x59-quesst-coming-together-at-famed-factory

NASA's X-59 QueSST, an experimental piloted aircraft designed to fly faster than sound without producing sonic booms of previous supersonic aircraft.
Credits: Lockheed Martin

Figure 2: Engineering Design Process



Engineering Design Process

NASA engineers ask questions, imagine solutions, plan designs, create and test models, and then make improvements. These steps all contribute to mission success and can be described as follows:

- **ASK:** Students identify the problem, requirements that must be met, and constraints that must be considered.
- **IMAGINE:** Students brainstorm solutions and research ideas. They also identify what others have done.
- **PLAN:** Students choose two to three of the best ideas from their brainstormed list and sketch possible designs, ultimately choosing a single design to prototype.
- **CREATE:** Students build a working model, or prototype, that aligns with design requirements and that is within design constraints.
- **EXPERIMENT:** Students evaluate the solution through testing; they collect and analyze data; they summarize strengths and weaknesses of their design that were revealed during testing.
- **IMPROVE:** Based on the results of their tests, students make improvements on their design. They also identify changes they will make and justify their revisions.

For more information, please visit the following website: https://www.nasa.gov/audience/foreducators/best/edp.html

Connections

- What is a problem you have had to work through and find a solution? ex. organizing your backpack

National Aeronautics and Space Administration

X-Plane Glider

Worksheet

Student Name ______________________________ Team Name ______________________________

Job Duty ______________________________

Glider Criteria
- The glider must move forward a minimum distance of 3 meters.
- The glider must remain intact upon landing.

Glider Constraints
- The glider must include an intact cardboard tube.
- The building and testing must occur within __________.
- The glider may be constructed using only the provided materials.
- The glider must be no larger than 18" x 18".

Sketch

Pre-Experiment Observations: What parts of your design will make your prototype a success?

____

____

What parts of your design could hinder your prototype?

____

____

Test 1

Trial	Flight length (cm)	Observations
1		
2		
3		

Test 2 - Improved Design

Trial	Flight length (cm)	Observations
1		
2		
3		

Discussion Questions

1. **What two things can you take away from this experience that may be similar to what NASA engineers experience when faced with building the X-59?**

2. **What was the greatest challenge in building your glider?**

3. **What would you do differently if you had the chance?**

4. **Did your glider changes improve your design? Why, or why not?**