ADVANCED: FPG-9 BUILD AND FLY

DESCRIPTION OF SESSION

In this session, participants will more deeply explore the engineering considerations with different types of planes. They will consider engineering trade-offs with different airfoil shapes, different wing shapes, and different control surfaces and powered versus non-powered flight.

CATEGORY

- Exploring, Aviation
- U.S. Department of Education, Transportation

OBJECTIVES

By the end of this session, participants will be able to:

- Compare and contrast powered flight with non-powered flight.
- Discuss design decisions behind various wing shapes.
- Compare and contrast the FPG-9 glider and balsa wood model with real-life airplanes.

SUPPLIES

- Rubber band–powered balsa wood model plane kits

ADVISOR NOTE: Text in italics should be read aloud to participants. As you engage your post in activities each week, please include comments, discussions, and feedback to the group relating to **Character, Leadership,** and **Ethics**. These are important attributes that make a difference in the success of youth in the workplace and in life.

ACTIVITIES

Activity 1

Powered versus Non-Powered Flight

If possible, purchase a couple of balsa wood model plane kits from the Academy of Model Aeronautics (https://www.modelaircraft.org/shopama/dept.aspx?id=DA090A0104E24ABFA8C167BCE9633365). There is a balsa wood plane kit for under $10 (model 6110) that is a rubber band–powered propeller plane. (Model 6110 is the least expensive, but there are other rubber band–powered models on the site.) Have the participants assemble a few balsa wood models and compare the attributes of the FPG and a powered plane. Ask: *Which plane flies longer, the powered or the non-powered plane? Do you think the plane's material (Styrofoam versus balsa wood) makes a difference? How do you think these two factors (powered versus non-powered flight and construction material) translate into real-life considerations for airplane design?*

Activity 2

Airfoil Shape and Wing Design

Discuss why the FPG-9 plane can fly so well if it's not rounded like an airfoil. Ask: *Are there real-life planes with airfoils that are flat like the FPG-9? What are they?* (Real-life planes have very thin but not completely flat airfoils. The F-105 jet and century series jet both have thin airfoils.) Also, point out that if you push a barn door fast enough and with an appropriate angle of attack, it will generate some lift. It won't fly efficiently, but it will "fly" in that it is a controlled fall. Explain that there are two halves of the lift equation (lift and gravity/weight). Enough thrust will help lift overcome gravity, at least temporarily.

Discuss wing shape. NASA has a resource about wings titled “Foam Wings” at https://www.nasa.gov/aeroresearch/resources/museum-in-a-box. There are a number of other resources on the website that may interest your participants. NASA offers other educator resources at https://www.nasa.gov/audience/foreducators/index.html.

Activity 3
Weight and Balance
Ask: *What components of the FPG-9 are essential? Can it fly, for example, without the penny? Without the tail?* Discuss why. (The penny is needed for weight and balance. Weight at a height is potential energy. The penny provides control for the center of mass. It shifts the center of mass forward, which gives the plane speed and balances the tail. Without the tail, the plane would not fly straight.)

Activity 4
Control Surfaces
Explain that elevons are a combination of ailerons and elevator. Ask: *Are there real-life planes designed like that? What are the advantages or disadvantages of having two moving parts versus one?* (The B-2 stealth bomber is designed this way. It is more efficient because fewer surfaces means less drag, but it is also less stable. It’s like a teeter-totter. A wide but short plane has the forces close together so it’s more difficult to make fine adjustments in flight.)

Activity 5
Optional Review
If your group designed a plane in the aerodynamics activity, how does the FPG-9 compare with the one you created in aerodynamics that also has thrust? Which is faster? Why? Which seems more stable? Hold a race to find out.

ADVISOR NOTE
Some sample questions are below. They are designed to help the participants apply what they have learned to their own interests. You are welcome to use these questions or develop your own questions that relate to your post or specific focus area.

REFLECTION
- *Name two different engineering design considerations you learned about today. Describe the advantages and disadvantages of each.*

ADVISOR AND OFFICER REVIEW
After the meeting, address the following:
- Identify what was successful about the meeting.
- Identify what needed improvement.
- Schedule an officer and Advisor planning meeting to prepare for the next post meeting or activity.

Content for this session provided by Youth Aviation Adventure (http://www.youthaviationadventure.org/yaa/).

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