NASA Glenn Research Center
Engineering Design Challenge

EDC-02:
Let It Glide
Welcome NASA Engineer Trainees

Aerospace Engineer Chris Randall tests rocket parts and life support systems to ensure they work as planned.

Simulation System Engineer Debbie Martinez works on developing a general aviation flight simulation software.
Introductory Video

https://www.youtube.com/watch?v=ium3IS41Xqc
Let It Glide

The Challenge:

- The glider must include an intact shoebox that simulates a space for a scientific payload to carry instruments for in-flight research.
- The glider must show improvement in glide slope with a positive percent change over the course of the challenge.
- The glider must not break apart in flight or upon landing.

\[
\frac{\text{horizontal distance traveled}}{\text{vertical distance traveled}} = \text{glide slope}
\]
Let It Glide

• Students work in teams of four.
• Each team should choose a team name.
• One team member will act as lead in the following roles
  – Design engineer—sketches, outlines, patterns, or plans the ideas the team generates
  – Technical engineer—assembles, maintains, repairs, and modifies the structural components of the glider
  – Operations engineer—sets up and operates the glider to complete a test
  – Technical writer/Videographer—records and organizes information, data, and prepares documentation, via pictures and/or video to be reported and published
The Engineering Design Process

Step 1: Identify the Need or Problem

Step 2: Research the Need or Problem

Step 3: Develop Possible Solutions

Step 4: Select the Best Possible Solution(s)

Step 5: Construct a Prototype

Step 6: Test and Evaluate the Solution(s)

Step 7: Communicate the Solution(s)

Step 8: Redesign
Step 1: Identify the Need or Problem

- State the problem in your own words.

Example: “How can I design a __________ that will __________?”

- Determine what general scientific concepts you will need to consider before beginning to solve the problem.
Step 2: Research the Need or Problem

Examine how this problem is currently being solved or how similar problems are being solved.

STEP 2: Research the Need or Problem

Conduct research to answer the following questions related to the challenge. Write where you found your information on the lines labeled “Source(s).”

1. Who is currently working on this or a similar problem today? What solutions have they created or are working on currently?

   
   
   Source(s):

2. What questions would you ask an expert who is currently trying to solve problems like this one?

   
   
   Source(s):

3. Who in our society will benefit from this problem being solved? How could this relate to everyday use?

   
   
   Source(s):

4. What are some innovative options for using the materials that are available to solve this challenge?

   
   
   Source(s):
Step 2: Research the Need or Problem

Leamington, ON (Canada)
Catawba Island
Cedar Point
Cleveland
Step 2: Research the Need or Problem
What is similar about these planes?
What is different?
Step 2: Research the Need or Problem
Other Types of Aircraft: Historic Aircraft

- Wright Brothers
- Biplane
- Amphibious
- Twin-engine
- Delta-wing
Other Types of Aircraft: Unique Aircraft

- Blended-wing-body
- Military
- Unmanned aerial systems (Drones)
- High-altitude
- Solar-powered
Other Types of Aircraft: Gliders

- Hang glider
- Sailplane
- Toy glider
- Space shuttle
The Four Forces of Flight

- Lift
- Thrust
- Drag
- Weight
Step 3: Develop Possible Solutions

• Use your mathematic and scientific knowledge to brainstorm all the possible ways you can think of to create a glider.

• Quickly sketch your design, using labels and arrows to identify parts.
Step 4: Select the Best Possible Solution(s)

• Share your ideas with your team.
• Discuss strengths and weaknesses from each design
• Which design best solves the challenge? Are there parts from other designs that could improve that idea?
Step 5: Construct a Prototype

- Construct a model of the selected solution.
- What materials will be needed for each part of the assembly?
- Who will build each part?
Safety is priority #1.

• Safety goggles must be worn by anyone in the test flight area to prevent eye injury. “If it flies, protect your eyes.”

• Designs will be approved by your facilitator to prevent sharp or dangerous models.

• Keep areas cleaned up. Nothing on the floor or in the way. Report any dangerous situations immediately.

A NASA researcher wearing personal protective equipment (PPE) appropriate for his work in this lab at Kennedy Space Center; PPE should be selected to match the potential risks of the work to be done.
Step 6: Test and Evaluate the Solution(s)

• Test your team’s model.
  – Stand at the start line
  – Measure what height you are throwing the glider from.
  – Throw the glider.
  – Measure how far the glider flew.

• How well did it fly?
Step 7: Communicate the Solution(s)

• Record and share what your team learned about your design based on testing.
  – What worked?
  – What needs improvement?
• Talk with other teams to get ideas.
Step 8: Redesign

• What changes will your team make to your design to improve the glider?
• Does your new design still meet the criteria and constraints?
Debriefing Questions

• What were the greatest challenges for your team throughout this process?
• What strategies did your team use to overcome challenges?
• How did you use the Engineering Design Process to help with your design?
• What concerns must be considered in constructing a quality glider?
• What problems did you have to address while designing the glider?
• Would you like to be a pilot operating your glider on a scientific mission? Why or why not?
Lead-up Investigations

Investigation One - Exploring Glider Design
Investigation Two - Air Force Three
Investigation Three - Airfoil on a String
Exploring Glider Design

- As an aircraft moves through the air, it could deviate from straight-and-steady flight. When this occurs, the aircraft rotates around its **center of gravity**, the point where the weight of the aircraft is evenly dispersed and all sides are in balance.
- This rotation occurs in one or more dimensions at the same time:
  - Rotation around the horizontal (longitudinal) or x axis is called roll (clockwise or counterclockwise).
  - Rotation around the vertical or y axis is called yaw (left or right).
  - Rotation around the lateral or z axis is called pitch (up or down).

**Connection to Let it Glide:**
Determine how altering aircraft changes its aerodynamic properties and the way it flies.
Exploring Glider Design

In this activity you will:

- Assemble the glider as the glider kit instructs.
- Throw your glider three times as control flights.
- Make one adjustment to the glider:
  - Slide the wing significantly to the left or to the right.
  - Slide the horizontal stabilizer significantly to the left or to the right.
  - Remove the horizontal stabilizer.
  - Remove the vertical stabilizer.
  - Change the location of the weight at the nose.
  - Remove the weight at the nose.
- Predict how this adjustment will change how the glider flies.
- Throw your modified glider 3 times and record results.
Aircraft wings are often designed in the shape of an **airfoil** to improve lift by applying Bernoulli’s principle:

- Faster moving air, exerts less pressure than slower moving air.
- Airfoils apply this principle to help create lift by increasing the speed of air moving over the wing compared to air moving under the wing.

**Connection to Let it Glide:**
Determine how to generate lift by applying Bernoulli’s principle.
Air Force Three

In this activity you will:

• Conduct three different demonstrations to show Bernoulli’s principle in action.
  • *Tent with a straw* - Fold an index card in half to make a tent and place it on a desk. Blow under the tent through the straw.
  • *Two sheets of paper* - Hold one sheet of paper by the top edge in each hand. Position the sheets in front of your face with the side edges facing you. Space the sheets several centimeters apart and blow between them.
  • *Single sheet of paper* - Hold one sheet of paper by the top edge just under your bottom lip. Blow across the top of the paper.

• Predict what will happen before conducting each investigation.

• Observe and record what actually happened.

• Discuss all predictions and observations with other students.
An airplane wing can direct the air above and below based on the wing’s angle of attack. This is an example of Newton’s third law of motion:

- For every action, there is an equal and opposite reaction.
- Because the wing is symmetrical, Bernoulli’s principle would not create lift. In this case, the wing must be tilted at a positive angle of attack to push air downward, creating upward lift on the wing.

**Connection to Let it Glide:**
Determine how to generate lift by modifying angle of attack.
In this activity you will:
• Create the airfoil from the template provided and the instructions given.
• Slide the airfoil onto a string, holding the string at the top and bottom.
• Conduct the investigation with three angles of attack:
  • Place the wing level in front of the fan and observe and record results.
  • Tilt the wing upward by moving the top end of the string away from the fan. Observe and record results.
  • Tilt the wing downward by moving the bottom end of the string away from the fan. Observe and record results.