Designing a Paper Airplane

<table>
<thead>
<tr>
<th>Prep Time:</th>
<th>Lesson Time:</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 minutes</td>
<td>60 minutes</td>
</tr>
</tbody>
</table>

**Essential Questions:**
- What parts of an airplane are the most essential for long-term sustained flight?

**Objectives:**
- Students will be able to explain aspects of the engineering design process and determine what factors lead to sustained flight.

**Standards:**
- MS-PS3-5. Construct, use and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from an object.
- MS-ESS1-3. Analyze and interpret data to determine similarities and differences in findings.
- MS-ETS-1. Evaluate competing design solutions using a systemic process to determine how well they meet the criteria and constraints of the problem.
- CCSS.ELA-Literacy.RI.6.7: Integrate information presented in different media or formats (e.g., visually, quantitatively) as well as in words to develop a coherent understanding of a topic or issue.

**Lesson Prep:**
- Cue video so that it is ready to play.
- Print a copy of the 3,2,1 worksheet for each student.
- Print a copy of the airplane instructions sheets for each student group (1 A and 1 B).
- Set out the supplies for the airplane design challenge.

**Teacher Notes/Background:**
- Read through all lesson materials, including handouts, before the lesson begins.
- Students who need extra assistance can be paired during any portion of the lesson.
- Use an area in your building that has a lot of space to throw paper airplanes (hallway, gymnasium etc.)
- A key component of this lesson is the introduction of careers that utilize the concepts covered. This lesson best connects the design process to the Product Development Engineer: https://www.youtube.com/watch?v=ccYw_BK5eDY&feature=youtu.be
## Designing a Paper Airplane

| Engage (5 minutes) | “I have not failed. I’ve just found 10,000 ways that won’t work”  
-Thomas Edison  
  
Write the Edison quote on the board prior to class. Have students take 3-5 minutes to respond to what they think the quote means. Have a few students share their answers.  
  
Use a few open-ended questions to gauge student thoughts on the quote. Introduce the idea of the struggle behind inventing and creating something new. Ask them for examples of times when they have designed something from scratch and how hard it was to take an idea and execute on it. |
|---|---|
| Explore (10 minutes) | “We will watch a short video that talks about the design process behind airplanes and what it takes to get an airplane from idea to flight. In this video you will hear directly from a Product Development Engineer at an aerospace company as he describes his average day and how he got to where he is today.”  
  
Pass out the 3,2,1 worksheet before the video so students can complete it as they watch.  
  
Play the video. Give students a few minutes after the video to complete the worksheet.  
  
Have students share their 3,2,1 worksheet responses with a neighbor or small surrounding group. Circulate to check for understanding. |

### Materials:
- Notebook paper
- 3,2,1 worksheet
- Product Development Engineer Video
Designing a Paper Airplane

“You and your partner are going to try to build the next great paper airplane. However, only one of you will have the instructions and only one of you will be the builder. The person with the instructions is the only person who can read and see the instructions. The builder is the only one who can manipulate your airplane. You will sit back to back so that neither of you can see what the other person sees.”

Assign partners. If you prefer small groups, you can extend it to 3 students.

Have the group decide who will be the instructor(s) and who will be the builder(s).

Pass out A or B sets of instructions to each group of students, alternating between the two for groups that are close to one another.

Have students spend the next 5 to 10 minutes trying to build a paper airplane with the guided instructions. Students should sit back-to-back so the instructor cannot see what the builder is making and vice versa.

When time has expired, have students turn in their old set of instructions for a new version. If they had the A instructions, they should receive the B instructions (and vice versa). They should also switch roles (i.e., have students that were builders the first round become instructors in this round).

After 5 to 10 minutes in the other role, ask the following questions to the entire class about their experience:

- What were some of the biggest challenges they saw in this experiment?
- Was it easier or harder than you expected to give instructions?
- Was it easier or harder than you expected to receive instructions?
- If you could do it again, how would you improve?

Materials:
- Printer paper
- Paper Airplane assembly instructions – Type A
- Paper Airplane Assembly instructions Type B
Designing a Paper Airplane

**Elaborate (20 minutes)**

“Now that you have learned how hard it is to hear a design from someone else and build it, it’s time to learn about how hard it is to do both jobs, designing and building the airplane.”

Have students remain with their partners.

Give students the design challenge handout. After reading the instructions, students can begin drawing their design on the back of the page.

Students will design and build a paper airplane with the different materials that you have provided.

Walk around the room to check for student understanding throughout the design process. The design process should take approximately 10 minutes.

After the initial design and build, the class will compete against each other to see which airplane travels the farthest. Students will get 3 attempts and can record their longest attempt. After each toss, have a student use a measuring tape to measure the flight distance. Students can record their farthest distance on the board. After all teams have tested their planes, the team that has traveled the farthest wins the competition.

**Evaluate (5 minutes)**

Have students fill out a quick worksheet detailing the pros and cons of their design.

How they would improve it in the future or if they had more time? What other materials could you have added to make it fly farther?

**Materials:**
- Paper clips
- Printer paper
- Construction paper
- Rubber bands
- Design challenge worksheet
- Measuring Tape

**Extensions and Enrichment**

- If time allows, add additional contests to the competition. Example ideas include: most control during the flight process, which plane goes the fastest, what is the longest time the plane can stay afloat, etc.
- For additional complexity, assign a different monetary value to each of the different design materials and have students try to compete to build the best plane for the lowest amount of money.
Blindfolded Design Challenge

A

1) Take a piece of paper and fold it vertically.

2) Unfold the paper to create a crease.

3) One at a time, take the upper right-hand and left-hand corners and fold them toward the center crease. This should make the top of your piece of paper a point.

4) Fold the piece of paper vertically again, so the corner folds are on the inside. Be sure to press hard against the crease.

5) Flip the piece of paper onto one of its sides.

6) Fold one flap on the top down so that the straight edges line up. Press hard to create a crease.

7) Flip it over. Fold the other side of the paper from the top down to match the bottom. This should be exactly what you did in step 6.

8) Pull up the pieces of paper that you just folded down in steps 6 and 7, so they are at 90 degrees. You have now completed your design.
Blindfolded Design Challenge B

1) 
2) 
3) 
4) 
5) 
6) 
7) 
8) 
9)
Design Challenge

The Problem:

All cellphone towers have gone down, leaving people with the inability to text or call each other! Luckily, students open an ancient illustrated book known as a comic book and realize that writing your notes on paper, building it into a paper airplane, and throwing it can be used as a means of communication.

To communicate effectively, the paper airplane should travel as far as possible.

Your Job:

Armed with only printer paper, construction paper, paperclips, and rubber bands, you will need to design and manufacture a paper airplane that can travel as far as possible. The back of this page can be used as scratch paper and your design area. Draw where you plan to fold or cut the paper and label which materials you would like to use. You will need to show your teacher your initial design ideas before receiving your building materials.
Exit Ticket - Designing a Paper Airplane

1. How did your airplane do today in the design competition? If you had more time, what would you have done to improve your design?

2. Planes go through several stages of testing. Today, you only completed one test. Do you think additional testing would have helped to improve your results?

Name: ____________________________________________