

A Paper Airplane Experiment

Your class has been randomly divided into three groups of approximately equal size. Each group has been randomly assigned one of three paper airplane designs. Instructions for making each plane are provided below. Your instructor should provide you with the protocol for the experiment where you can see which of the planes you are to make. After each student has had a chance to construct his or her plane, you will line up in a randomly assigned throwing order at the front of the classroom. Each student will throw his or her assigned plane a single time in the assigned order. The distance of each flight will be recorded. Our goal is to determine if there is a difference in mean flight distance among the three designs. If a difference is found, we will of course want to describe the difference in as much detail as possible.

The *Dart* can be made as follows:

1. Fold an 8.5 by 11 inch sheet of paper in half lengthwise.
2. Unfold the paper and lay it down in front of you as if it were a book that you were reading.
3. Bring the upper left corner to the center fold line and make a fold at a 45° angle to the original fold.
4. Do the same with the upper right corner.
5. Now take the fold that you made in step 3, bring it in line with the original fold in the center of the sheet, and crease the paper.
6. Make the analogous fold on the right side of the paper.
7. Now refold the paper along the original fold made in step 1.
8. From the side, the folded paper should look almost like a right triangle. Fold the left side back along an imaginary line that runs from the top point of the triangle to around the center of the base.
9. Repeat step 8 using the right side of the paper.

The *Flyer* can be made as follows:

1. Fold an 8.5 by 11 inch sheet of paper in half lengthwise.
2. Lay the paper down in front of you as if it were a closed book whose cover you were examining.
3. Take the upper right corner of the “cover” and fold it back so that the top edge of the “cover” is in line with the left edge of the “book”. The fold that you are making should be at a 45° angle to the original fold.
4. Do the same to the “back cover” of the “book.”
5. Lay the “book” face up. Take the fold made in step 3 and fold it back so that the fold made in step 3 is in line with the original fold in the center of the paper.
6. Make the analogous fold on the other side.
7. Lay the “book” face up. Take the fold made in step 5 and fold it back so that the fold made in step 5 is in line with the original fold in the center of the paper.
8. Make the analogous fold on the other side.

The *Floater* can be made as follows:

1. Fold an 8.5 by 11 inch sheet of paper in half lengthwise.
2. Unfold the paper and lay it down in front of you as if it were a book that you were reading.
3. Bring the lower left corner up across the center fold toward the right edge of the paper. Make a fold that runs from the bottom center of the page to the left edge of the page about two inches below the top.
4. Bring the lower right corner up across the center fold toward the left edge of the paper. Make a fold that runs from the bottom center of the page to the right edge of the page about two inches below the top. Some of the paper from the lower right corner should overhang the fold made in step 3.
5. Fold the overhanging piece of paper from step 4 underneath your plane so that the overhanging piece is folded along the fold made in step 3.
6. Now take the bottom center point and fold it up to the center of the page near the point where the folded pieces from steps 3 and 4 cross.
7. Now refold again on the original fold made in step 1 (i.e., “close the book”).
8. Looking at the “front cover of the book” that should have a wide top and narrow bottom, fold the cover back parallel to the original fold made in step 1 at the middle of the bottom of the “cover.”
9. Make the analogous fold on the “back cover of the book.”
10. Your plane is almost done. You made the wings in the previous two steps. Relax those folds to about 90°.
11. Lay the plane on its top so that the original fold made in step 1 is pointing up at you. Each wing should have a point along its side near the back of the plane. Take one of these corners and fold it up so that the fold runs from the corner of the wing to approximately one inch beyond the point that you are folding. Relax the fold to about 90° after you have creased the paper.
12. Repeat step 11 with the other wing point so that both wings are similarly folded.

Discussion Questions

1. What are the experimental units in this experiment?
2. What are the treatments?
3. What is the point of having students throw in a random order?
4. We could have asked one student to throw all the planes in this experiment. Name one advantage of this strategy.
5. Suppose our goal is to determine which design to recommend to other graduate students who want to make and throw a paper airplane that will travel a long distance. Which experimental design is better, one thrower or many?
6. Can you describe an experimental design that would be better than the one that we used?