

Paper Airplane Flight

Question / Hypothesis

How do I maximize the distance a paper airplane will fly when thrown?

If you distribute the weight of the plane in the center of the plane, then it will increase the distance it flies.

The plane must glide on the air, and with the balance of the weight of the plane in the center, the plane should maintain balance on the air when it flies.

Safety Considerations

Use caution when throwing planes, so as not to hit someone.

Take care when folding the plane not to cut your fingers on the paper edges.

Procedure and Observations

Materials

- $8\frac{1}{2}$ " by 11" copy paper
- Paper clips
- Open indoor area for throwing
- measuring tape and ruler

Procedure

- 1) Fold a "dart" style plane with the $8\frac{1}{2}$ by 11" paper

Step 1



Step 2



Step 3



Step 4



Turn over

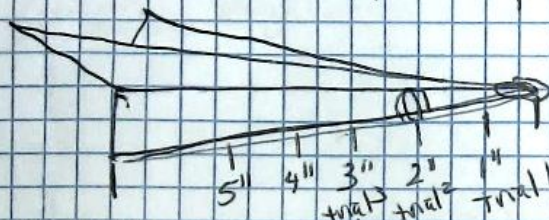
Step 5



Step 6

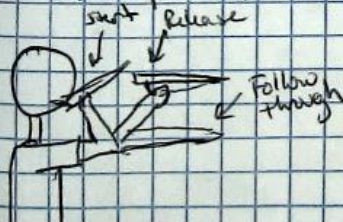


- 2) You will place two paper clips along the bottom of the plane at measured positions relative to the tip of the plane



- 3) Throw the plane and measure the distance it travels, changing the placement of the paper clip with each trial. Record 5 throws with each trial.

- 4) Be careful to throw the plane the same way each time, in the same place.



Observations

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- 1) The plane was folded using cardstock paper. The folding left the plane slightly front heavy as the density of the plane decreased as you moved front to back on the plane.

It might be useful to fold the plane in a different way and run the experiment again.

- 2) Two paperclips were attached to the plane and the added mass was slight.

Just like to try an object of more mass like a penny, and see if that changed the weight distribution more.

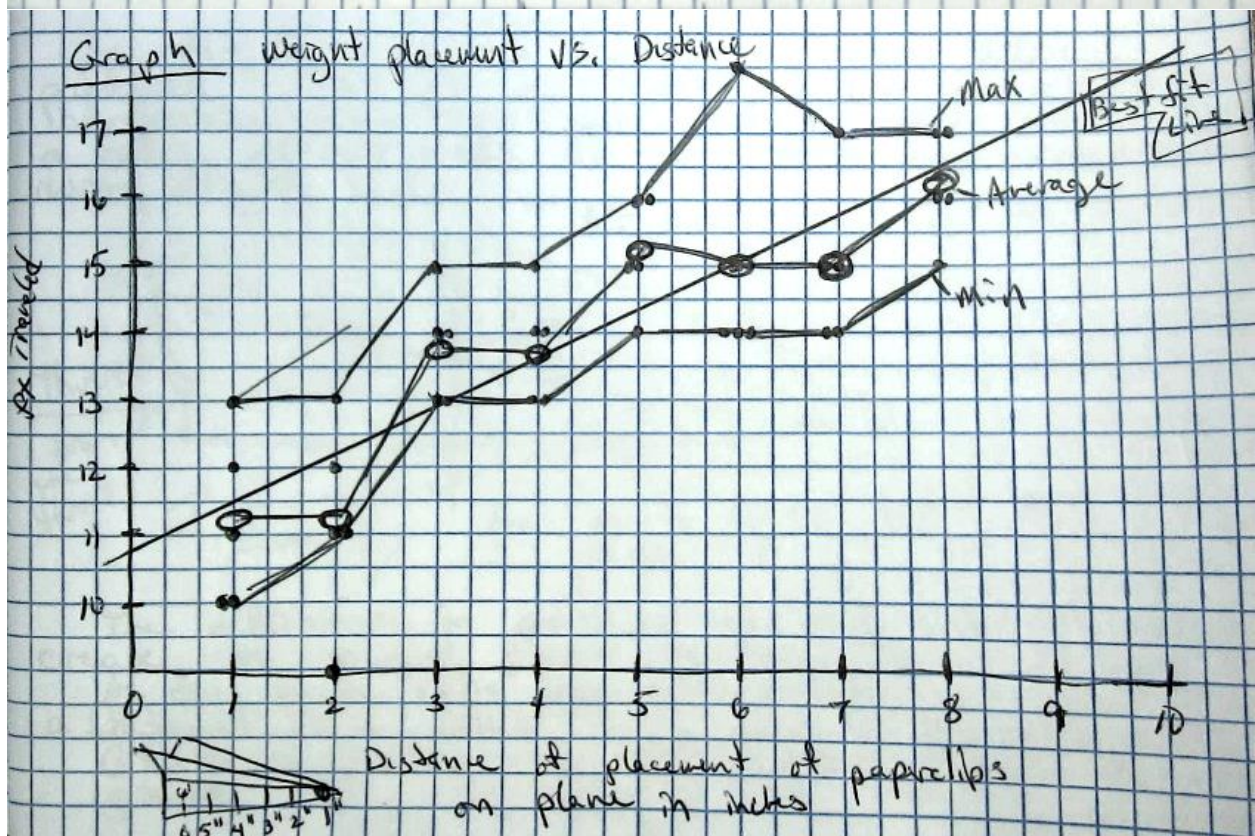
- 3) Throw was made in the hallway outside my class room. Occasionally the plane would curve in its flight, but generally the plane stayed level.

- 4) Throws were not perfectly consistent. Some felt like they were more smooth. Some throws were a little choppy. It would be interesting to create a throwing machine to even out and make throwing more consistent.

Data Table and Graph

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Placement of paper clip from tip in inches	Distance Thrown					Average
	1	2	3	4	5	
1"	12'	10'	11'	13'	10'	11.2'
2"	13'	12'	11'	11'	9'	11.2'
3"	13'	14'	13'	15'	14'	13.8
4"	13'	14'	13'	15'	14'	13.8
5"	15'	16'	15'	14'	16'	15.2
6"	14'	15'	14'	18'	14'	15.0
7"	17'	15'	14'	15'	14'	15.0
8"	16'	16'	15'	17'	17'	16.2



Claim

Additional. On a light heavy airplane, additional weight added near the back of the plane increased flight distance.

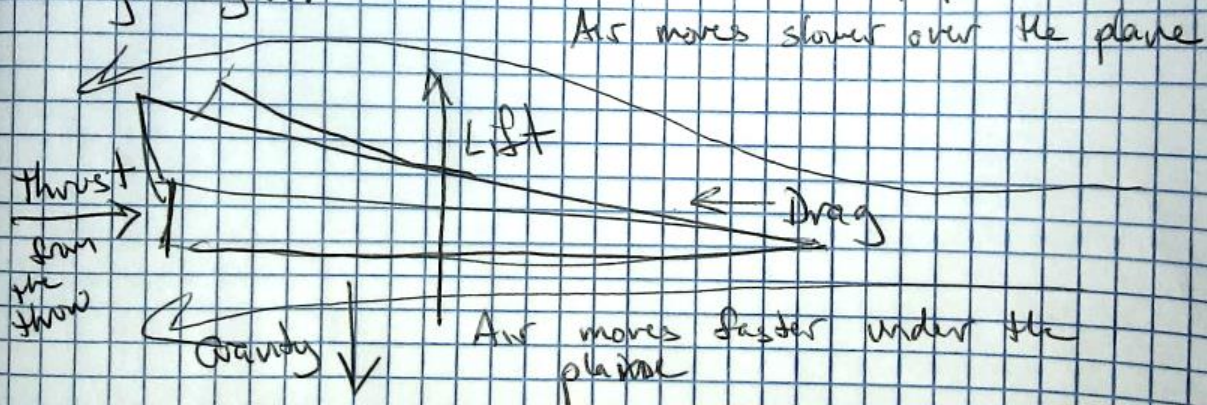
Analysis/Evidence

Trials with the paperclip placed 6, 7, and 8 inches from the tip of the plane, in the region near the back, resulted in an increase of flight distance of nearly three feet.

The plane used in testing was made from cardstock, and the addition of two paperclips was minimal compared to the overall mass of the plane. It may be necessary to increase the amount of weight placed on the plane to observe better evidence of the weights effect on the flight of the plane.

Reading & Reflection

According to an article provided by Science Buddies, published online at www.sciencebuddies.com/article/bring-science-home-paper-planes-drag/, there are a variety of ~~see~~ forces at play on a paper airplane during flight.



The difference in air speed over and under the plane create an upward force called lift. As the plane "rubs" against the air it creates a frictional force called drag, slowing the plane. Gravity is pulling the plane down toward the ground.

(5)
By changing the position of weight along the length of the plane, ~~the~~ it changed the way in which gravity affected the plane. The angle at which the plane cut through the air was also affected. It appears that by leveling the plane in the air, drag was minimized, and lift was improved, increasing the distance ~~with which~~ the plane flew.

It would be interesting to manipulate the shape of the plane to observe and measure how each force adjusts to each shape.

References

Soaring Science: Test Paper Planes with Different Drag (Scientific American Global RSS)

<http://www.scientificamerican.com/article/bring-science-home-paper-planes-drag/>