Final Project Data Summary
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Section 2

Design

Interest and Objective: In preparing this experiment, we were interested in the effect that both type of paper and size of paperclip has on the descent time of a paper helicopter. We thought that helicopters made with thinner paper may descend faster because of less air resistance. Likewise, we thought that helicopters made with bigger paper clips may descend faster because they weigh a little more.

Response Variable: Time to fall (Seconds)

Factors (with Factor Levels): Paper Type (Copy Paper and Lined Notebook Paper) and Paper Clip Size (1.75” and 1.375”)

Procedure

1. Obtain 10 pieces of copy paper, 10 pieces of lined college ruled paper, and 20 paper clips, 10 being 1.75” and the other 10 being 1.375”, and a pair of scissors to cut the paper.
2. Line up all 20 pieces of paper and hold them together using the paper clips. Using scissors, cut the copy paper to be the same size as the lined college ruled paper.
3. Create 20 paper helicopter replicates, 5 of each factor combination, by cutting (using scissors) a 5 inch vertical line starting from the midpoint on the top edge of the paper, creating the helicopters two wings. Next, cut two 2⅔ inch horizontal lines on each side of the paper starting 2 inches from the bottom, creating the helicopters tail parts. Finally, fold the two wings in opposite directions, and fold both tail parts in the same direction, placing the paper clip over the folded tail parts in the center. [See diagram below]
4. For each replicate, have the designated dropper hold the helicopter 9 feet in the air with no obstacles below it. The designated timekeeper should count “3,2,1,Go,” and on Go, the dropper lets go of the copter and the timekeeper starts the timer. The timekeeper should stop the timer as soon as no movement is observed anymore.
5. After stopping the timer, the timekeeper should tell the designated recorder the time observed on the timer. The recorder should record this time onto the check sheet.

Experimental Unit: The trial in which the helicopter is created and dropped.

Randomization Procedure: We used R to create a random run order with a seed set to “1234” for the experiments 1-20 without replacement.

Replicates: For each treatment combination of the two factors, we created 5 replicates for a total of 20 replicates. This replicate number was chosen because the library only allowed us to take

20 pieces of paper and we all didn't have money to buy copier paper. In addition, one paper helicopter took around 2 minutes to create, giving us 40 minutes to create our replicates and the remainder to run the experiment. The library didn't have any rooms available for more than two hours when we all could meet to set up and perform the experiment, and we wanted to drop the helicopters from the same place in the same room every time as different rooms with vents in different places could skew the data.

Controls: Helicopters were dropped from the same place and by the same person in each trial. Each task (cutting, folding, paper clipping, timing, recording, dropping) was performed by the same team member for every trial (e.g. Cory folded the helicopters that Jacob cut).

Perform the Experiment

The experiment was performed at 5:30 on 11/13/18. Jacob cut each of the papers using the procedural guidelines found above. Cory folded each of the papers using the same method for all 20 helicopters. Before each trial, Sam clipped the tails together. Each helicopter took between 60 and 90 seconds to complete. Sam would pass the completed helicopters to Cory, who would then drop them from the ceiling. Cory would place the back of his hand in the same spot on the ceiling and drop them on “3, 2, 1, go”. Jacob timed all 20 trials. Sam recorded the results. Jacob cleared the trial from the floor -- so that Cory would not have to climb on and off the table -- and passed the paper clip back to Sam. It took ten minutes to complete and record all 20 trials.

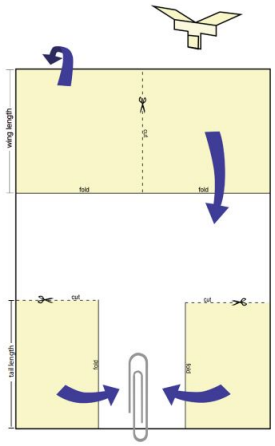
Safety:

Cory used a chair to step up onto the table, and made sure the table was heavy enough to support him without flipping.

Materials:

-10 pieces of copy paper
-10 pieces of college ruled notebook paper
-10 1.375” paper clips (metal)
-10 .1.75” paper clips (metal)
-1 pair of scissors for cutting

Diagram:



Group Photo:

Experiment Results

See Appendix *Table 1: Check Sheet* for the experiment results.

Summary Statistics

Helicopter Summary Statistics

Material	Paper Clip Size	Mean Time (seconds)	Std Deviation (seconds)	Number of Replicates
Copier	Big	1.728	0.061	5
Notebook	Big	1.796	0.138	5
Copier	Small	1.924	0.413	5
Notebook	Small	2.002	0.253	5

Appendix

Table 1: Check Sheet

Run	Experiment	Factor Level 1: Paper Type	Factor Level 2: Paper Clip Size	Time (seconds)
1	3	Copier	Small	2.62
2	12	Notebook	Small	2.10
3	11	Notebook	Small	1.98
4	18	Notebook	Big	1.86
5	14	Notebook	Small	2.24
6	10	Copier	Big	1.79
7	1	Copier	Small	1.64
8	4	Copier	Small	1.65
9	8	Copier	Big	1.72
10	6	Copier	Big	1.71
11	7	Copier	Big	1.64
12	5	Copier	Small	1.98
13	20	Notebook	Big	1.84
14	15	Notebook	Small	2.11
15	2	Copier	Small	1.73
16	9	Copier	Big	1.78
17	17	Notebook	Big	1.65
18	16	Notebook	Big	1.97
19	19	Notebook	Big	1.66
20	13	Notebook	Small	1.58