Paper Airplanes

Nathan Bresette and Samuel Park

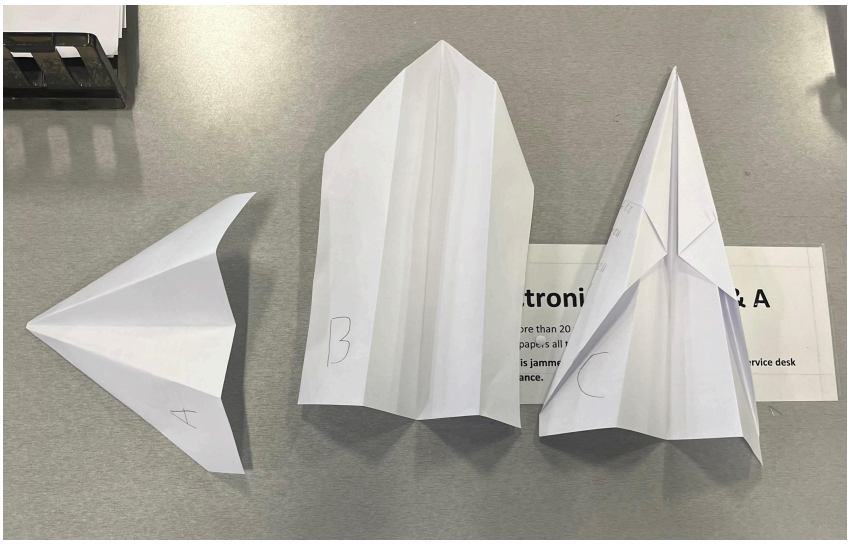
Stat 330

Dr. DeCock

May 2, 2023

Project Description

For this experiment, there will be three paper airplanes with different designs but the same type of paper. They will be thrown by the same person (Sam) in an open room with no barriers or wind to affect the paper airplane. The three paper airplanes will be thrown six times each and the vertical distance will be recorded. The explanatory variable will be the paper airplane and the response will be the distance traveled in inches. The distance will be measured and recorded (Nathan) by using a tape measure from the point of release to the end spot of the paper airplane.



(Airplanes in order from A to C)

Randomization

The “ideal” randomization is a machine that throws the paper airplane every time with the same force, angle, and exact spot of release. There are zero wind currents and no outside variables. Because this experiment is not crucial to have the most accurate results, there were some confounding variables. The actual randomization is that Sam throws the paper airplane every time with similar force, angle, and release point but it can not be the exact same every throw. There could be small wind currents due to the vents inside the room. This will cause some

errors on every throw because Sam is not a machine. There could be some wind currents that have a slight effect on the airplane. It is not a major problem but will cause some slight errors.

Data

The table below shows the data for the three planes A, B, and C of the distance traveled in inches on each throw.

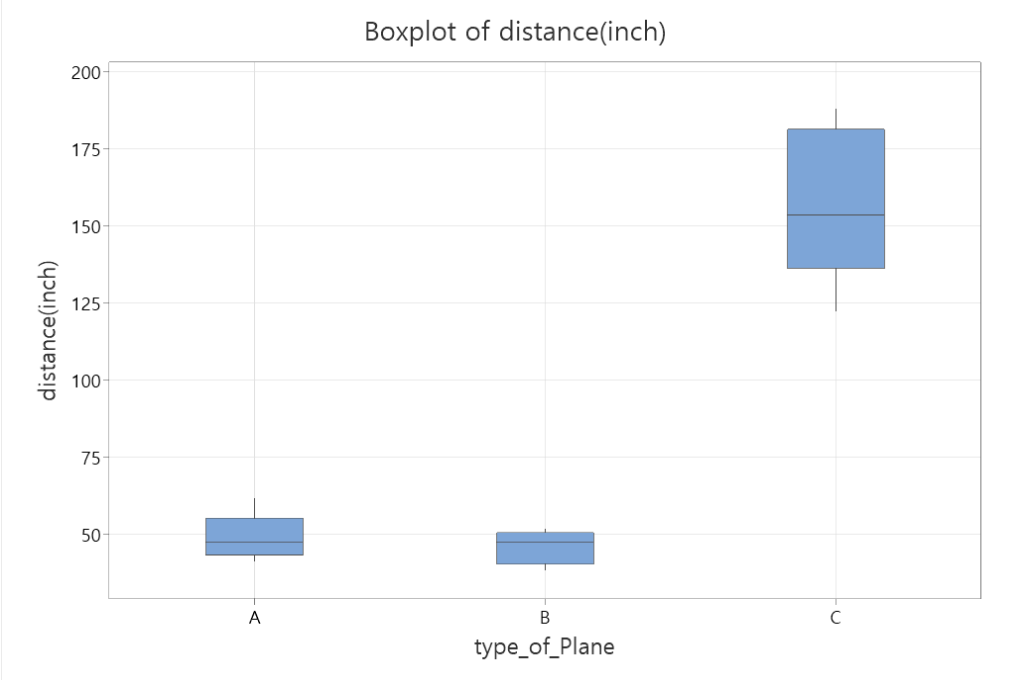
Plane A	Plane B	Plane C
41	45	122
62	50	144
47	38	141
48	41	188
53	52	163
49	50	179

Results

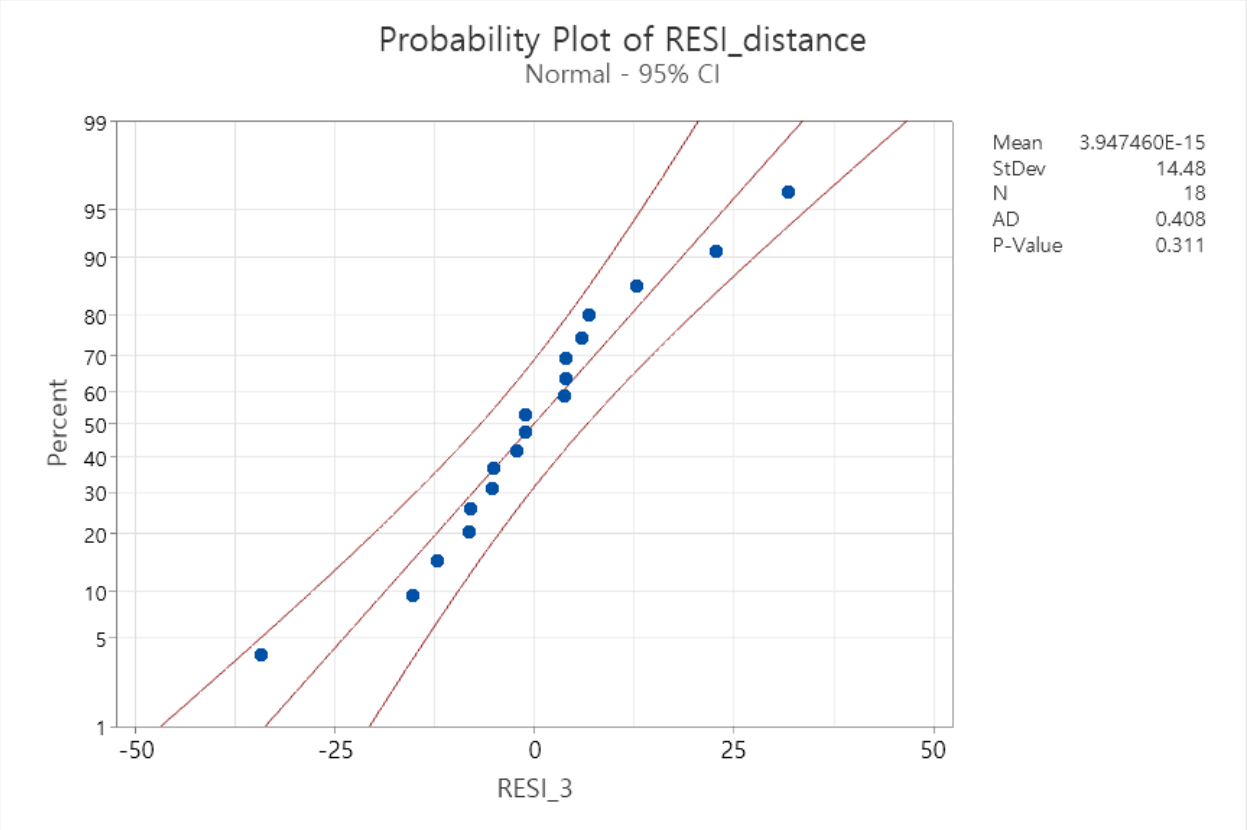
With the data collected, we are now able to analyze our results. Looking at the table of basic statistics below, there is a substantial difference in the mean and standard deviation between plane C compared to A and B. From this table, we are also able to calculate a 95% confidence interval for the means.

Basic Statistics				
Type of Plane	**N**	**Mean**	**StDev**	**95% CI**
A	6	49.17	7.47	(35.75, 62.58)
B	6	46.00	5.62	(32.59, 59.41)
C	6	156.2	25.0	(142.8, 169.6)

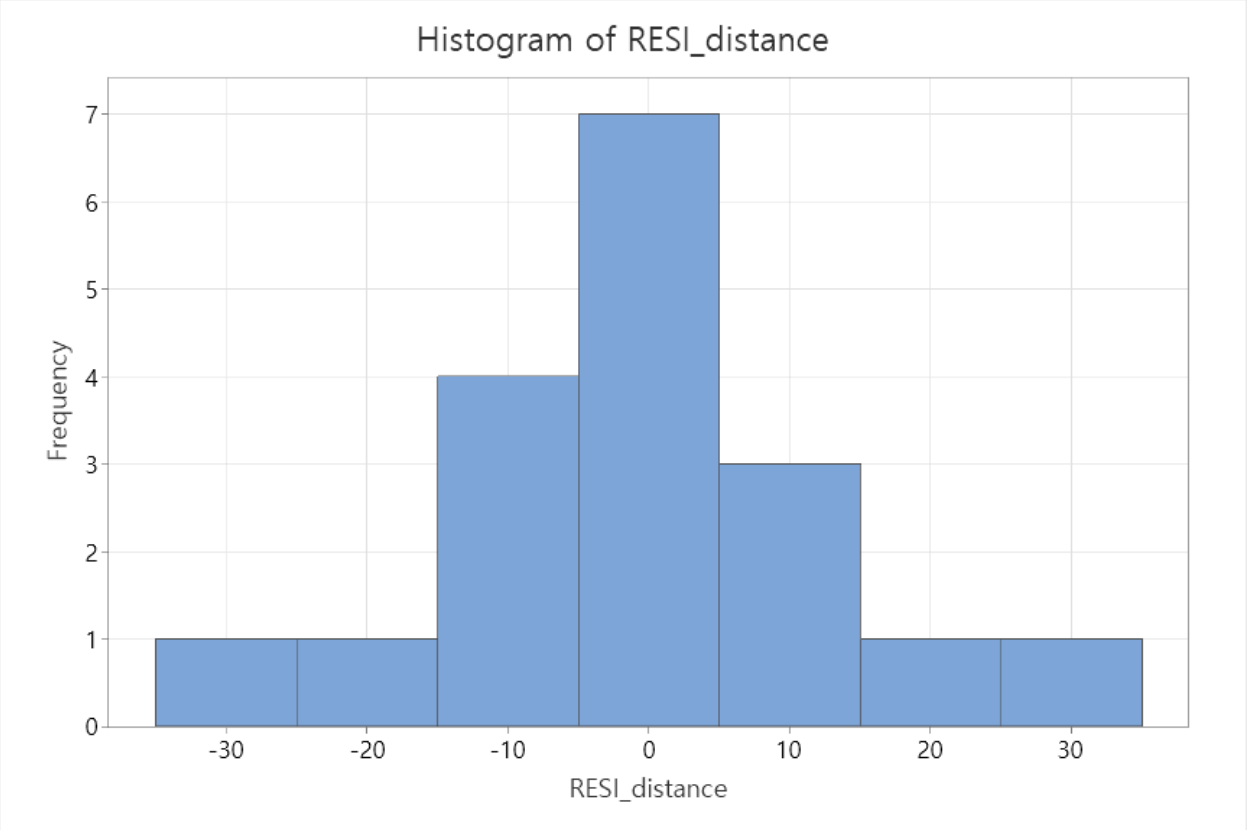
Below is a box plot for visualization to show how drastic the difference is in means between plane C compared to A and B.



Before running any tests, the assumptions must be checked by an Anderson Darling Test for normality. The Ho is the errors are normal and the Ha is the errors are not normal. The test is performed below by plotting the residuals on a normal probability plot. The results are an AD of .408 and a p-value of .311. Because the p-value is greater than .05, we fail to reject the null hypothesis so there is insufficient evidence that errors are not normal. The plot and numbers of the AD and p-value are directly below.

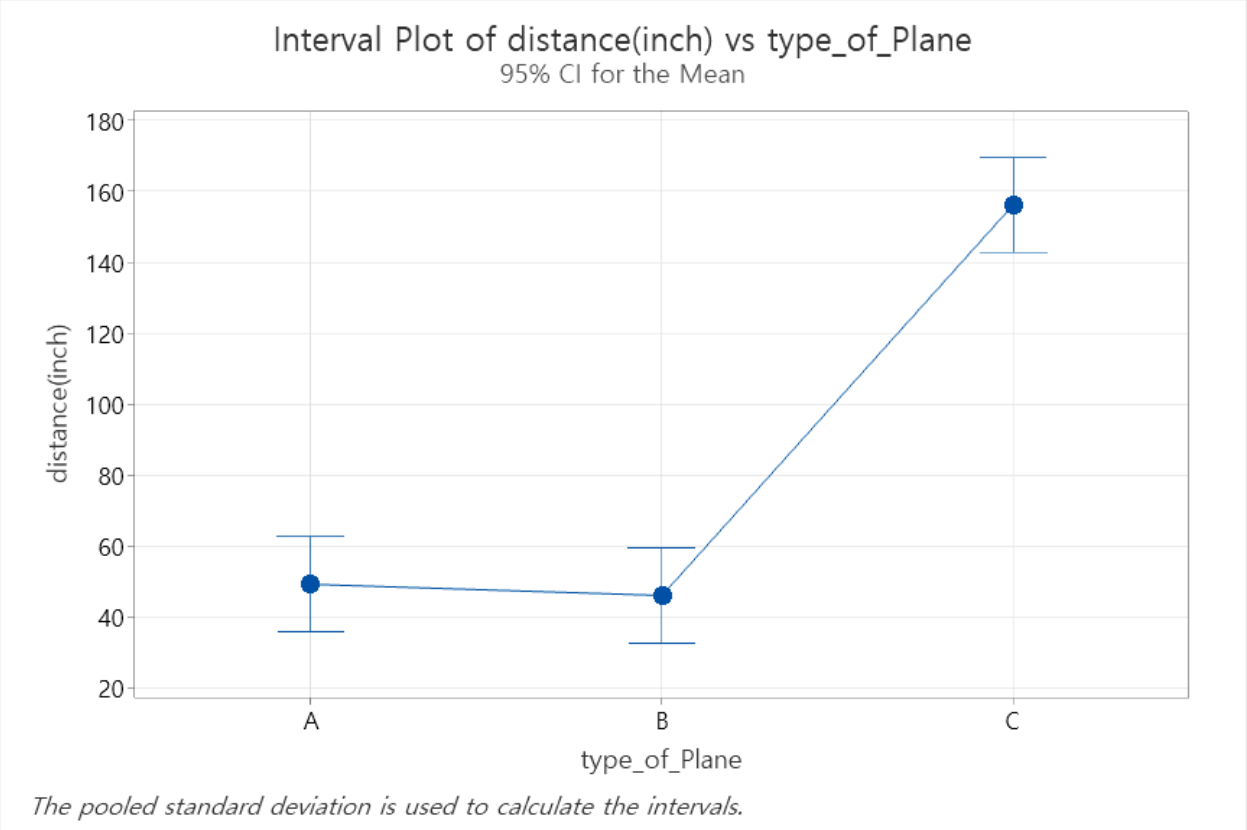


We also made a histogram to see how the distribution of the residuals looks. The residuals look normal and the shape of the graph almost looks like a bell curve. The image of the histogram is attached below.



After checking the assumption that the errors are normal, it is now appropriate to run a one-way ANOVA. The table below shows the ANOVA.

Analysis of Variance				
Source	**DF**	**Adj SS**	**Adj MS**	**F-value**
Type of plane	2	47191	23595.7	99.32
Error	15	3564	237.6	
Total	17	50755		



Utilizing the ANOVA table, there can be a test checking if all means are equal.

Test	Factor Information
Null hypothesis: H_0: All means are equal Alternative hypothesis: H_1: Not all means are equal Significance level: $\alpha = 0.05$ RR: $F > 3.68$ F-value: **99.32**	Factor levels: 3 Values: A, B, and C (Plane designs are different)

From the ANOVA table, the F test statistic of 99.32 is calculated. Our rejection region is an F test statistic greater than 3.68 (F.05,2,15). Because 99.32 is greater than 3.68, we reject the

null hypothesis that all means are equal. There is significant evidence that at least one of the means is different.

Conclusion

For this experiment, it is calculated through an ANOVA test that at least one of the means is different. Before running the ANOVA, it was pretty clear that plane C was going to be different from A and B but this proved it statistically.