Final Project Analysis
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Model Specification

The model for the experiment is BF[2], which is defined by $y_{ijk} = \mu + \alpha_i + \beta_j + \gamma_{ij} + \varepsilon_{ijk}$, where y_{ijk} is the response for the k^{th} replicate of the i^{th} level of factor A (Paper type) and the j^{th} level of factor B (Paperclip size), μ is the grand mean of response, α_i is the treatment effect for the i^{th} level of factor A (Paper type), β_j is the treatment effect for the j^{th} level of factor B (Paperclip size), γ_{ij} is the interaction effect for the i^{th} level of factor A (Paper type), and the j^{th} level of factor B (Paperclip size), ε_{ijk} is the error the the k^{th} replicate of the i^{th} level of factor A (Paper type) and the j^{th} level of factor B (Paperclip size). In this model, $i \epsilon I$ and $I = \{1, 2\} = \{\text{Copier, Notebook}\}$ = indexes the level for factor A (Paper Type), $j \epsilon J$ and $J = \{1, 2\} = \{1.375", 1.75"\}$ = indexes the level for factor B (Paperclip Size), $k \epsilon K$ and $K = \{1, 2, 3, 4, 5\}$ = indexes the replicates of factor level i and j.

This model is appropriate since we are dealing with two different factors (Paper Type, Paperclip Size) and there wasn't a need to block.

From this model, we have three sets of hypotheses to test, seen in the following exhibits:

1. **Exhibit 1.** Paper Type Treatment Effect Hypotheses

   H_0: $\alpha_1 = \alpha_2 = 0$
   H_a: Some $\alpha_i \neq 0$ for some $i \epsilon I$

2. **Exhibit 2.** Paperclip Size Treatment Effect Hypotheses

   H_0: $\beta_1 = \beta_2 = 0$
   H_a: Some $\beta_j \neq 0$ for some $j \epsilon J$

3. **Exhibit 3.** Paper Type – Paperclip Size Interaction Effect Hypotheses

   H_0: $\gamma_{11} = \gamma_{12} = \ldots = 0$
   H_a: Some $\gamma_{ij} \neq 0$ for some $i \epsilon I$, $j \epsilon J$

ANOVA Table

Table 1. ANOVA Table for Helicopter Drop Time

Source	Df	SS	MS	F–Value	P–Value
Paper Type	1	0.0267	0.0267	0.4146	0.5288
Paperclip Size	1	0.2020	0.2020	3.1434	0.0953
Interaction	1	0.0001	0.0001	0.0019	0.9654
Residual	16	1.0282	0.0643		

Inference

From our ANOVA table (see Table 1 above), we can see that none of the effects have statistical significance, with the lowest P–value being 0.0953 (corresponding to the main effect of Paperclip Size factor) and our highest P–value being 0.9654 (corresponding to the interaction effect between the two factors). With that known, we can accept our three null hypotheses and conclude that

1. There is no treatment effect for any level of the Paper Type factor.
2. There is no treatment effect for any level of the Paperclip Size factor.
3. There is no interaction effect between any level of Paper Type factor and any level of Paperclip Size factor.

Assumptions

As seen below in Figure 1, our index plot has no visible pattern, so we can assume our residuals are independent. We can assume that the residuals are normal since the normal QQ plot (seen in Figure 2) is straight except for the last point that is much higher than the rest of the data points. The mean of the residuals is zero. Our constant variance assumption is not met since our standard deviation ratio isn't satisfied ($\frac{0.41}{0.06} = 6.83 > 2$). Some causes of this could be timing errors, or random chance.

Figure 1. Index Plot for Helicopter Experiment

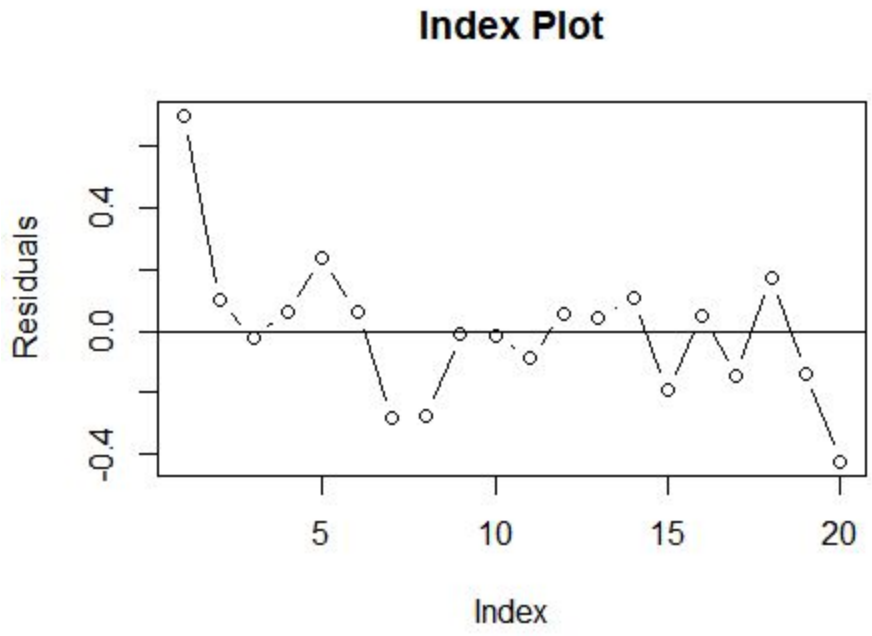

Figure 2. Normal QQ Plot for Helicopter Experiment