

**IE 361 Lab#10/ Two-Way Analysis of a Paper Helicopter Experiment**

(Name) \_\_\_\_\_

Below are some data collected by one team in the helicopter study of Lab #9. This lab consists of making a two-way analysis of these data. Recall that in Lab #9 we called the helicopter designs Type 1,2,3, and 4 according to:

- Type 1 -- "regular tail" and 1 paper clip
- Type 2 -- "regular tail" and 2 paper clips
- Type 3 -- "short tail" and 1 paper clip
- Type 4 -- "short tail" and 2 paper clips

Type	y's			$\bar{y}$	s
1	1.66	1.63	1.59	1.627	.0351
2	1.42	1.40	1.45	1.423	.0252
3	1.64	1.62	1.58	1.613	.0306
4	1.35	1.40	1.36	1.370	.0265

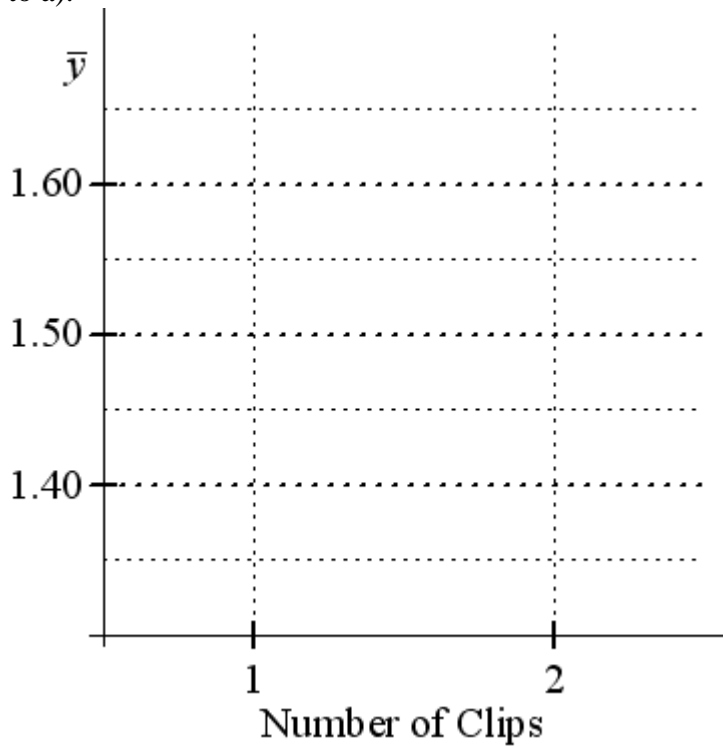
and it is possible to verify that for these data  $s_{pooled} = .0296$  sec .

Reorganize the 4 sample means into the table below and fill in the row, column, and grand averages of these sample means.

		Number of Clips		
		1	2	
Tail	Regular	$\bar{y}_{11} =$	$\bar{y}_{12} =$	$\bar{y}_{.1} =$
	Short	$\bar{y}_{21} =$	$\bar{y}_{22} =$	$\bar{y}_{.2} =$
		$\bar{y}_{.1} =$	$\bar{y}_{.2} =$	$\bar{y}_{..} =$

a) What is a "margin of error" for each sample mean based on 95% two-sided confidence limits for the corresponding design type mean flight times? (Note that  $n - r = 12 - 4 = 8$ .)

b) Make an interaction plot for these means and enhance it with "error bars" based on your answer to a).



c) Based on your graph above, do you expect "Tail" main effects to be statistically detectable? What about "Number of Clips" main effects? What about "Tail × Number of Clips" interactions? Explain.

d) Compute the fitted effects  $a_1, a_2, b_1, b_2, ab_{11}, ab_{12}, ab_{21},$  and  $ab_{22}$  from the means in the 2<sup>nd</sup> table on page 1 using the formulas in Section 6.2.

e) Interpret the magnitudes and signs of  $a_2$  and  $b_2$ . What does the magnitude of  $ab_{22}$  relative to those of  $a_2$  and  $b_2$  indicate about the plot in part b)?

f) Use formula (6.25) and Table 6.5 of *SQAME* to make 95% confidence limits for the main effect of short tails.

g) Use formula (6.25) and Table 6.5 of *SQAME* to make 95% confidence limits for the main effect of 2 clips.

h) Use formula (6.25) and Table 6.5 of *SQAME* to make 95% confidence limits for the interaction effect of short tails with 2 clips.

i) By the standards of the confidence limits in f), g) and h), which  $2^2$  factorial effects are statistically detectable?

Since the two factors "Tail" and "Number of Clips" each have only two levels, one can apply the methods of Section 6.3 to analyze the data on page 1. (If one or the other had more than 2 levels, the methods of Section 6.2 would still apply.)

j) Use the Yates algorithm to compute  $\bar{y}_{..}$ ,  $a_2$ ,  $b_2$ , and  $ab_{22}$ .

k) Use the limits (6.31) of *SQAME* and 95% confidence to produce the margin of error to associate with any fitted effect and compare it to the plus or minus parts of your answers to f), g) and h).