

SOLUTIONS FOR HOMEWORK 2

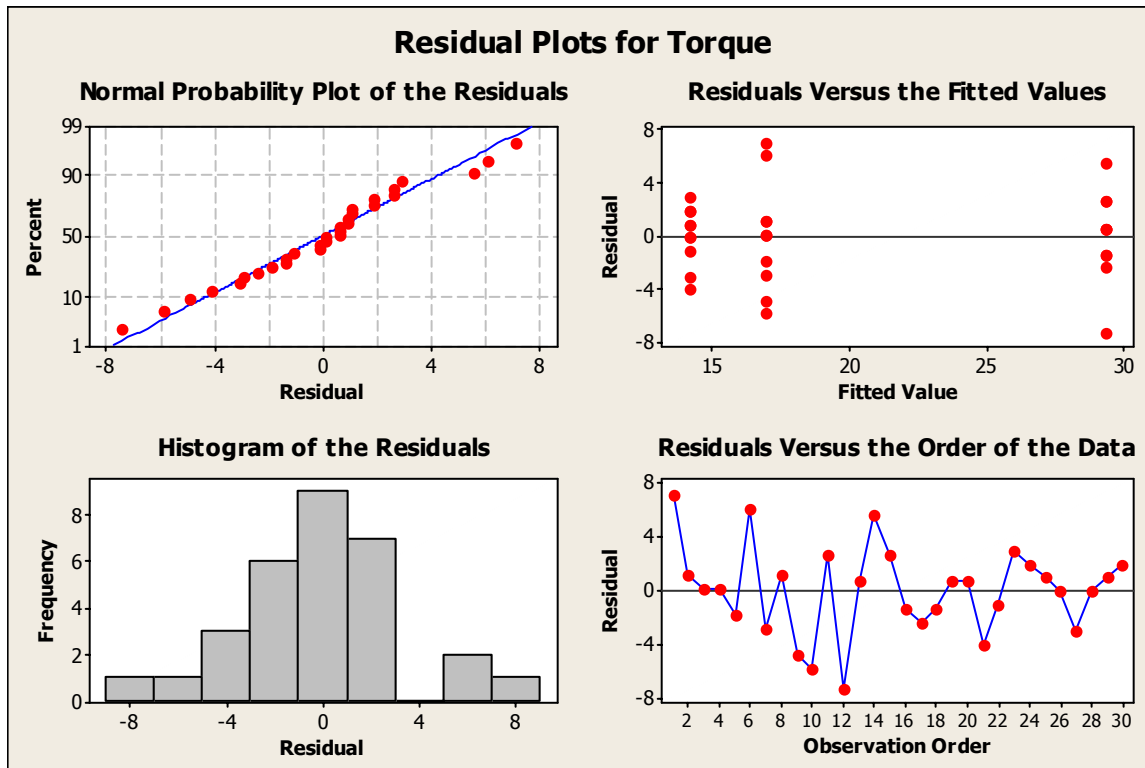
1. The variances appear to be equal, however it seems that the residuals for machine two are mostly negative and different from the other two. Conclusions are:

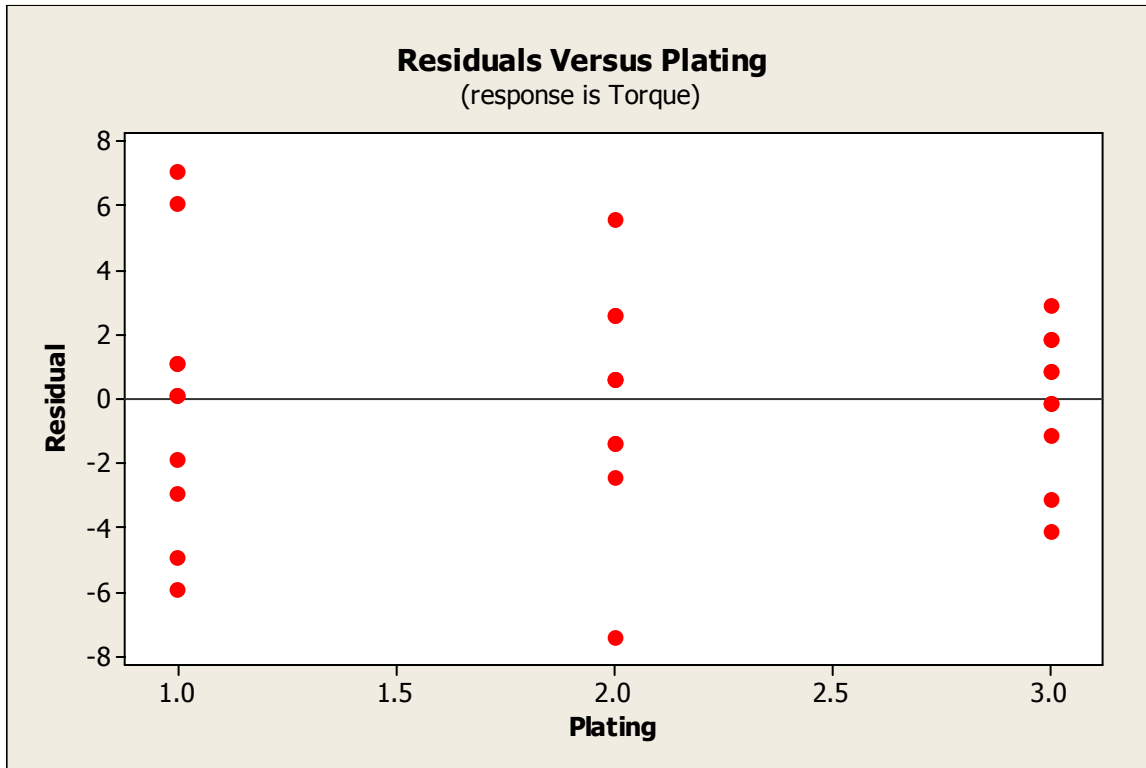
- i. The choice of machines as replicates is incorrect (note that replication means repetition of the basic experiment under identical conditions).
- ii. Thus, machine should be treated as another factor, and it seems that a one-way layout is not adequate; one needs a two-factor model (treatment + machine) in this case; in fact the same data can be analyzed as that from a randomized block design (RBD) with machine as block (Chapter 2).

2. One-way ANOVA: Torque versus Plating

Source	DF	SS	MS	F	P
Plating	2	1327.3	663.6	56.67	0.000
Error	27	316.2	11.7		
Total	29	1643.5			

S = 3.422 R-Sq = 80.76% R-Sq(adj) = 79.34%





There are gross violations of assumptions, based on residual analysis:

1. Systematic decreasing pattern for the first ten observations (residuals versus order of data).
2. Unequal residual variance across treatments.

The Tukey critical value at the .05 level is 2.479418. The observed multiple comparison t-statistics are:

CW-HT	CW-PO	HT-PO
-8.17	1.83	10.00

So method HT is significantly different than the other two methods.

3.

ANOVA	df	SS	MS	F
Treatment	3	281376	93792	0.6751
Residual	68	9447325	138931.3	
Total	71	9728701		

The F-critical value is 2.76 (approx) at 5% level. Therefore there is no significant difference between the treatments.

It appears as though there is unequal variance since the standard deviation for the treatment ‘grapefruit trees without oscillator’ is much higher than the other groups. However, the difference in variation doesn’t seem to be explained by the difference among means; in other words, treatment-wise residual variance is not proportional to the mean.

4. The following are the MINITAB outputs:

ANOVA: Plant1 versus M/C

Factor	Type	Levels	Values
M/C	random	3	1, 2, 3

Analysis of Variance for Plant1

Source	DF	SS	MS	F	P
M/C	2	31.652	15.826	59.51	0.000
Error	57	15.159	0.266		
Total	59	46.812			

S = 0.515703 R-Sq = 67.62% R-Sq(adj) = 66.48%

Source	Variance component	Error term	Expected Mean Square for Each Term (using unrestricted model)
1 M/C	0.7780	2	(2) + 20 (1)
2 Error	0.2659		(2)

ANOVA: Plant2 versus M/C

Factor	Type	Levels	Values
M/C	random	3	1, 2, 3

Analysis of Variance for Plant2

Source	DF	SS	MS	F	P
M/C	2	0.02534	0.01267	0.15	0.860
Error	57	4.77847	0.08383		
Total	59	4.80382			

S = 0.289539 R-Sq = 0.53% R-Sq(adj) = 0.00%

Source	Variance component	Error term	Expected Mean Square for Each Term (using unrestricted model)

1	M/C	-0.00356	2	(2) + 20	(1)
2	Error	0.08383		(2)	

Physical interpretations:

- i. Machine-to-machine variation is significantly high for the old plant; but almost negligible for the new plant.
- ii. Within machines variations (s^2) are much less in the new plant as compared to the old plant. Thus, the machines of the new plant are definitely better as they produce much more consistent output.

95% confidence intervals for the mean weight of bags filled in plant 1:

$$\hat{\eta} \pm t_{k-1, \alpha/2} (\text{MST}/nk)^{1/2} = 50.102 \pm t_{2, 0.025} (15.826/20 \times 3)^{1/2} = [47.892, 52.312]$$

95% confidence intervals for the mean weight of bags filled in plant 2:

$$\hat{\eta} \pm t_{k-1, \alpha/2} (\text{MST}/nk)^{1/2} = 49.842 \pm t_{2, 0.025} (0.0082/20 \times 3)^{1/2} = [49.842, 49.942]$$