Data File Used in this Analysis:

```
# Math 3080 - 1         Cleaning Data   March 11, 2010
#
# from Navidi, "Statistics for Engineers and Scientists, 2nd. ed,"
# (McGraw Hill, 2008)
#
# An experiment measured the effect of two factors on the ability of
# a cleaning solution to remove oil from cloth.
# Soap = concentration (Pct. by weight)
# LauricAcid = fraction (pct in solution)
# PctRemoved = percentage of oil removed (response variable)
#
# each combination was replicated twice.
# Estimate the main effects and the interactions. Construct the ANOVA table.
# Is the additive model plausible? Can the effect of soap concentration on the
# amount of oil removed be described by interpreting the main effects? can the
# effect of lauric acid fraction on the amount of oil removed be described by
# interpreting the main effects of lauric acid fraction?
#
"Soap"   "LauricAcid"   "PctRemoved"
15   10   52.8
15   10   54
15   30   57.8
15   30   53.3
25   10   56.4
25   10   58.4
25   30   42.7
25   30   45.1
```

R Session:

```
R version 2.10.1 (2009-12-14)
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  Natural language support but running in an English locale

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Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
```
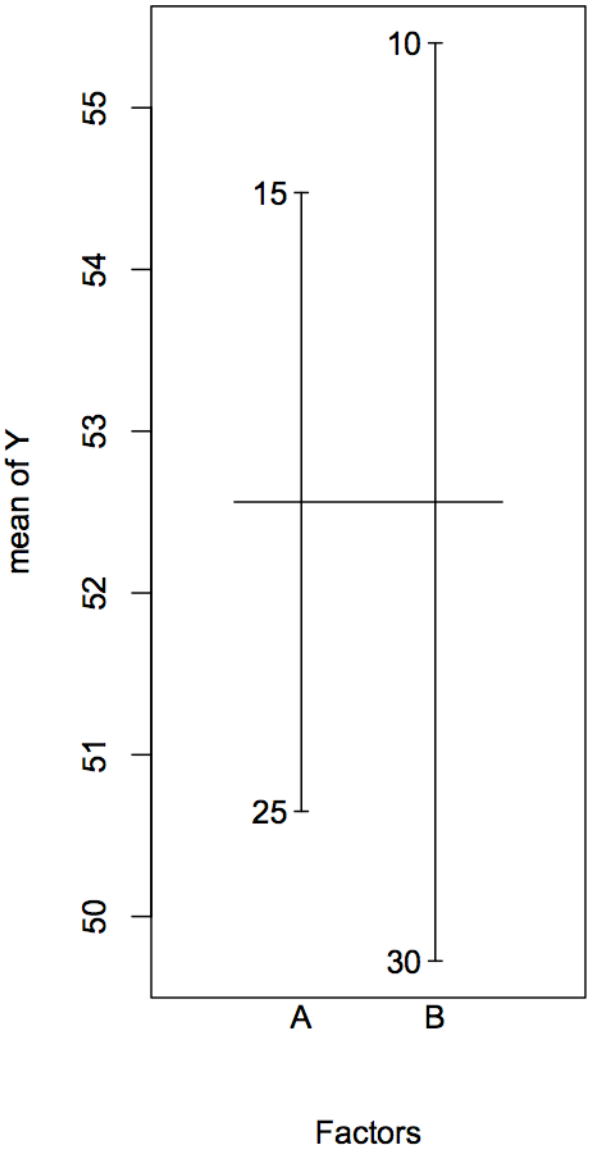
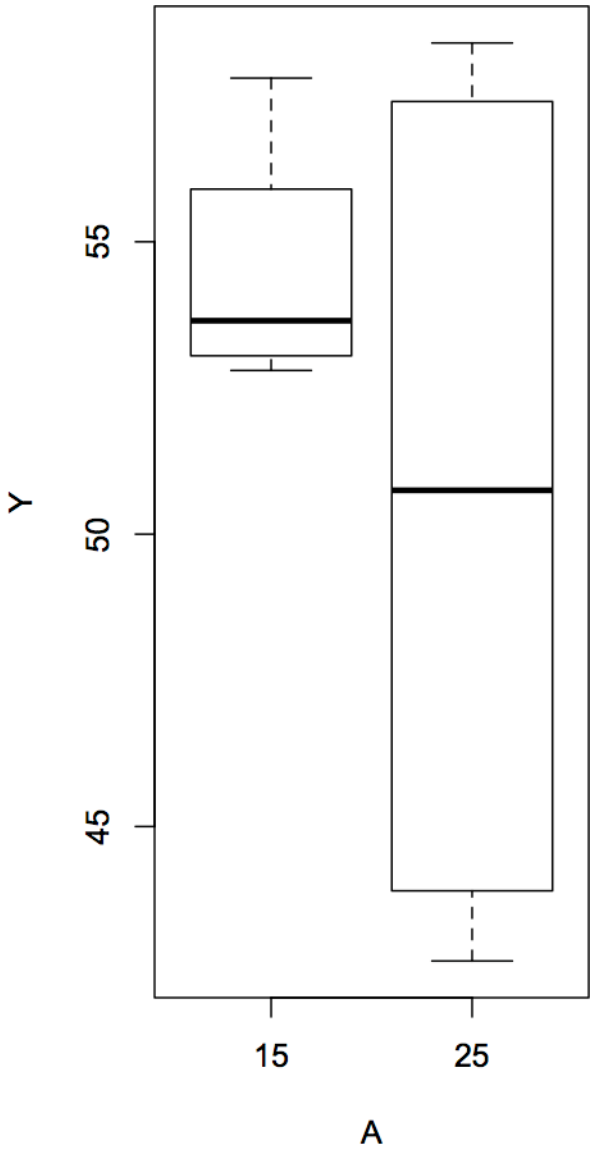
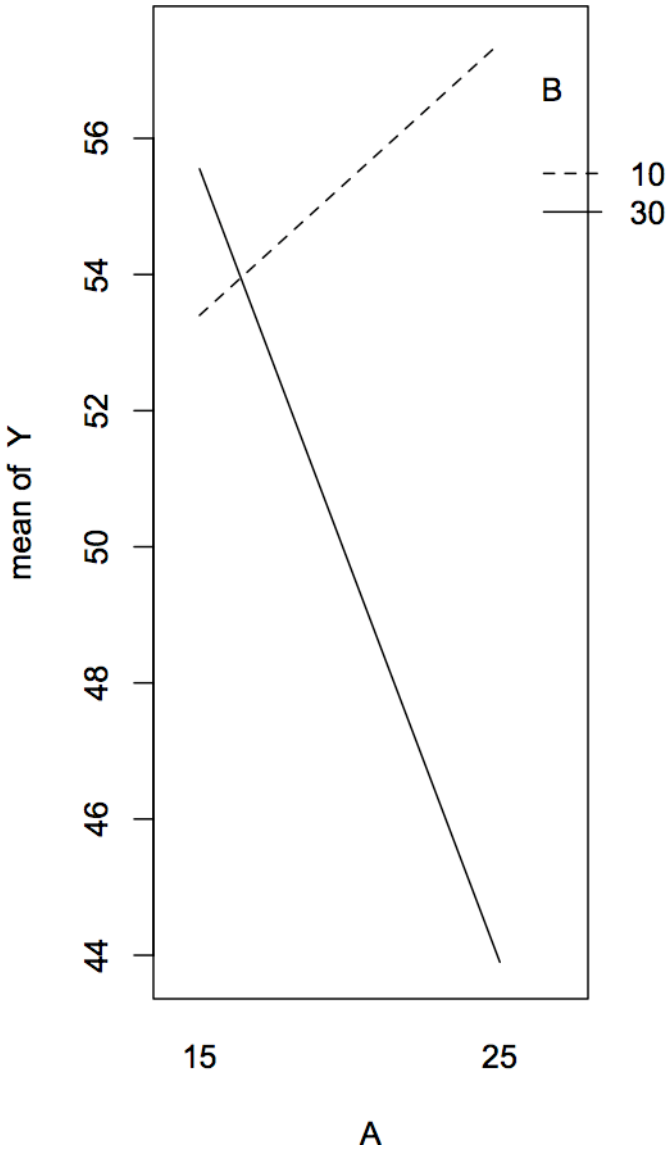

```
Type 'q()' to quit R.

[R.app GUI 1.31 (5538) powerpc-apple-darwin8.11.1]

[Workspace restored from /Users/andrejstreibergs/.RData]

> tt <- read.table("Math3081DataCleaning.txt",header=TRUE)
> tt
  Soap LauricAcid PctRemoved
1   15         10       52.8
2   15         10       54.0
3   15         30       57.8
4   15         30       53.3
5   25         10       56.4
6   25         10       58.4
7   25         30       42.7
8   25         30       45.1
> attach(tt)
> A <- factor(Soap)
> B <- factor(LauricAcid)
> Y <- PctRemoved

>#==============================PLOT DESIGN AND BOX====================
> layout(matrix(1:2,ncol=2))
> plot.design(data.frame(A,B,Y))
> plot(Y~A)
>#==============================PLOT INTERACTION=======================
> interaction.plot(A,B,Y)
> interaction.plot(B,A,Y)
>#==============================RUN TWO-WAY ANOVA WITH INTERACTIONS=====
> f1 <- aov(Y~A*B)
> anova(f1)
Analysis of Variance Table

Response: Y
          Df  Sum Sq Mean Sq F value   Pr(>F)
A          1  29.261  29.261  7.4432 0.052539 .
B          1  64.411  64.411 16.3844 0.015504 *
A:B        1 122.461 122.461 31.1507 0.005053 **
Residuals  4  15.725   3.931
---
Signif. codes:  0 *** 0.001 ** 0.01 * 0.05 . 0.1   1
>#=================NOTE THAT THE INTERACTION IS SIGNIFICANT==========
>#=====THIS MEANS THAT NEITHER MAIN EFFECT CAN BE INTERPRETED AS THE===
>#=======INCREASE ON REMOVAL PCT DUE TO PRESENCE OF FACTOR.============
```

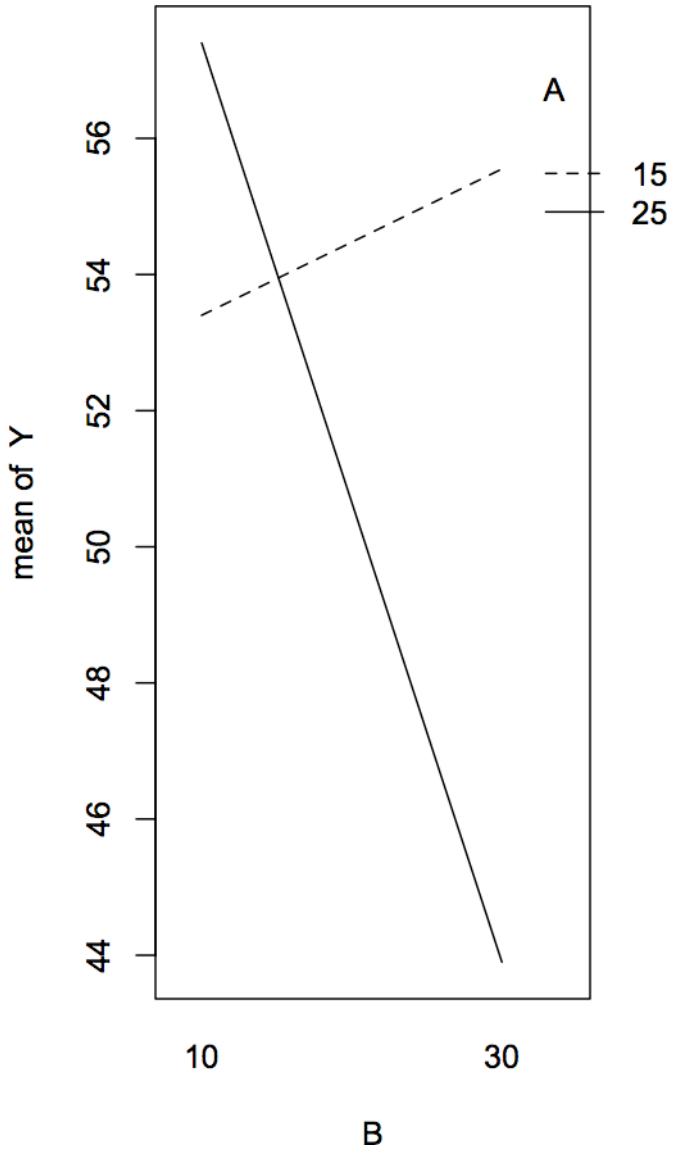
```
>#======================MEANS, SE=======================================
 > model.tables(f1,"means",se=TRUE)
Tables of means
Grand mean

52.5625

A
   15    25
54.47 50.65

B
   10    30
55.40 49.72

 A:B
    B
A    10    30
  15 53.40 55.55
  25 57.40 43.90

Standard errors for differences of means
            A     B   A:B
        1.402 1.402 1.983
replic.     4     4     2

>#========================TABLE OF MAIN EFFECTS AND INTERACTIONS=====
> model.tables(f1,"effects",se=TRUE)
Tables of effects

A
     15      25
 1.9125 -1.9125

B
     10      30
 2.8375 -2.8375

 A:B
    B
A    10     30
  15 -3.913  3.913
  25  3.913 -3.913

Standard errors of effects
             A      B    A:B
        0.9914 0.9914 1.4020
replic.      4      4      2
```

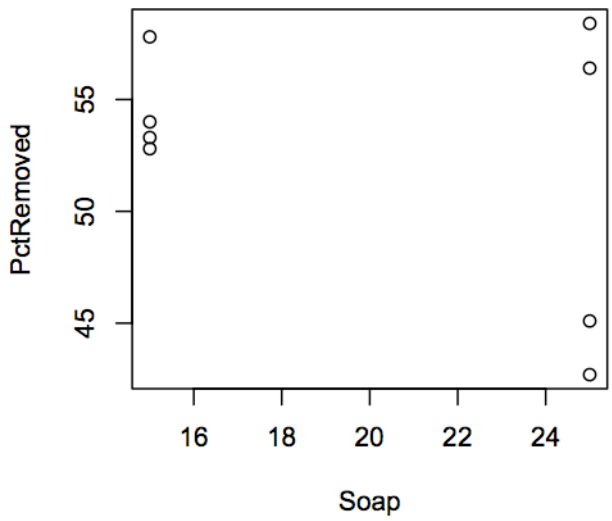
```
>#==============================PLOT USUAL DIAGNOSTICS================
> layout(matrix(1:4,ncol=2))
> plot(Soap,PctRemoved)
> plot(rstandard(f1)~fitted(f1),ylab="Standard. Resid.",xlab="Predicted Values",
  ylim=max(abs(rstandard(f1)))*c(-1,1));abline(h=c(0,-2,2),lty=c(2,3,3))
> plot(fitted(f1)~Y,ylab="Y hat");abline(0,1)
> qqnorm(rstandard(f1),ylab="Standard. Resid.",
  ylim=max(abs(rstandard(f1)))*c(-1,1))
> abline(h=c(0,-2,2),lty=c(2,3,3));abline(0,1)

>#========================SHAPIRO-WILK TEST FOR NORMALITY============
> shapiro.test(rstandard(f1))

Shapiro-Wilk normality test

data:  rstandard(f1)
W = 0.9672, p-value = 0.8752
```

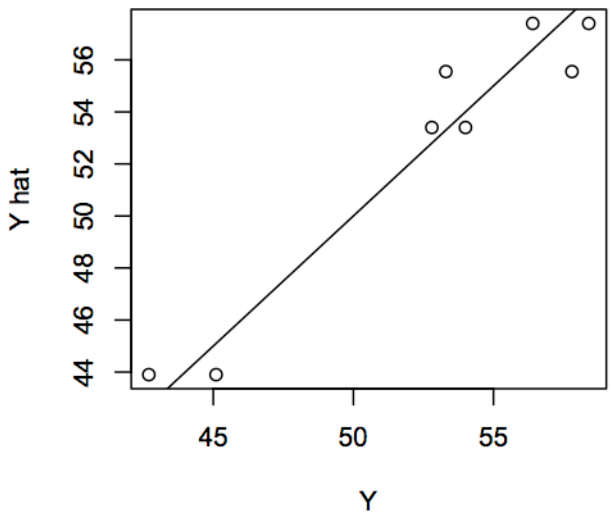

mean of Y
50
51
52
53
54
55
10
15
25
30
A
B
Factors

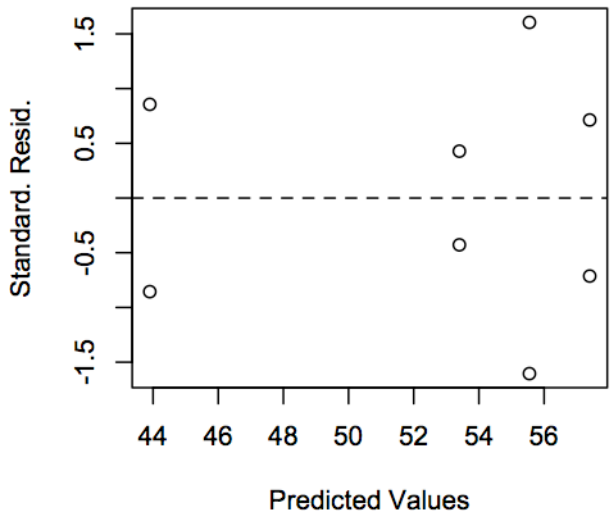

Y
45
50
55
15
25
A

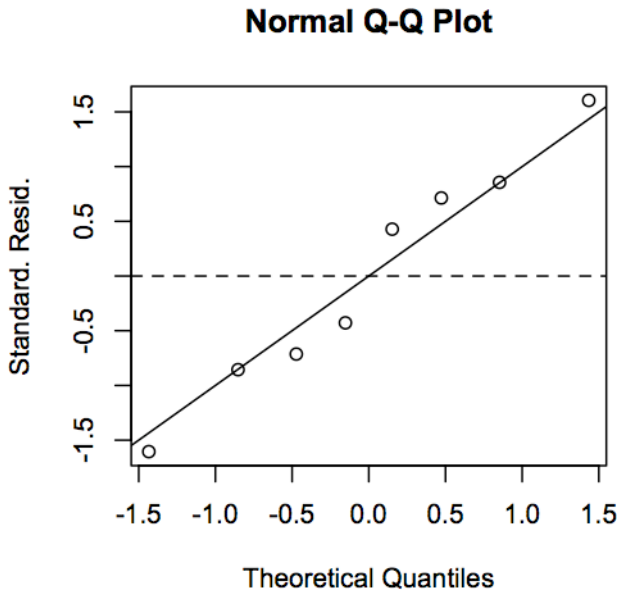

mean of Y
44
46
48
50
52
54
56
15
25
A
B
10
30


mean of Y
44
46
48
50
52
54
56
10
30
B
A
15
25


PctRemoved
45
50
55
16
18
20
22
24
Soap


Y hat
44
46
48
50
52
54
56
45
50
55
Y


Standard. Resid.
-1.5
-0.5
0.5
1.5
44
46
48
50
52
54
56
Predicted Values


Normal Q-Q Plot
Standard. Resid.
-1.5
-0.5
0.5
1.5
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
Theoretical Quantiles