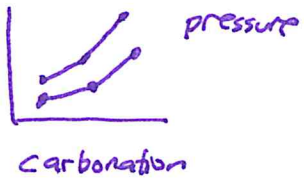
Stat 581, Problem Set #6 Solutions

(1.) A = percent carbonation, (a=3) B = operating pressure, (b=2) C = line speed (c=2)
y = deviation from target, n = 2, abc = 12

(a) important effects:

$F_A = 178.41$ ($P_A = .000$), $F_B = 64.06$ ($P_B = .000$), $F_C = 31.12$ ($P_C = .000$), $F_{AB} = 3.71$ ($P_{AB} = .056$)

(b) see interaction plot



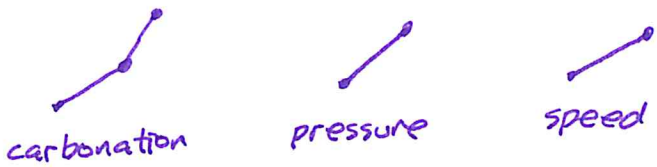
If an interaction plot is parallel, or nearly so, then there is no need to include the interaction term.

(c) see fitted values plot

```
x.mod = aov( y ~ (A+B)^2 + C)
a.mod = aov ( y ~ A+B+C)
```

The interaction model fits in our problem show only slight differences from the additive model fits.

(d) see box plots



Carbonation, pressure, speed each has a positive effect on fill height.

(2.) A = speed, B = geometry, C = angle, Y = lifetime

2^3 design, $n = 3$

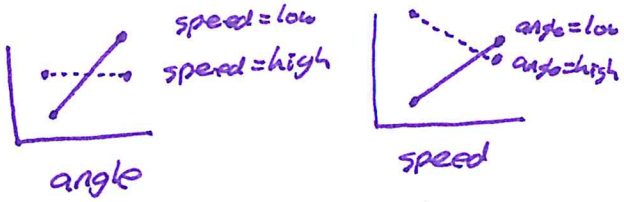
(a) $F_B^* = 25.55$, $F_C^* = 9.29$, $F_{AC}^* = 15.52$

($P_B = .000$) ($P_C = .008$) ($P_{AC} = .001$)

The experiment finds that geometry has a main effect on lifetime, and that speed / angle have an interaction effect.

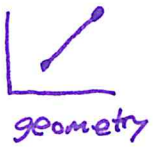
(b) reduced.mod = aov(Y ~ A + B + C + A:C)

(i) see interaction plot



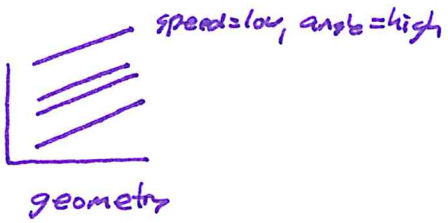
The experiment finds that angle has a positive effect on lifetime, when speed is at its low level.

(ii) see box plot



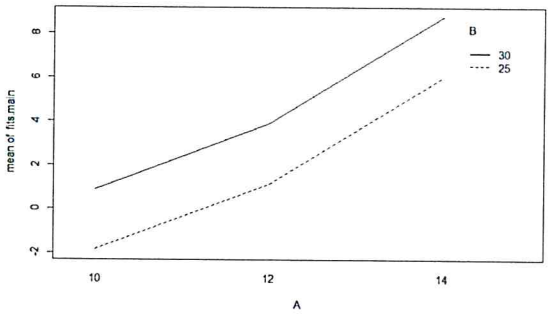
The experiment finds that geometry has a positive effect on lifetime.

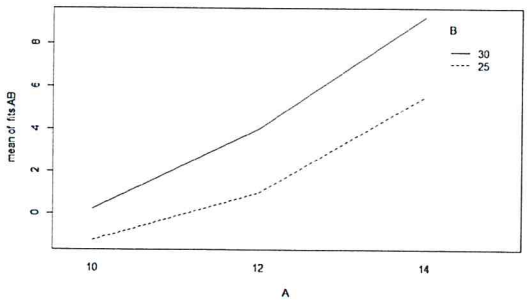
(iii) see fitted value plot

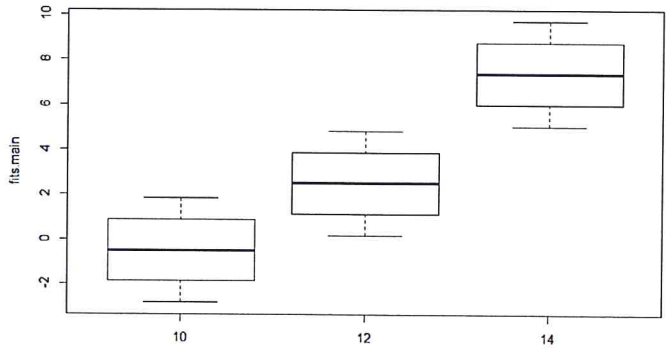


The optimal setting is low speed, high geometry, high angle. This makes sense based on the finding that high angle is better at low speed, and high geometry is better.

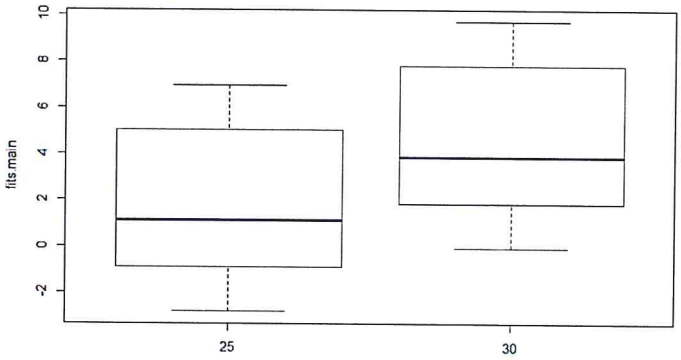
```
> A = as.factor(na.omit(hw6.data$carbon))
> B = as.factor(na.omit(hw6.data$pressure))
> C = as.factor(na.omit(hw6.data$speed))
> y = na.omit(hw6.data$deviation)
>
> three.mod = aov(y ~ A*B*C)
> summary(three.mod)
            Df Sum Sq Mean Sq F value   Pr(>F)
A            2 252.75  126.38 178.412 1.19e-09 ***
B            1  45.37   45.37  64.059 3.74e-06 ***
C            1  22.04   22.04  31.118  0.00012 ***
A:B          2   5.25    2.63   3.706  0.05581 .
A:C          2   0.58    0.29   0.412  0.67149
B:C          1   1.04    1.04   1.471  0.24859
A:B:C        2   1.08    0.54   0.765  0.48687
Residuals   12   8.50    0.71
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
>
> main.mod = aov(y ~ A+B+C)
> fits.main = predict(main.mod)
> interaction.plot(A,B,fits.main)
>
> AB.mod = aov(y ~ A+B+C + A:B)
> fits.AB = predict(AB.mod)
> interaction.plot(A,B,fits.AB)
>
> plot(fits.main~A)
> plot(fits.main~B)
> plot(fits.main~C)
>
```



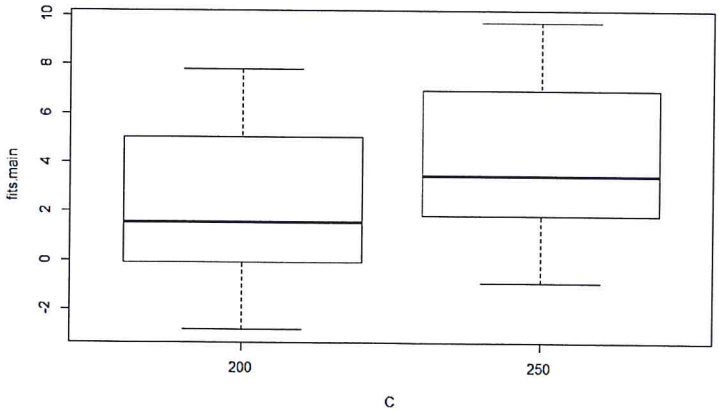



fits.main
10
8
6
4
2
0
-2
10
12
14

A

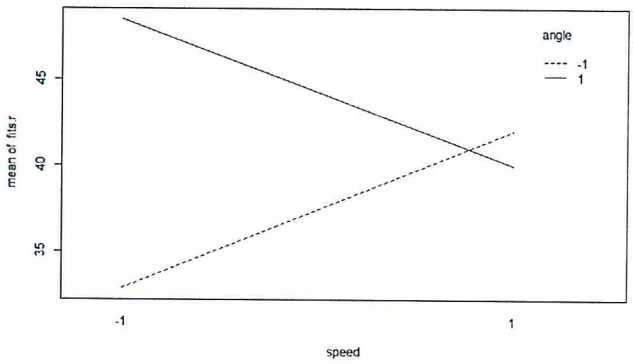

fits.main
10
8
6
4
2
0
-2
25
30

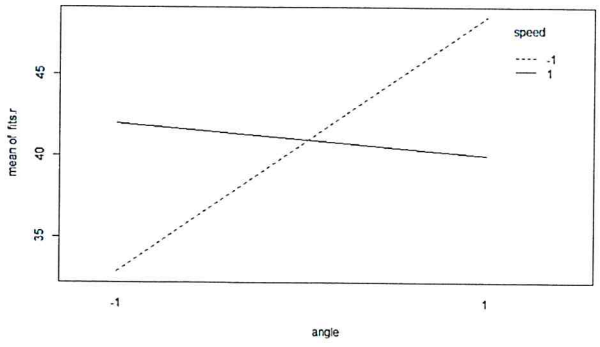
B

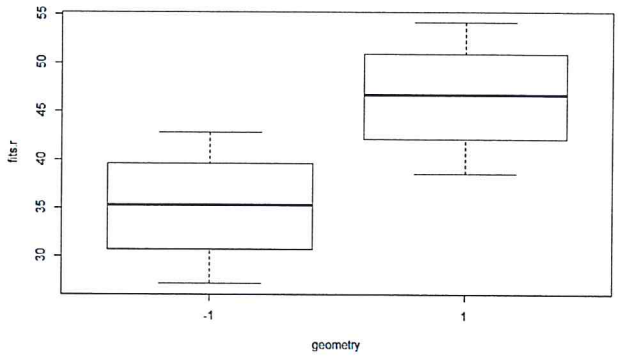

fits.main
10
8
6
4
2
0
-2
200
250

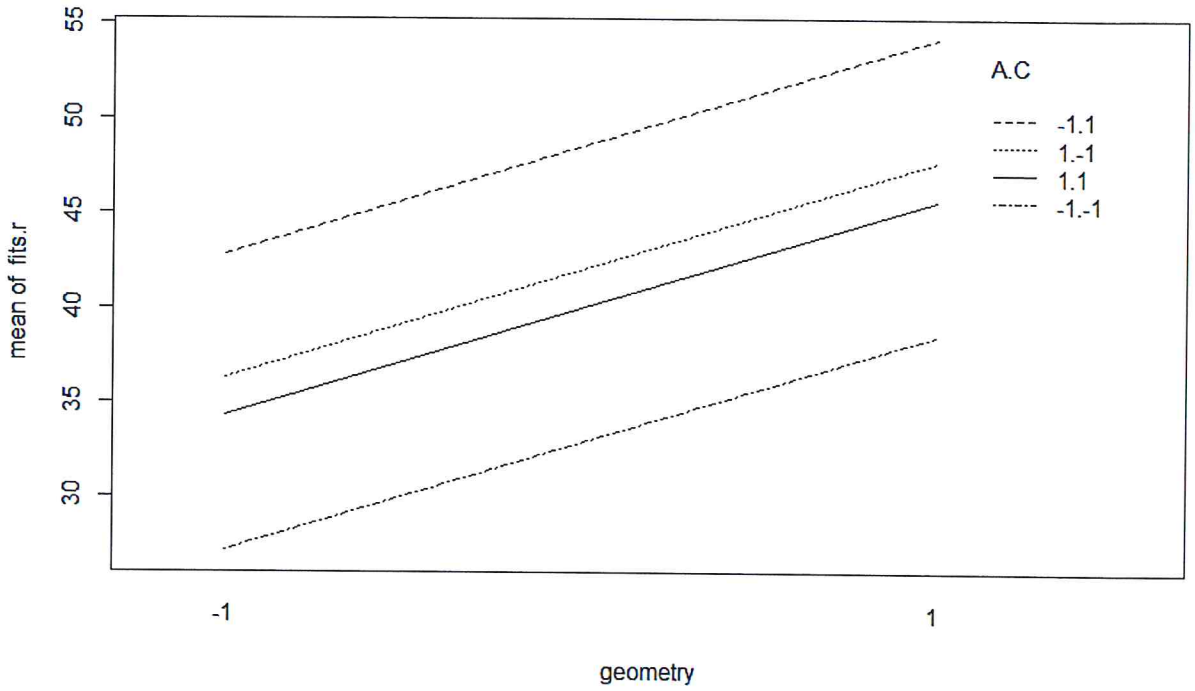
C

```
> speed = as.factor(na.omit(hw6.data$spd))
> geometry = as.factor(na.omit(hw6.data$geo))
> angle = as.factor(na.omit(hw6.data$angle))
> lifetime = na.omit(hw6.data$life)
>
> full.mod = aov(lifetime ~ speed*geometry*angle)
> summary(full.mod)
                    Df Sum Sq Mean Sq F value   Pr(>F)
speed                1    0.7     0.7   0.022 0.883680
geometry             1  770.7   770.7  25.547 0.000117 ***
angle                1  280.2   280.2   9.287 0.007679 **
speed:geometry       1   16.7    16.7   0.552 0.468078
speed:angle          1  468.2   468.2  15.519 0.001172 **
geometry:angle       1   48.2    48.2   1.597 0.224475
speed:geometry:angle 1   28.2    28.2   0.934 0.348282
Residuals           16  482.7    30.2
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
>
> reduced.mod = aov(lifetime ~ speed+geometry+angle + speed:angle)
> fits.r = predict(reduced.mod)
>
> interaction.plot(speed,angle,fits.r)
> interaction.plot(angle,speed,fits.r)
>
> plot(fits.r ~ geometry)
>
> A.C = interaction(speed,angle)
> interaction.plot(geometry,A.C,fits.r)
```






fits.r
55
50
45
40
35
30
-1
1
geometry


mean of fits.r
55
50
45
40
35
30
A.C
-1.1
1.-1
1.1
-1.-1
-1
1
geometry