STEVENS
INSTITUTE of TECHNOLOGY
THE INNOVATION UNIVERSITY

Beer Pong: Design Of Experiment

BIA 654: Experimental Design II
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Introduction

- **Beer pong**, also known as **Beirut**, is a popular drinking game in which players throw a ping pong ball across a table with the intent of landing the ball in a cup of beer on the other end.

- We thought it would be a good idea to apply what we have learned in class to an activity that many of us at the university enjoy outside of class.

Experiment Objective

- Minimize the number of tries it take to land the ball in a cup
- Determine which factors influence the game
- Develop suggestions to strategize and improve the performance of player

Equipment Required

Experiment Factors and Levels

Factor	Level 1 (+)	Level 2 (-)
Alcohol Consumption	Drunk	Sober
Music	On	Off
Experience	Skilled	Amateur
Hand	Dominant	Non-Dominant

Design

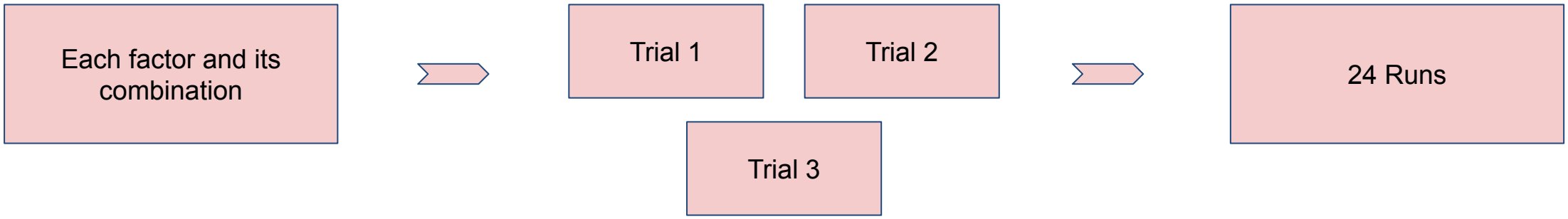
Two methodologies were used in this experiment:

- **2^(4-1) Fractional Factorial Design**
    a. Choose two levels (+) and (-) of each factor
    b. Conduct with Replication and Blocking effects
- **One Factor at a Time (OFAT)**
    a. Rate one setting (all +) at the beginning and change the first factor of the setting to negative level
    b. Change the second factor for the next round comparison
    c. Stop when there is no other factor to change

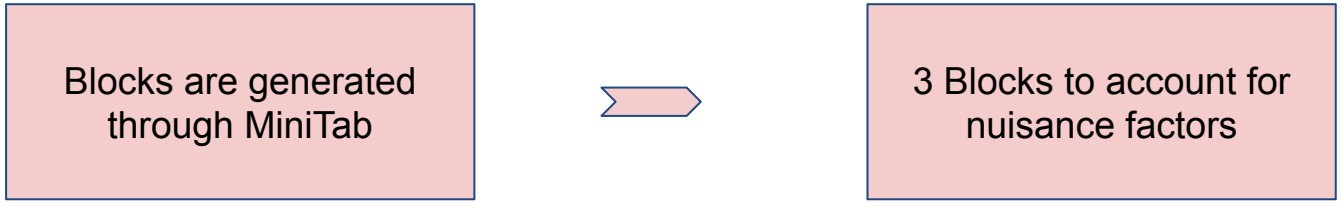
Minitab was used to arrive at the generating of the design matrix and the run orders.

Replication and Block Effects for FFD

- **Replication Effect:** It is the repetition of an experimental condition so that the variability associated with the phenomenon can be estimated



- **Blocking Effect:** It reduces unexplained variability



Fractional Factorial Design

Minitab - ExpDOE654.mpx

File Edit Data Calc Stat Graph View Help Assistant Additional Tools

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
	StdOrder	RunOrder	CenterPt	Blocks	Alcohol	Experience	Hand	Music	Response	
1	1	17	1	1	-1	-1	-1	-1	11	
2	2	23	1	1	1	-1	-1	1	2	
3	3	24	1	1	-1	1	-1	1	8	
4	4	22	1	1	1	1	-1	-1	2	
5	5	19	1	1	-1	-1	1	1	20	
6	6	21	1	1	1	-1	1	-1	9	
7	7	18	1	1	-1	1	1	-1	1	
8	8	20	1	1	1	1	1	1	5	
9	9	3	1	2	-1	-1	-1	-1	38	
10	10	1	1	2	1	-1	-1	1	5	
11	11	8	1	2	-1	1	-1	1	11	
12	12	4	1	2	1	1	-1	-1	9	
13	13	6	1	2	-1	-1	1	1	31	
14	14	7	1	2	1	-1	1	-1	5	
15	15	2	1	2	-1	1	1	-1	9	
16	16	5	1	2	1	1	1	1	4	
17	17	16	1	3	-1	-1	-1	-1	10	
18	18	10	1	3	1	-1	-1	1	7	
19	19	11	1	3	-1	1	-1	1	8	
20	20	15	1	3	1	1	-1	-1	1	
21	21	9	1	3	-1	-1	1	1	6	
22	22	12	1	3	1	-1	1	-1	21	
23	23	13	1	3	-1	1	1	-1	4	
24	24	14	1	3	1	1	1	1	3	
25										
26										
27										
28										
29										
30										
31										
32										

Worksheet 1

Worksheet 1 100%

Fractional Factorial Design

Regression Equation and ANOVA

Regression Equation in Uncoded Units

Response = 9.58 - 3.50 Alcohol - 4.17 Experience + 0.25 Hand - 0.42 Music
+ 2.08 Alcohol*Experience + 1.50 Alcohol*Hand - 1.33 Alcohol*Music

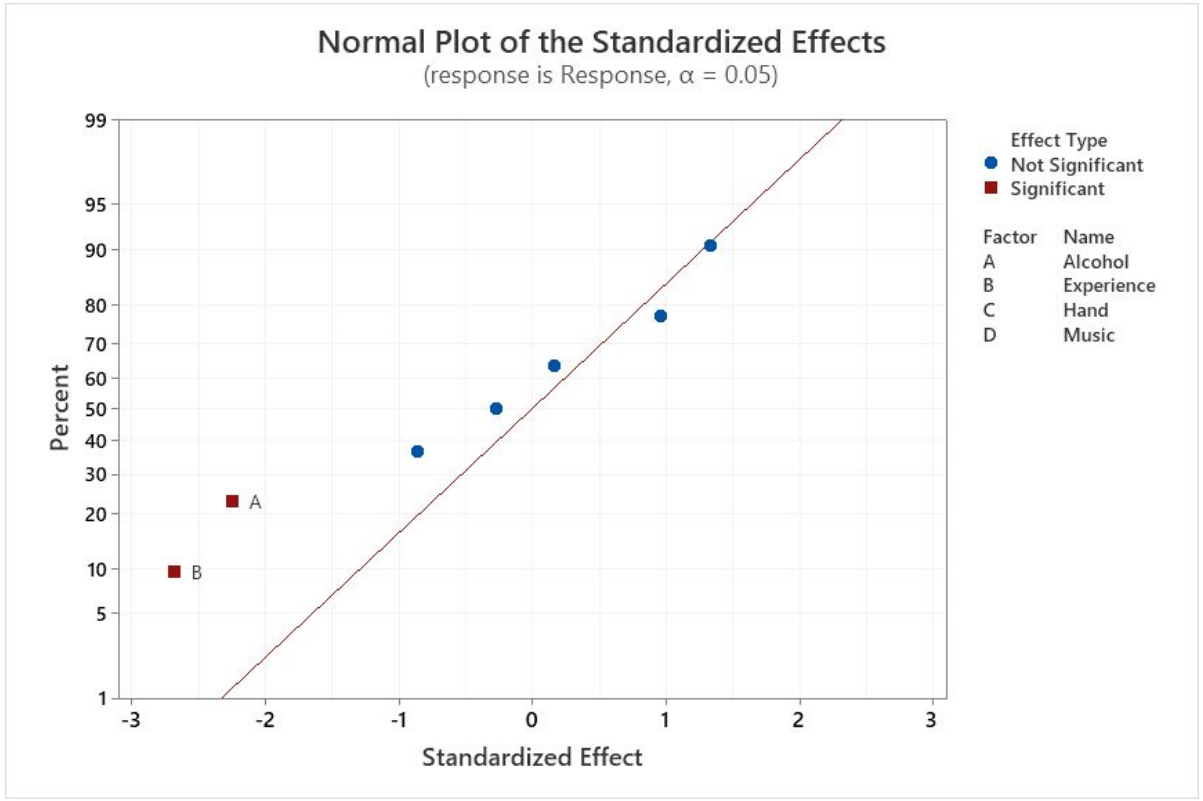
Equation averaged over blocks.

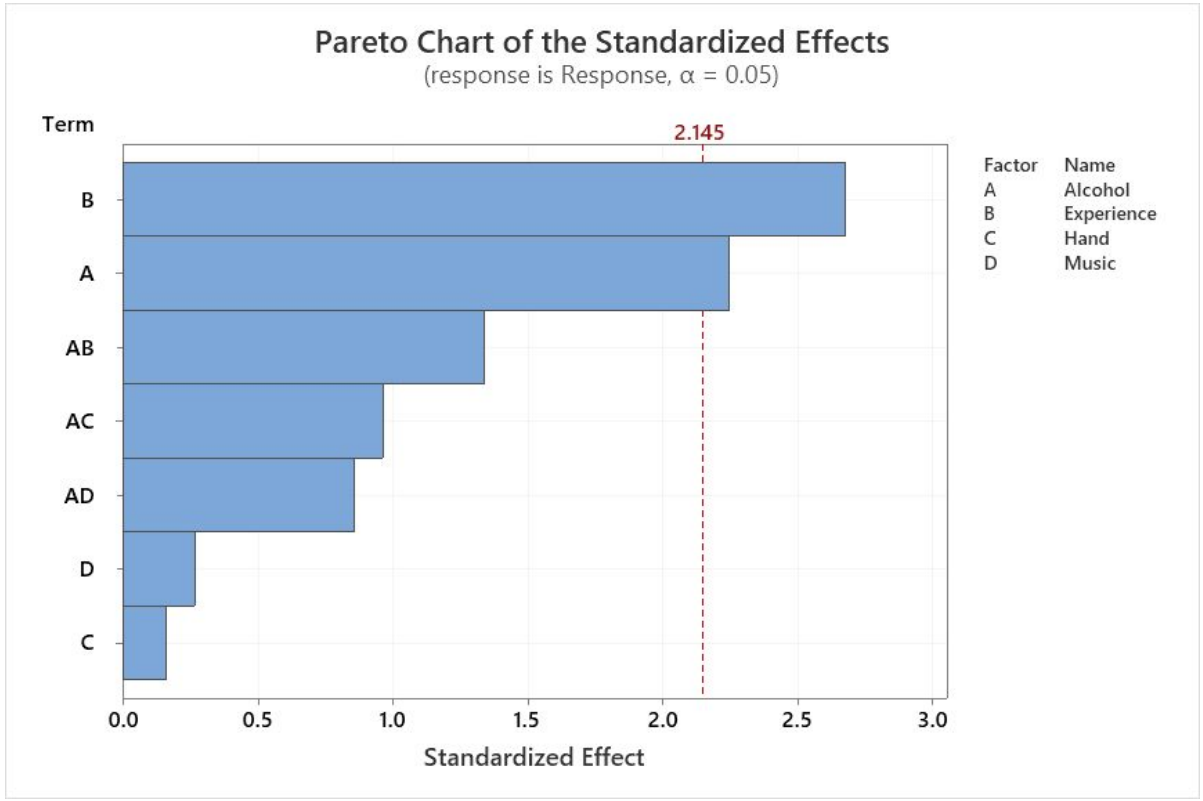
Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Model	9	1151.50	127.944	2.20	0.090
Blocks	2	234.33	117.167	2.01	0.170
Linear	4	716.33	179.083	3.08	0.052
Alcohol	1	294.00	294.000	5.05	0.041
Experience	1	416.67	416.667	7.16	0.018
Hand	1	1.50	1.500	0.03	0.875
Music	1	4.17	4.167	0.07	0.793
2-Way Interactions	3	200.83	66.944	1.15	0.363
Alcohol*Experience	1	104.17	104.167	1.79	0.202
Alcohol*Hand	1	54.00	54.000	0.93	0.352
Alcohol*Music	1	42.67	42.667	0.73	0.406
Error	14	814.33	58.167		
Total	23	1965.83			

Fractional Factorial Design

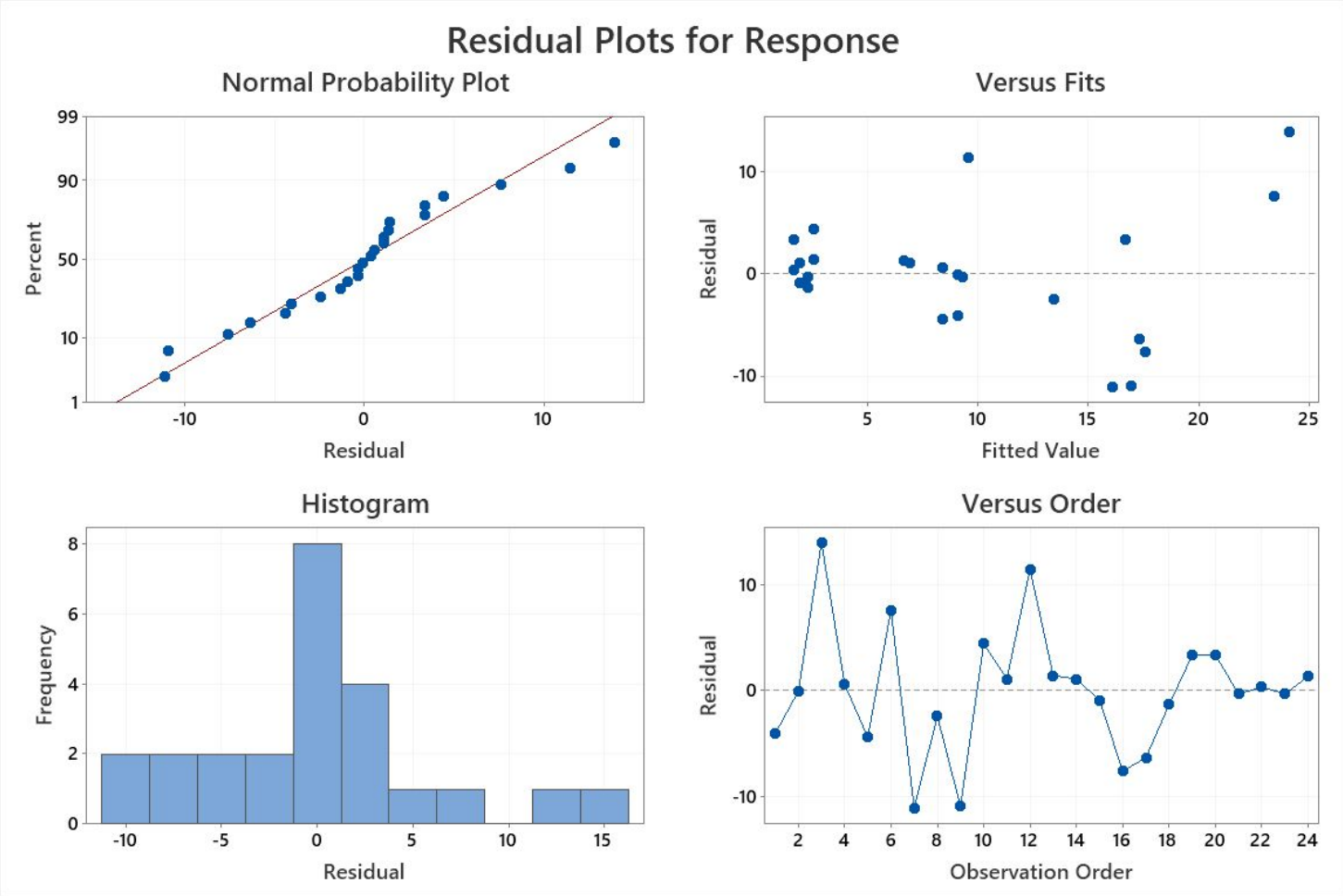
Normal Probability Plot and Pareto Chart





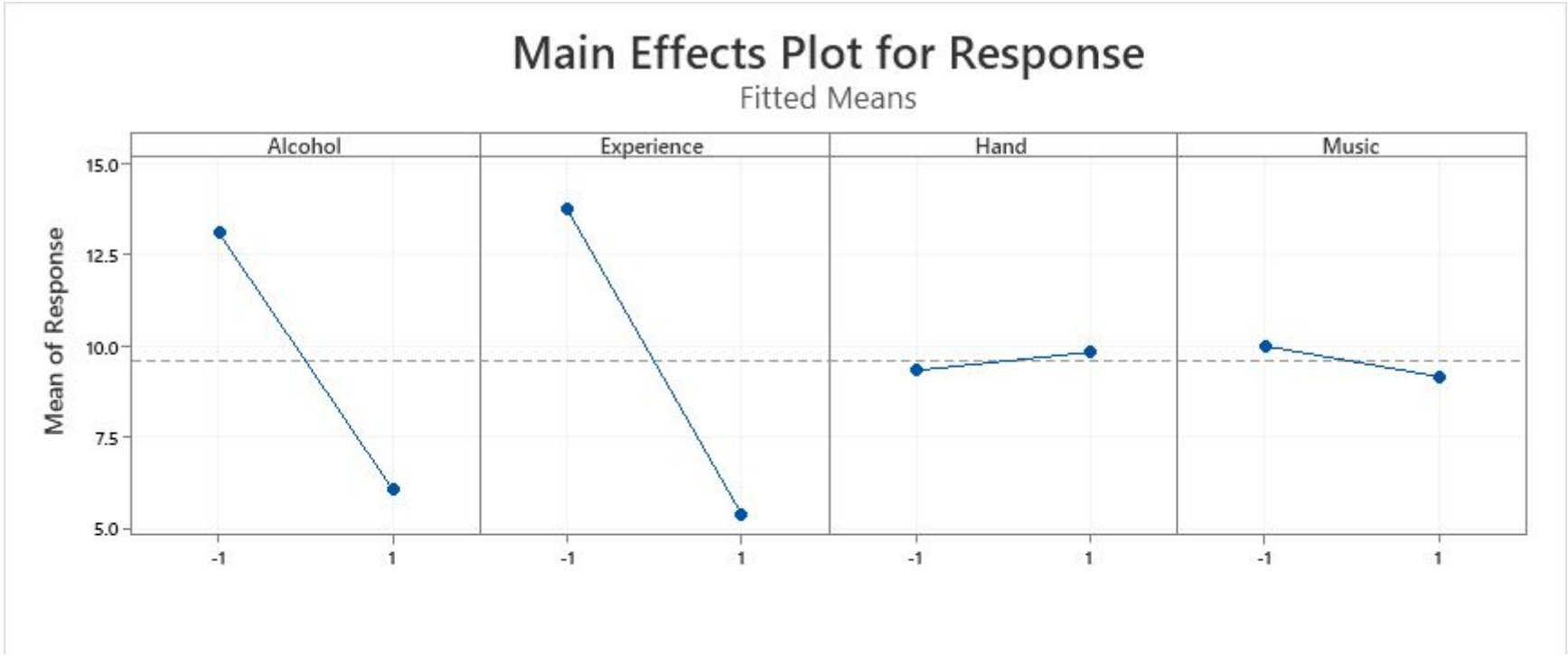
Fractional Factorial Design

Residual Plot



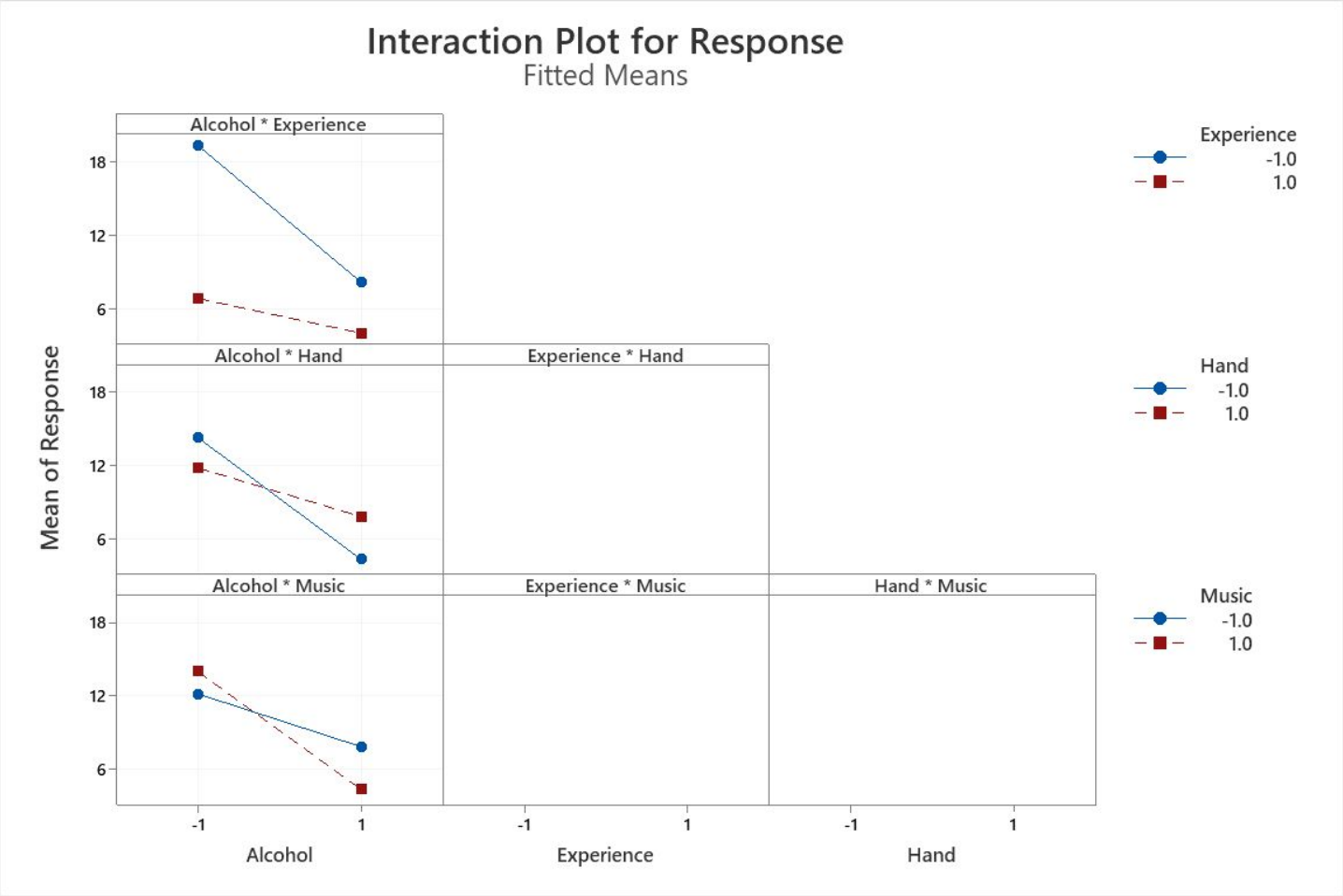
Fractional Factorial Design

Main Effects Plot



Fractional Factorial Design

Interaction Plot



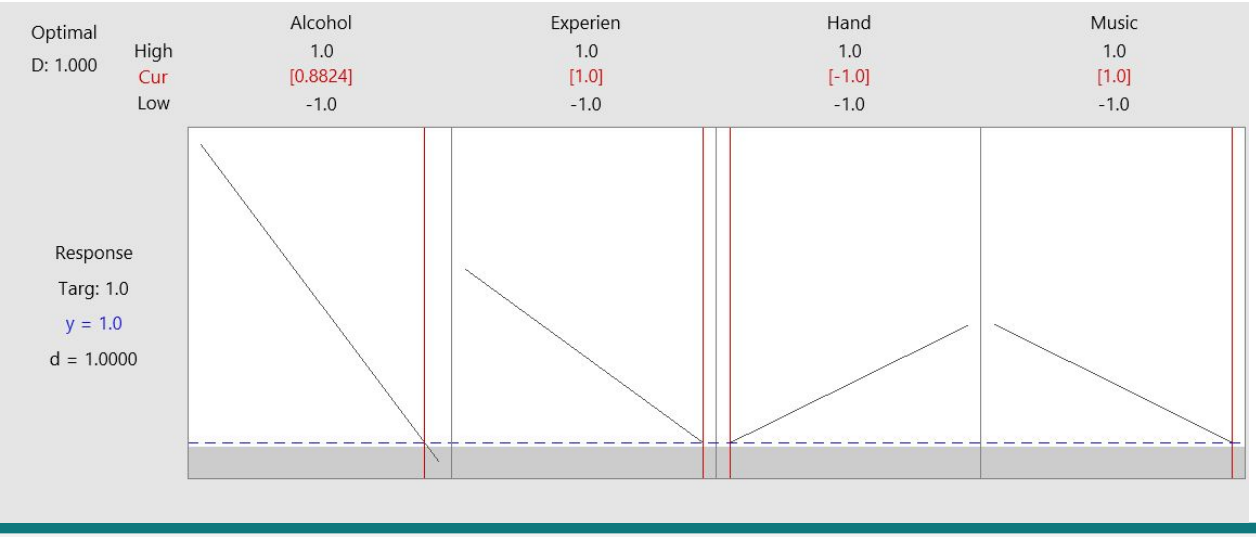
Fractional Factorial Design

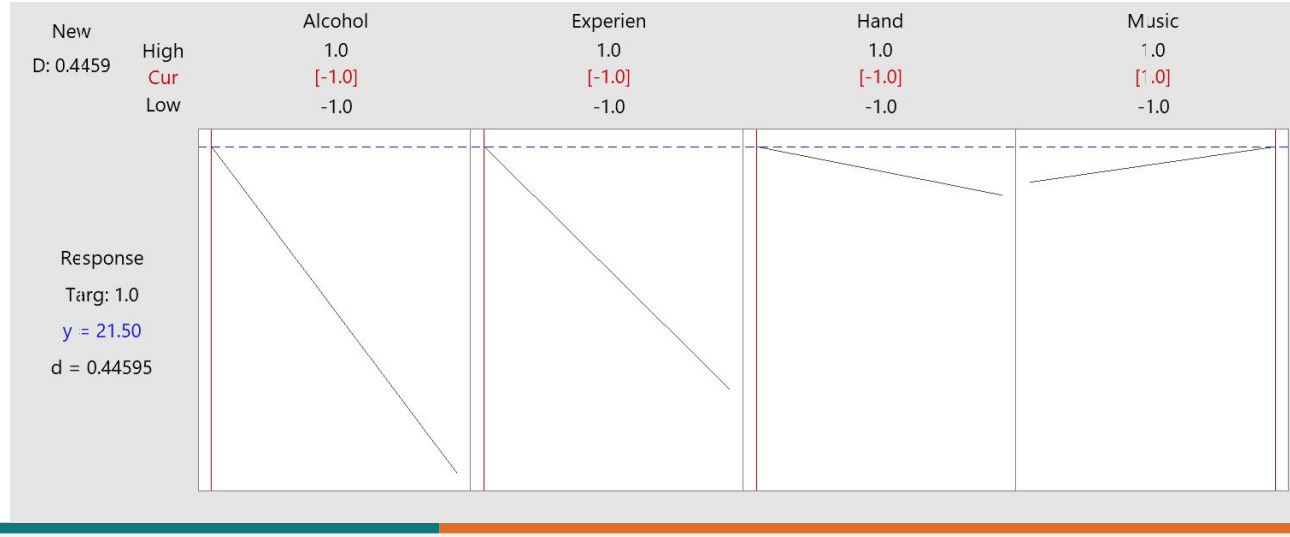
Response Optimization

Multiple Response Prediction

Variable	Setting
Alcohol	0.882353
Experience	1
Hand	-1
Music	1

Response	Fit	SE Fit	95% CI	95% PI
Response	1.00	4.15	(-7.91, 9.91)	(-17.62, 19.62)





OFAT

Run Order	Alcohol	Experince	Hand	Music	Response
1	+	+	+	+	10
2	+	+	+	+	5
3	+	+	+	+	5
4	-	+	+	+	2
5	-	+	+	+	13
6	-	+	+	+	4
7	+	-	+	+	11
8	+	-	+	+	23
9	+	-	+	+	15
10	+	+	-	+	2
11	+	+	-	+	3
12	+	+	-	+	8
13	+	+	+	-	11
14	+	+	+	-	5
15	+	+	+	-	7
16	-	-	+	+	2
17	-	-	+	+	3
18	-	-	+	+	5
19	-	-	-	+	18
20	-	-	-	+	5
21	-	-	-	+	19
22	-	-	-	-	6
23	-	-	-	-	16
24	-	-	-	-	21

Conclusion

- Experience and Alcohol are significant factors. There were no interactions that turned out to be significant.
- Using replications and blocking helped us in factoring nuisance factors, which otherwise would have been left ignored.
- Some of the nuisance factors in this experiment could include the fact that the experiment was performed over the course of 4 days at different periods of time. The music choices were varied. Alcohol affects every person differently.

We recommend that it is best to play Beer Pong after having a couple of drinks. Make sure you practice to ace the game.

you play beer pong when you are either a couple of drinks down or when you are ready to down a couple of drinks

- Rana (Stevens Grad Student Beer Pong Champion)

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