Design and Analysis Report

Tables 1a and 1b summarize the factors and responses studied.

Factors	Role	Changes	Values
Sensitizer 1	Continuous	Easy to change	50, 90
Sensitizer 2	Continuous	Easy to change	50, 90
Dye	Continuous	Easy to change	200, 300
Reaction Time	Continuous	Easy to change	120, 180

Table 1a: Factors

Response(s)	Goal	Limits	Importance	Detection Limits
Speed	Maximize	5.3 ≤ Speed	1	NA
Contrast	Maximize	0.7 ≤ Contrast	1	NA
Cost	Minimize	Cost ≤ 0.28	1	NA

Table 1b: Responses

The initial model used in designing the experiment included the following model terms.

Sensitizer 1, Sensitizer 2, Dye, Reaction Time, Sensitizer 1*Sensitizer 1, Sensitizer 1*Sensitizer 2, Sensitizer 2*Sensitizer 2, Sensitizer 1*Dye, Sensitizer 2*Dye, Dye*Dye, Sensitizer 1*Reaction Time, Sensitizer 2*Reaction Time, Dye*Reaction Time, Reaction Time*Reaction Time

The experimental results are presented in Table 2.

Speed	Contrast	Cost	Sensitizer 1	Sensitizer 2	Dye	Reaction Time
5.33505	0.56243	0.37765	70	72	300	180
5.48046	0.72716	0.33616	70	70	250	120
5.37946	0.5997	0.34372	90	90	300	180
5.36272	0.6427	0.4511	90	70	250	150
5.44445	0.64438	0.44128	90	90	200	180
5.42634	0.6829	0.35714	70	70	250	150
5.06625	0.52293	0.16642	50	90	250	180
5.46153	0.56442	0.19726	50	70	200	150
5.3868	0.65447	0.21787	90	90	300	120
5.28837	0.54178	0.28936	50	70	300	120
5.47311	0.59034	0.299	50	50	250	120
5.30701	0.52035	0.51017	70	50	200	180
5.39078	0.55087	0.17781	59.2	90	200	120
5.34741	0.5673	0.48708	70	50	300	150
5.0644	0.42764	0.73533	90	50	250	180
5.12038	0.56276	0.70655	90	50	200	120
5.08353	0.48682	0.25444	50	50	300	180
4.78455	0.39648	0.20411	50	90	300	150
5.06525	0.50509	0.57591	90	50	300	120
5.41007	0.6739	0.24267	70	90	250	150
5.57554	0.69888	0.39956	70	70	250	150

Table 2: Design

Final parameter estimates for the remaining terms after model selection are presented in Table 3.

Response Speed			
Term	**Estimate**	**Lower 95%**	**Upper 95%**
Intercept	5.48333	5.42109	5.54557
Dye(200,300)	-0.0852	-0.1264	-0.044
Reaction Time(120,180)	-0.0434	-0.0826	-0.0041
Sensitizer 1*Sensitizer 1	-0.1501	-0.2225	-0.0776
Sensitizer 1*Sensitizer 2	0.16449	0.11743	0.21154
Sensitizer 2*Sensitizer 2	-0.1129	-0.1832	-0.0427
Sensitizer 1*Dye	0.0784	0.03103	0.12577
Sensitizer 1*Reaction Time	0.03638	-0.0109	0.0837
Sensitizer 2*Reaction Time	0.0371	-0.0077	0.08185

RSquare	0.9331
Root Mean Square Error	0.0648

Response Contrast			
Term	**Estimate**	**Lower 95%**	**Upper 95%**
Intercept	0.68995	0.66942	0.71048
Sensitizer 1(50,90)	0.03218	0.02002	0.04434
Sensitizer 2(50,90)	0.02563	0.01382	0.03743
Dye(200,300)	-0.0228	-0.0355	-0.01
Reaction Time(120,180)	-0.0311	-0.0431	-0.0192
Sensitizer 1*Sensitizer 1	-0.0709	-0.0933	-0.0484
Sensitizer 1*Sensitizer 2	0.07174	0.05719	0.08629
Sensitizer 2*Sensitizer 2	-0.0493	-0.0716	-0.027
Dye*Dye	-0.0505	-0.0717	-0.0294
Sensitizer 1*Reaction Time	-0.0256	-0.0402	-0.011
Sensitizer 2*Reaction Time	0.02473	0.01072	0.03874

RSquare	0.9749
Root Mean Square Error	0.0194

Response Cost			
Term	**Estimate**	**Lower 95%**	**Upper 95%**
Intercept	0.3646	0.35348	0.37573
Sensitizer 1(50,90)	0.13871	0.12434	0.15308
Sensitizer 2(50,90)	-0.1164	-0.1302	-0.1027
Dye(200,300)	-0.0091	-0.0236	0.00534
Reaction Time(120,180)	0.01945	0.00571	0.03319
Sensitizer 1*Sensitizer 2	-0.0672	-0.0838	-0.0506
Sensitizer 1*Dye	-0.0406	-0.0581	-0.0231
Sensitizer 1*Reaction Time	0.04004	0.02343	0.05664
Sensitizer 2*Reaction Time	0.01136	-0.004	0.02675

RSquare	0.9884
Root Mean Square Error	0.0228

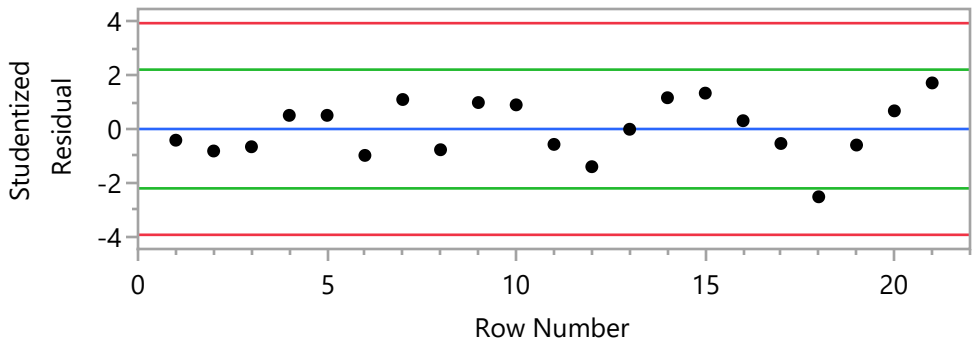
Table 3: Parameter Estimates

The following terms were excluded from the final model.

Response Speed: Sensitizer 1(50,90), Sensitizer 2(50,90), Sensitizer 2*Dye, Dye*Dye, Dye*Reaction Time, Reaction Time*Reaction Time;
Response Contrast: Sensitizer 1*Dye, Sensitizer 2*Dye, Dye*Reaction Time, Reaction Time*Reaction Time;
Response Cost: Sensitizer 1*Sensitizer 1, Sensitizer 2*Sensitizer 2, Sensitizer 2*Dye, Dye*Dye, Dye*Reaction Time, Reaction Time*Reaction Time;

The residual plot from the final model, along with an estimate of residual standard error, is shown in Figure 1.

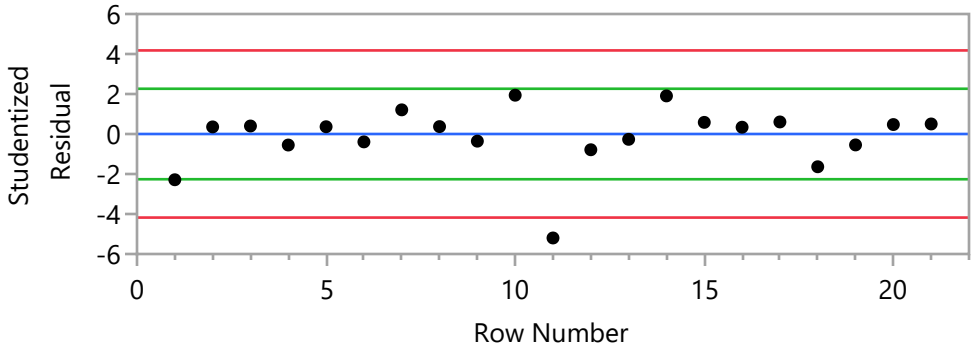
Response Speed



Root Square
0.0

Residuals should appear random (no pattern, trend). Individual residuals should not exceed 95% limits. Green limits assess each residual individually. Red limits account for the number of residuals in the comparison.

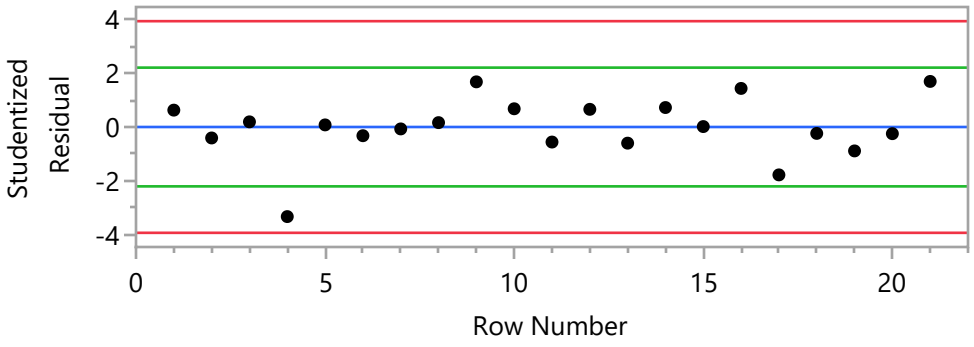
Response Contrast



Roc Squa
0

Residuals should appear random (no pattern, trend). Individual residuals should not exceed 95% limits. Green limits assess each residual individually. Red limits account for the number of residuals in the comparison.

Response Cost



Root M Square E
0.022

Residuals should appear random (no pattern, trend). Individual residuals should not exceed 95% limits. Green limits assess each residual individually. Red limits account for the number of residuals in the comparison.

Mean
Error
64778

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re Error
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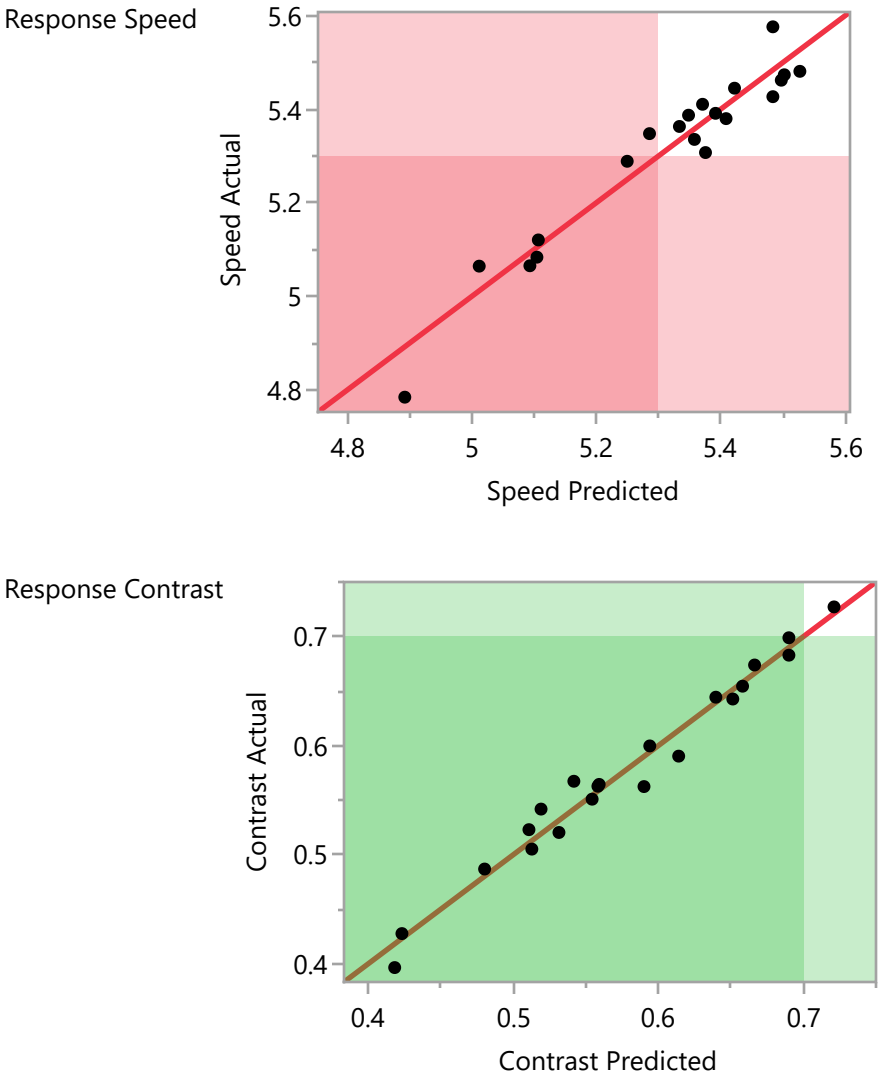
lean
rror
2814

Figure 1: Studentized Residual Plot and Root Mean Square Error for each response.

A plot of the actual responses against the predicted responses for the final model is shown in Figure 2.



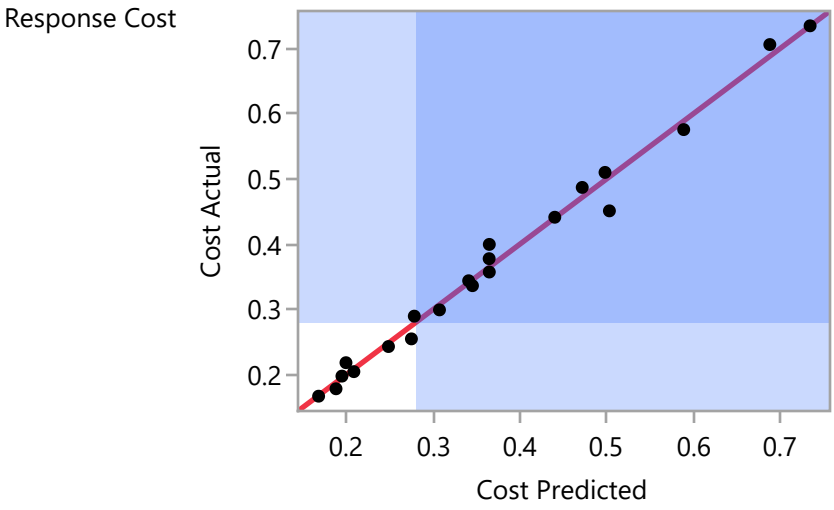


Figure 2: Actual by Predicted plot for each response.

A profiler showing the relationship between each factor and the response is shown in Figure 3.

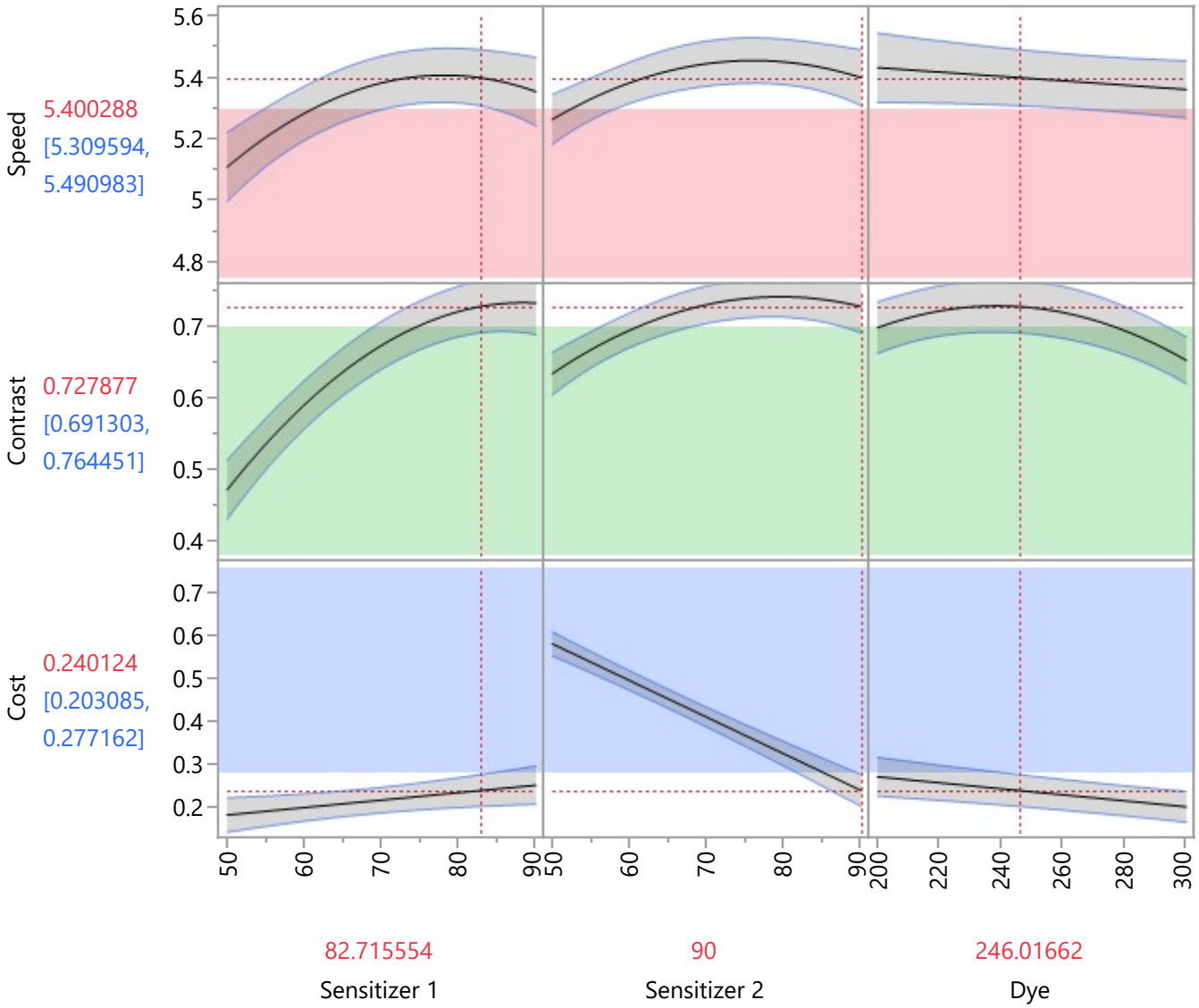
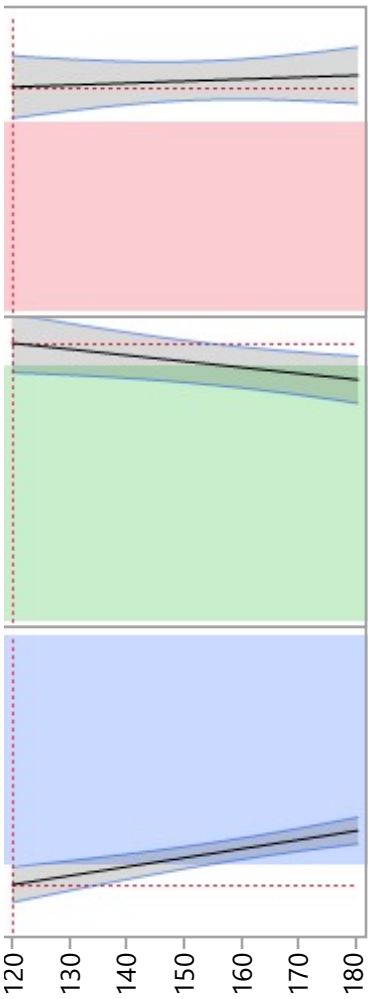


Figure 3: Profiler


120
130
140
150
160
170
180
120
Reaction
Time