Golf Game Improvement

INDE 524 Final Project Report

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Project Summary

For over 10 years, I have considered purchasing a new driver to improve my golf game. The goal is to use a statistical design of experiment approach to make the correct decision. My current set of golf clubs are in good shape, however, I am under the impression that new clubs will improve my game.

Advertisements in magazines, television, and otherwise claim that if you purchase their state of the art clubs, your game will be improved. I subconsciously tend to believe their claims, but am skeptical and want to research if the data can enlighten me.

The practical findings I am searching for are include the following:

1) Will the new driver improve my shot with statistical significance?

2) Should I even use a driver from the tee-box, or rather use my 4-iron which I suspect does not go as far, but I suspect is a straighter shot?

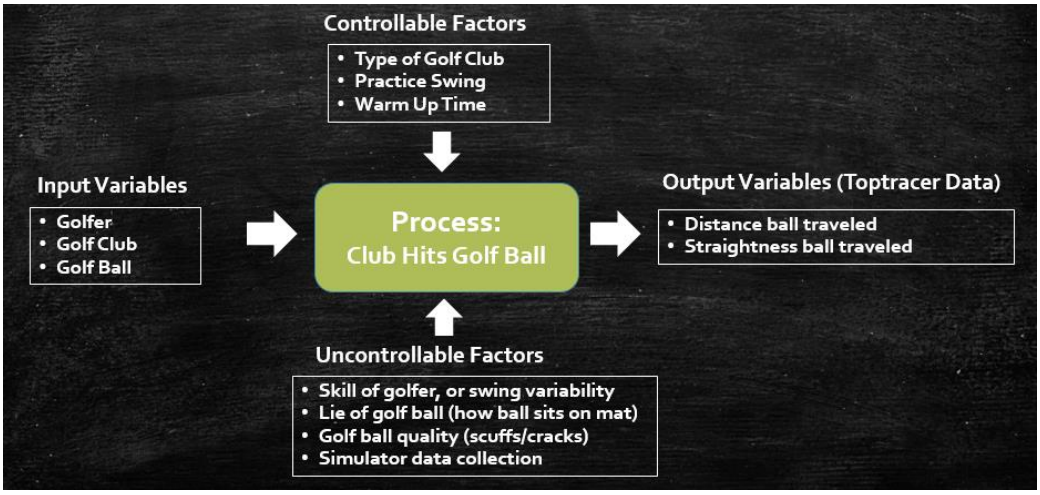
3) Ultimately, should I buy a new $349 driver?

Design of Experiment Setup

The DOE setup process diagram is shown below.

The input variables are me (the Golfer), Golf Club, and Golf Ball. These inputs enter the process of striking the ball which is the Process identified in this DOE.

The output variables are the Distance the Ball travels (in yards), and the Straightness the ball travels (in feet). These are the Y1 and Y2 response variables I am interested in. If I aim down the middle of the target line, then a negative straightness value is left and a positive straightness value is right. The optimal straightness response factor is zero (or directly in the position aimed).

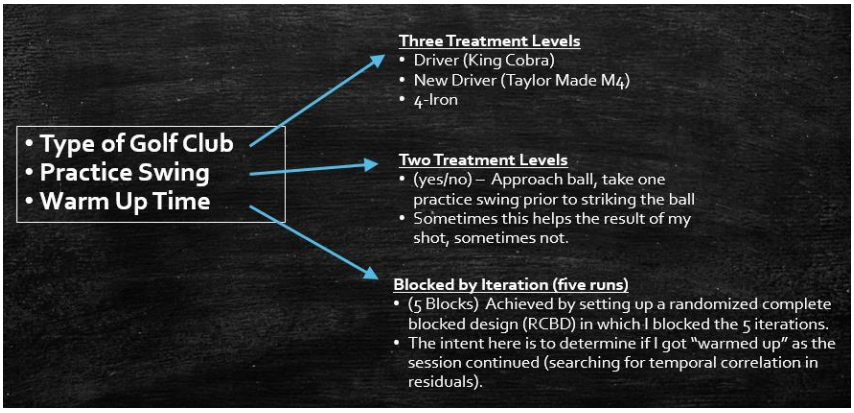


The controllable factors that are subject to this research are the type of Golf Club, whether or not I take a Practice Swing, and Warm Up time.

My main factor I am studying is the type of club, however, I want to know if taking a practice swing improves my golf game. When I am out on a golf course, I sometimes believe this helps, but I have never studied it definitively.

I am also interested if warm up time improves my game. When I play a golf course, I generally show up 30 minutes early, so I can "warm up" by purchasing a bucket of balls and hitting them in the nearby golf range. From there, I will go play a round of golf thinking my "warm up" prepared me for my best performance while on the course. Is this true? The study will tell.

Below shows a breakout of these main research variables (Control Factors) I am interested in and the treatment levels.



Taking a closer look at the main purpose of my study. Below shows the three levels of "Type of Club." This is the primary purpose of this study; to determine if I should buy a new Driver which cost $349.99 retail.

Driver	New Driver	4- Iron
		
Cost = $0	Cost = $349.99	Cost = $0
I currently own this. I use it to hit the ball far, but have a high degree of directional variability. My ball often ends up in the trees. ☹	Should I buy this to replace my current driver?	I currently own this. This club does not go as far, but is more precise than the driver (less variability).

Lastly, setting up this experiment required controlling as many of the non-research variables I could. I recreated as many variables as possible that would be true if I were at a golf course (rather than at a practice range). This included:

- I wore my same golf shoes
- I wore a glove on my left hand for every shot
- I approached the ball consistently
- I stretched for 5 minutes before starting

Some variables I was unable to control are documented as my Uncontrollable Factors. These include:

- Skill of golfer, or swing variability
- Lie of golf ball (how ball sits on mat)
- Golf ball quality (scuffs/cracks)
- Simulator data collection

Data Collection Process

I setup my data collection worksheet in support of my DOE factors. I used Minitab to setup a multilevel full-factorial design, and then translated it into an easier collection worksheet while out “in the field” (or at the range). I color coded my runs so I could easily follow my observation order and quickly document my observations on paper.

The readings were taken from the screen setup at the driving range. The technology is new to the driving range called “Top Tracer.” I utilized this technology which optically followed my ball flight for each of my shots.

Note, the “Warm-up” research factor was Blocked with the 5 iterations of the expirement design. The data collection sheet, with 5 blocked replications is shown below.

Below shows the process steps I took to ensure independent observations. I hit the ball, then immediately put the club down. I read the two response variables from the screen, then documented the observation on the data collection worksheet.

Distance (Y1) Results

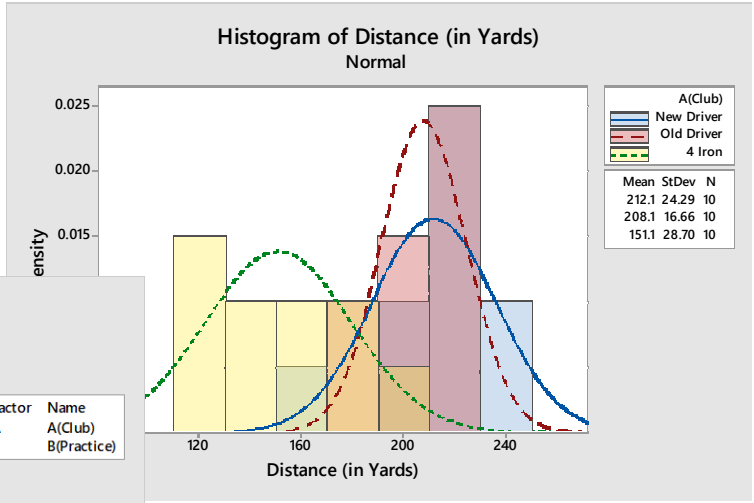
See below for the ANOVA results of “Distance”. The Type of Club is significant with a very low P-value. The practice swing does not significantly affect the distance I hit the golf ball. Surprisingly, my Blocking factor (or Warm Up Time) is not significant either.

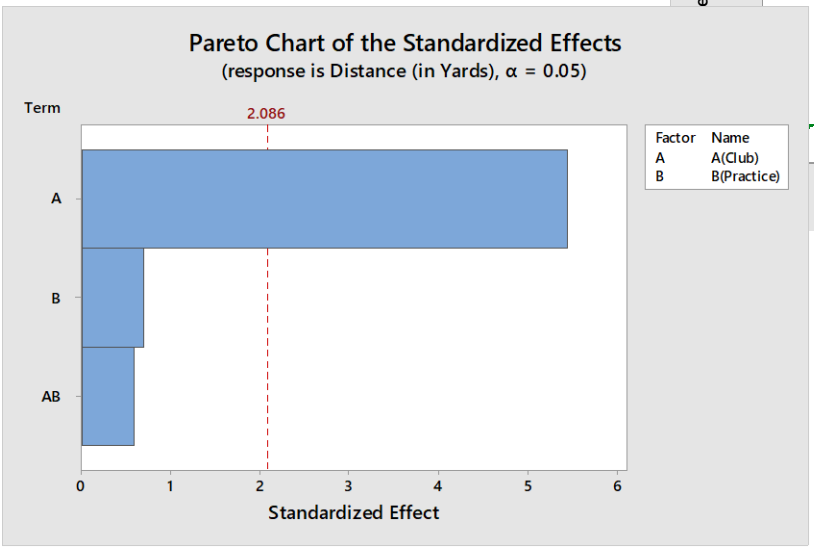
Factor Information

Factor	Levels	Values
A(Club)	3	New Driver, Old Driver, 4 Iron
B(Practice)	2	Yes, No

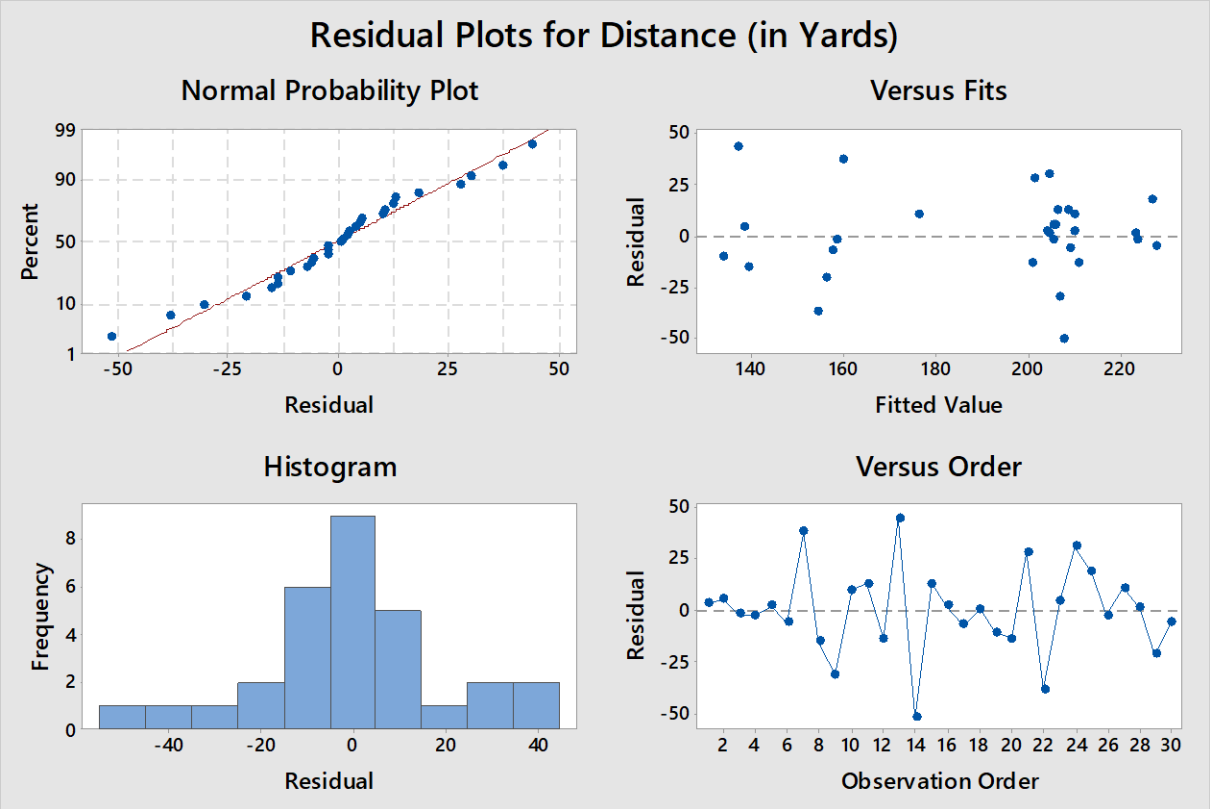
Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Model	9	26152.1	2905.8	4.70	0.002
Blocks	4	1843.5	460.9	0.75	0.572
Linear	3	23587.5	7862.5	12.73	0.000
A(Club)	2	23286.7	11643.3	18.85	0.000
B(Practice)	1	300.8	300.8	0.49	0.493
2-Way Interactions	2	721.1	360.5	0.58	0.567
A(Club)*B(Practice)	2	721.1	360.5	0.58	0.567
Error	20	12355.3	617.8		
Total	29	38507.4			



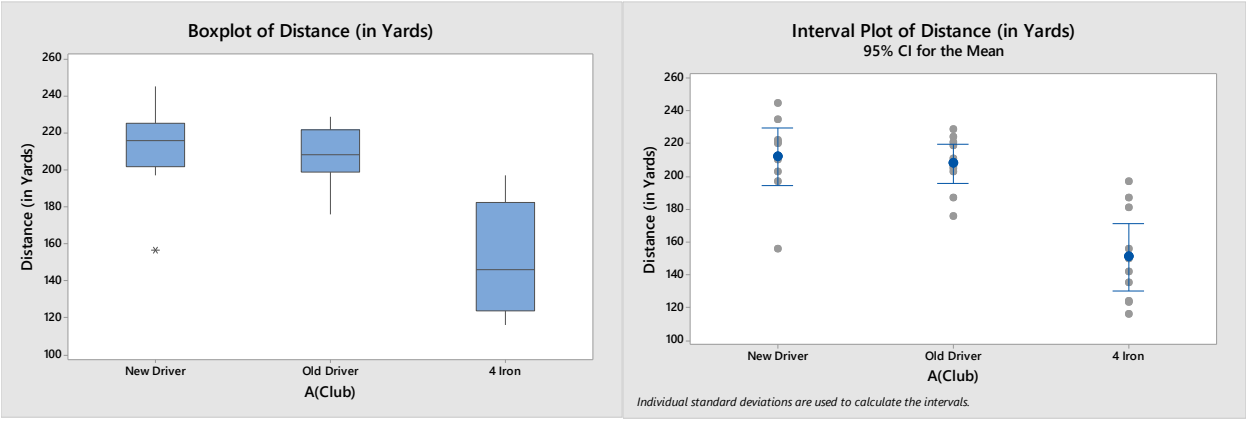


Below shows the residual plots of my Distance response. The normality plot and the histogram look as expected and do not raise any concerns of non-normality. The versus fits plot do not raise any concerns of non-constant variance. The observation order plot seems ok as well. I did notice, however, that my initials shots were all misses of about the same distance. I notice the first few observation run order residuals are tight, and then expand into the second blocked replication.



In conclusion, while I found that club selection generated a statistically significant difference in Distance, it was between the 4-Iron and the Drivers, not between the New and Current Driver. As the boxplot and interval plot below clearly show, this experiment does not support the claim that I should buy a new driver to increase how far I hit the ball.

Rather, I should use my "Old Driver" off the tee-box. Taking a practice swing or warming-up is not necessary.



Straightness (Y2) Results

See below for the ANOVA results of “Straightness”. Similar to the Distance response variable, the Type of Club is significant while the practice swing and warm-up is not significant. In this case, however, the P-value indicates that club selection is not as strong as in the first response.

Method

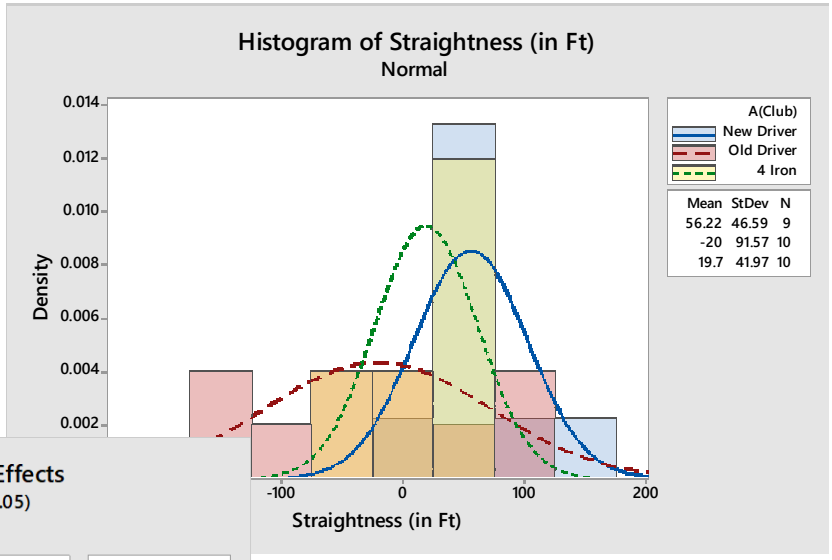
Rows unused 1

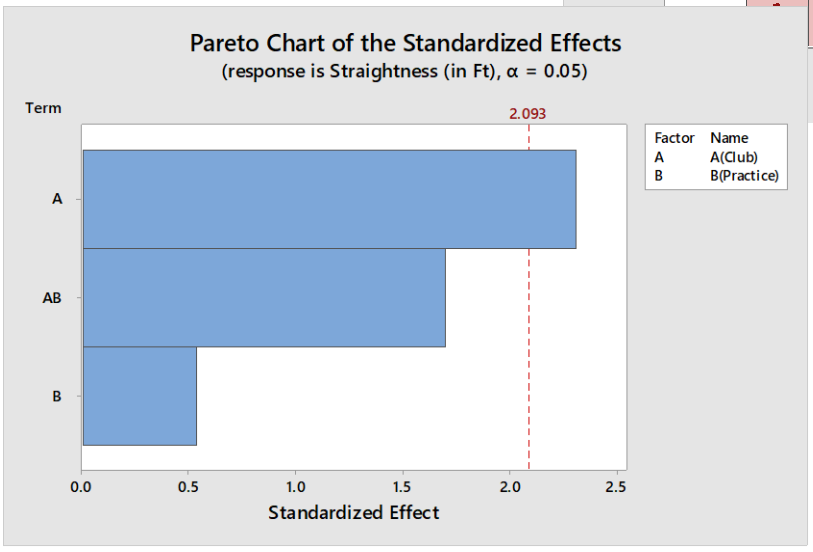
Factor Information

Factor	Levels	Values
A(Club)	3	New Driver, Old Driver, 4 Iron
B(Practice)	2	Yes, No

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Model	9	65917	7324	1.98	0.101
Blocks	4	18610	4653	1.26	0.321
Linear	3	32500	10833	2.92	0.060
A(Club)	2	30680	15340	4.14	0.032
B(Practice)	1	1065	1065	0.29	0.598
2-Way Interactions	2	18755	9378	2.53	0.106
A(Club)*B(Practice)	2	18755	9378	2.53	0.106
Error	19	70373	3704		
Total	28	136291			

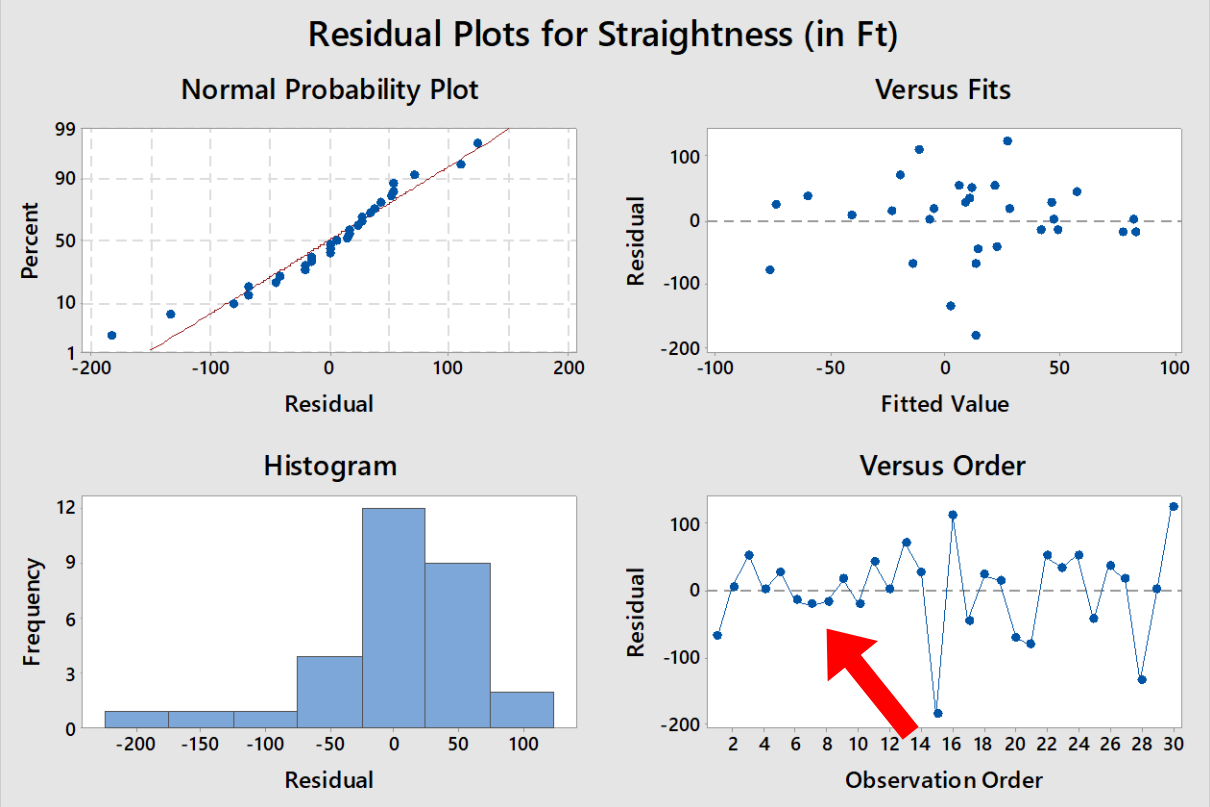




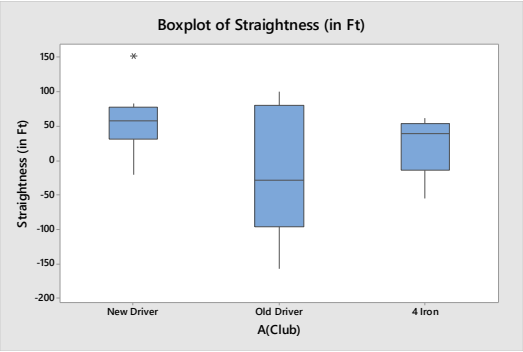
Below shows the residual plots of my Straightness response. The normality plot and the histogram look slightly skewed. This is because I had a couple "very bad" misses to the left (or negative value). I noticed these bad misses while I was at the driving range as being not common. While I left these in the analysis, I did take the worst shot out of the analysis as an outlier.

The versus fits plot do not raise any concerns of non-constant variance. The observation order plot however shows some funneling. Notice that the first 10 shots are close to the residual zero value. I did notice while I was hitting balls that I missed a lot of shots right (this is my common miss).

Throughout the data runs, I eventually corrected this issue with my swing and hit the ball straight more. Reflecting back to my data sheet, of the first 14 runs (or shots), I hit all but 2 balls to the right. I suspect this skewed my average to the right, and thus my initial observations look to be straight, but rather, were "Precise Misses" instead of "Accurate." See the red arrow below.



In conclusion, I found that club selection generated a statistically significant difference in Straightness. However, the residuals give me concern with this conclusion. I would like to record more replications before I conclude that I one of these clubs straighter than the other. The P-value was not as significant with the straightness response as it was with the distance response. See boxplot below.



Experiment Conclusion

I used Minitab optimizer to determine the optimal control factor selections to hit my best shot. I set the “Distance” response be maximized, and the “Straightness” response target 0, with a +/- 30 feet boundary.

Response Optimization: Straightness (in Ft), Distance (in Yards)

Parameters

Response	Goal	Lower	Target	Upper	Weight	Importance
Straightness (in Ft)	Target	-30	0	30	1	1
Distance (in Yards)	Maximum	116	245		1	1

Solution

Solution	A(Club)	B(Practice)	Straightness (in Ft) Fit	Distance (in Yards) Fit	Composite Desirability
1	Old Driver	No	-20	208.4	0.488630

Multiple Response Prediction

Variable	Setting
A(Club)	Old Driver
B(Practice)	No

Response	Fit	SE Fit	95% CI	95% PI
Straightness (in Ft)	-20.0	20.4	(-62.0, 22.0)	(-159.4, 119.4)
Distance (in Yards)	208.4	11.1	(185.2, 231.6)	(151.6, 265.2)

The result of the optimizer is that I use my trusty old driver, and do not take a practice swing. See the optimizer results above.

After the analysis, I cannot conclude that buying a new driver at this time is justified. Rather, I will spend the money on lessons and practice sessions to improve my golf swing variability (uncontrolled variable).

I was surprised that my “warm-up” was not significant. This means I can avoid buying a bucket of practice balls before I play a round of golf. Regarding club selection off the tee-box, I will use driver rather than 4-iron. My increased distance is significant, while my “straightness” is not between these two clubs.