Problem 9-2 (as stated in *RSM Simplified*)

Consider the following standard deviations in the input factors for the DOE golfer discussed in Problem 8-2:

A. *Length, plus or minus 1 inch.*

B. *Angle, plus or minus 1 degree.*

C. *Weight, plus or minus 0.1 (assume washers vary in weight).*

There are many setups that achieve the goal of 72 inches, but will some result in less propagation of error (POE) transmitted from these variations?

Solution to Problem 9-2

Start by running Design-Expert® software – the program provided with the *RSM Simplified* book. If you have not already completed Problem 8-2, do so now and save your work as noted near the end. Now, go to **File**, **Open Design** and double-click the analyzed data you saved as "**8-2 Prob - Golf - analyzed.dx7**" or the like.

Now select **View**, **Column Info Sheet**. Note that the standard deviation of the response is already entered based on root means square error of the model ANOVA (done previously). Enter the standard deviations for the input factors as noted above and shown on the screen shot below.

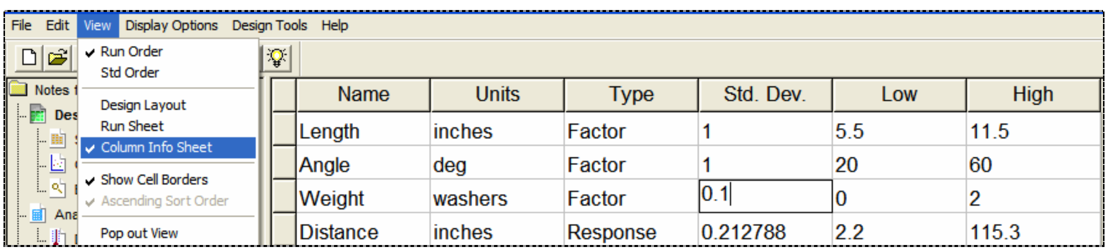


Figure 9-2.1: Entering standard deviations for factors

Under the **Analysis** branch click the **Distance** node, which should be labeled "analyzed" based on the work you did in Problem 8-2. The response was transformed via the square root function as you will see on screen.

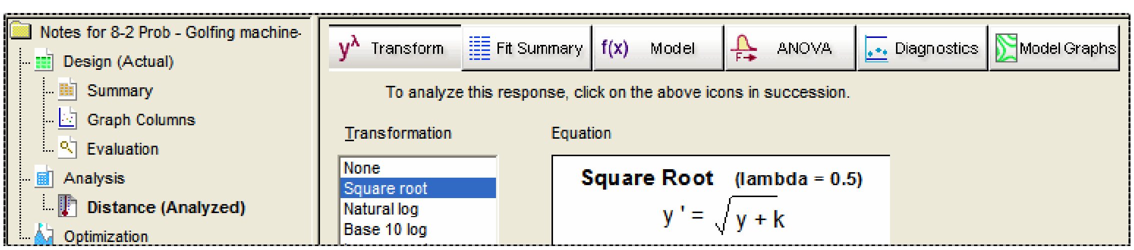


Figure 9-2.2: Looking at the response analysis

Press ahead to ***Model Graphs*** and select **Display Options** and make sure it is checked off on **Responses in Transformed Scale** (may already be there by default).

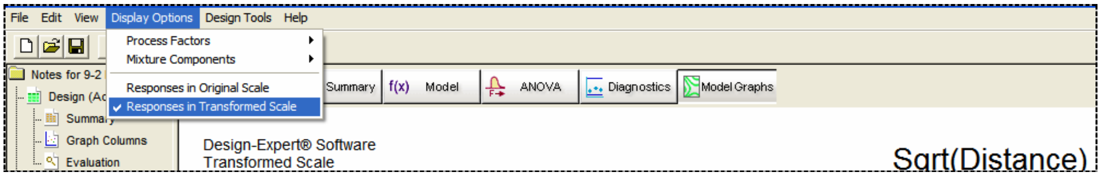


Figure 9-2.3: Display option in transformed scale

Now you will be enabled to select **View**, **Propagation of Error**. (Note: POE cannot be calculated in original scale from a model done on a transformed response.)

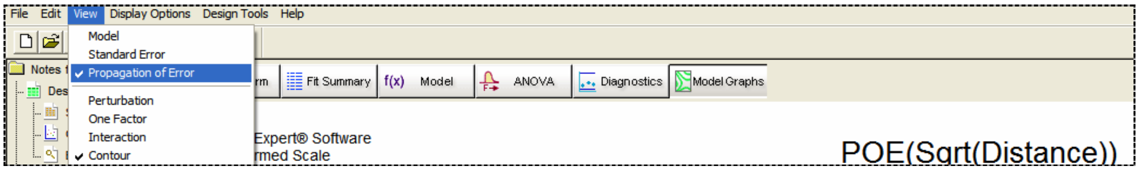


Figure 9-2.4: Viewing propagation of error

Next go to **View** and select **3D Surface**. Now you can see that variation in the distance response due to propagation of error from the input factors can be reduced by lessening the angle (B) and increasing the length (A).

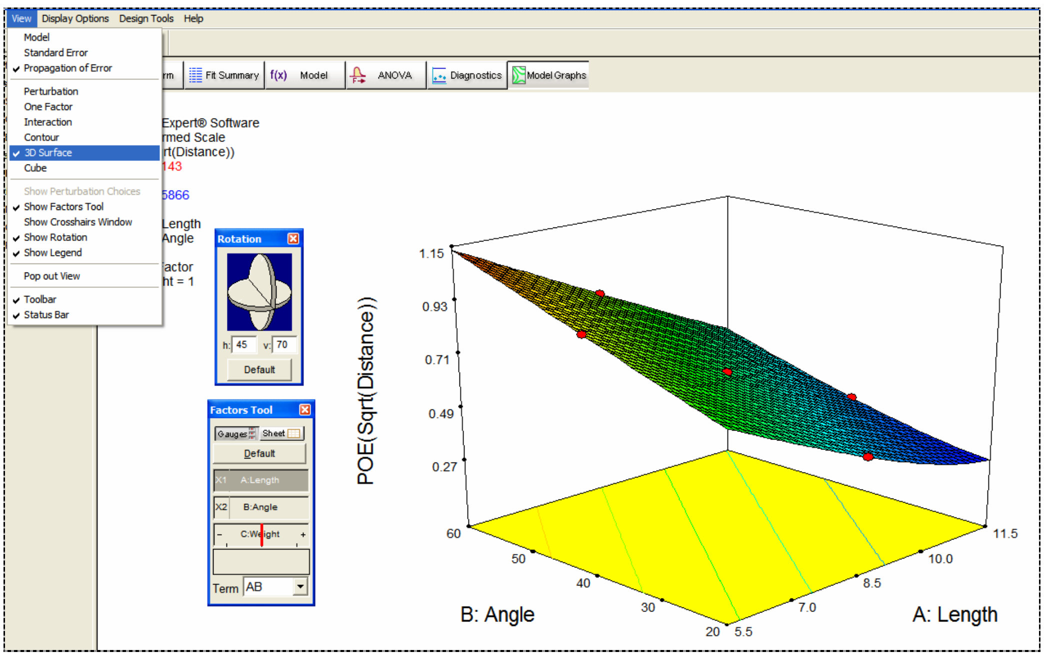


Figure 9-2.5: 3D view of POE

However, it won't do to simply make these adjustments on DOE Golfer because the putt will then go far off target. See what you can do to keep your putting both accurate and precise under the **Optimization** branch by clicking the **Numerical** node and selecting the **Sqrt(Distance)** variable. Then in **Display Options** and select **Responses in Original Scale**.

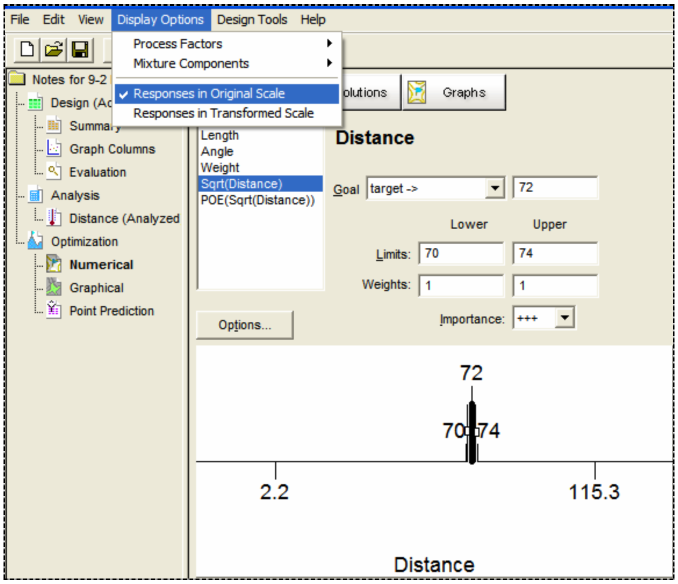


Figure 9-2.6: Checking criteria for primary response

The target for distance should be entered as 72 inches with a range of 70 to 74 inches. Now click the **POE** and set its **Goal** to **minimize**.

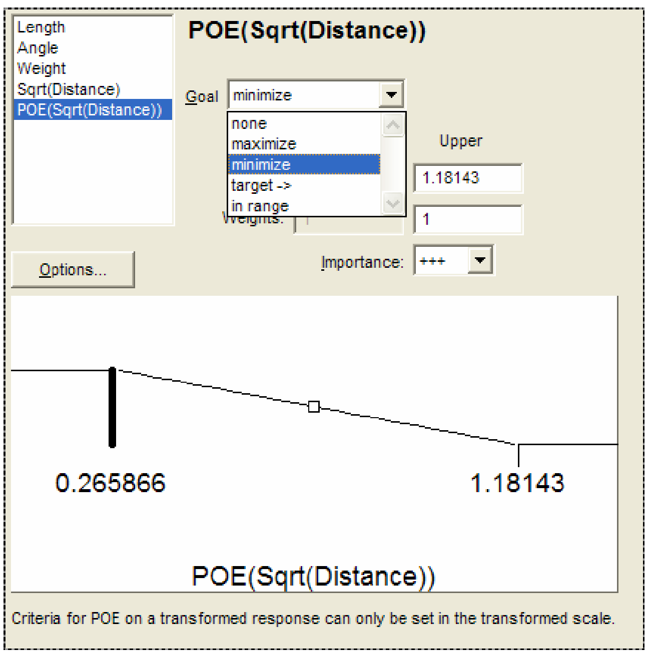
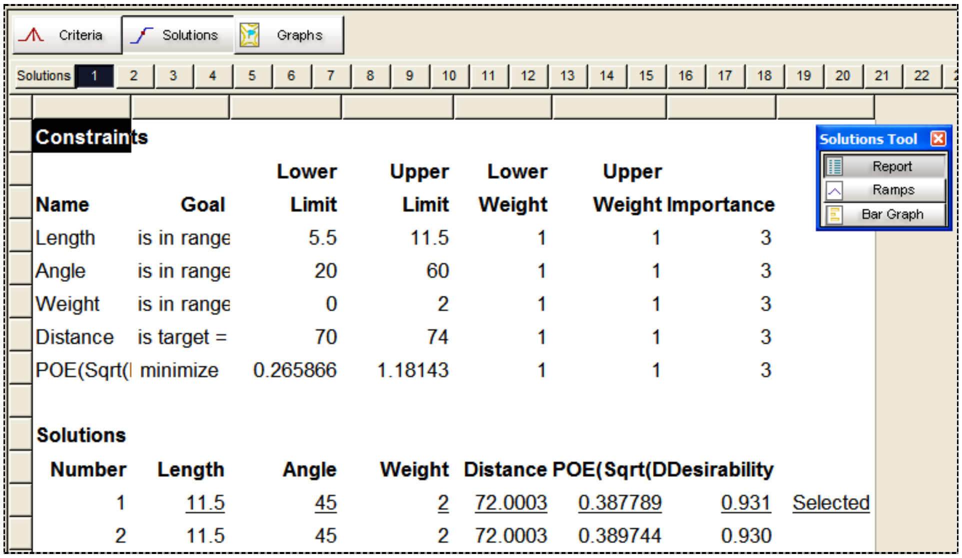


Figure 9-2.7: Minimizing POE

Click the ***Solutions*** button. Due to the random nature of its search, the software will produce varying solutions, but you should see a most desirable outcome similar to that shown in the screen shot below.



Constraints

Name	Goal	Lower Limit	Upper Limit	Lower Weight	Upper Weight	Importance
Length	is in range	5.5	11.5	1	1	3
Angle	is in range	20	60	1	1	3
Weight	is in range	0	2	1	1	3
Distance	is target =	70	74	1	1	3
POE(Sqrt(I	minimize	0.265866	1.18143	1	1	3

Solutions

Number	Length	Angle	Weight	Distance	POE(Sqrt(D	Desirability	
1	11.5	45	2	72.0003	0.387789	0.931	Selected
2	11.5	45	2	72.0003	0.389744	0.930	

Figure 9-2.8: Optimizing DOE Golfer to putt a given distance with minimal POE

Notice that the top solutions are relatively consistent compared to what you generated in Problem 8-2 – prior to taking POE into account. Wouldn't it be nice to not only be good at lagging your putts near the hole, but also do it consistently, regardless of how your stroke may vary?