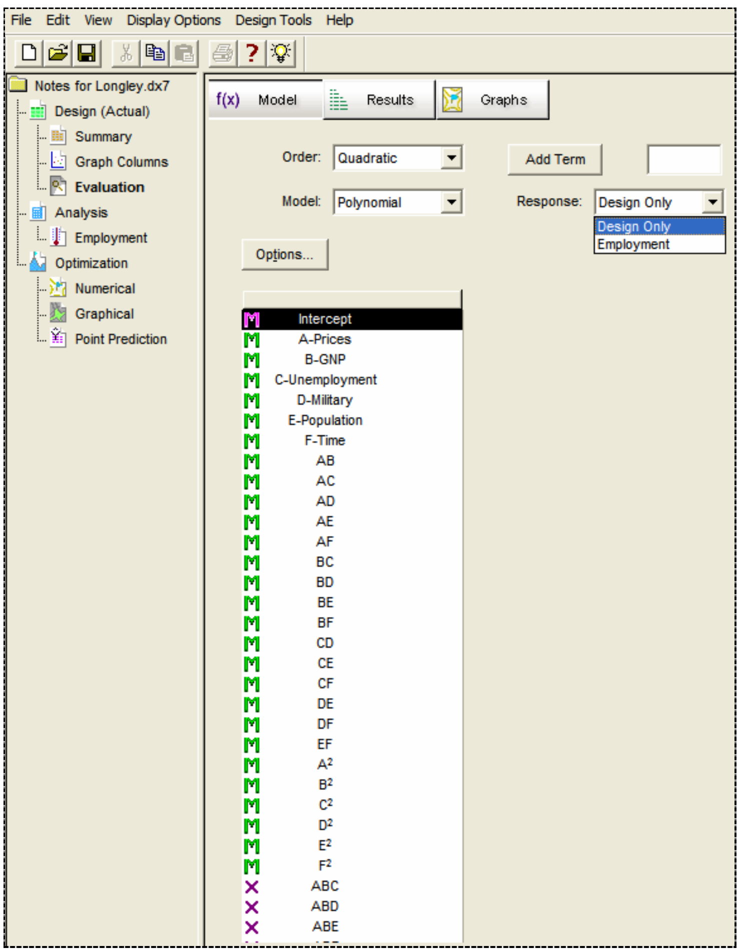
Historical Data RSM Tutorial (Part 2 – Advanced Topics)

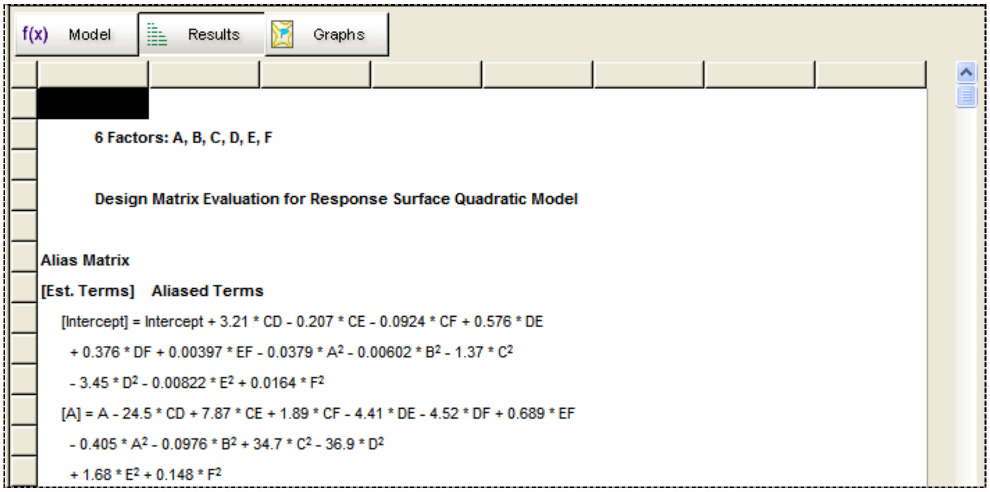
Design Evaluation

If you still have the Longley data active in Design-Expert software from Part 1 of this tutorial, continue on. If you exited the program, re-start it and use **File, Open Design** to open your data file (**Longley.dx7**). Then under the **Design** branch of the program click **Evaluation**. The software comes up with a quadratic polynomial model by default, but, as you will see, the order must be downgraded to linear (we will get to that momentarily). The screen shot shows the Response field set at "Design Only" as opposed to the response of Employment. In other words, it will evaluate the entire matrix of factors, regardless of whether response data are present. The other option comes in handy when users set up a design for multiple responses, but then end up with missing data for some, thus degrading the "designed-for" model.



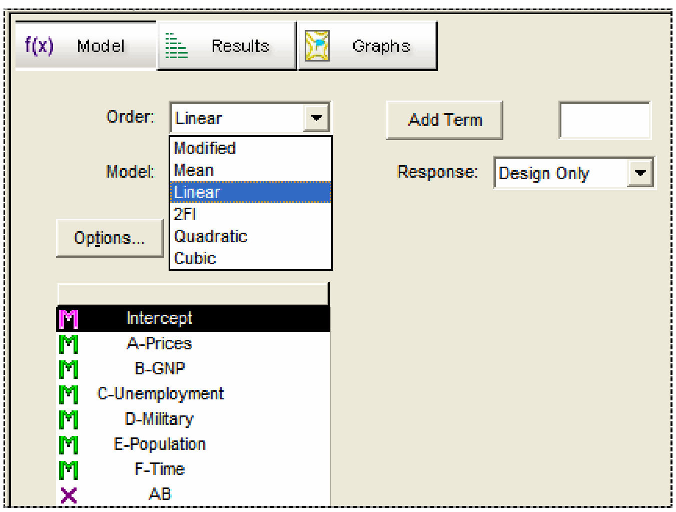
Design evaluation (design only)

Press the ***Results*** button.



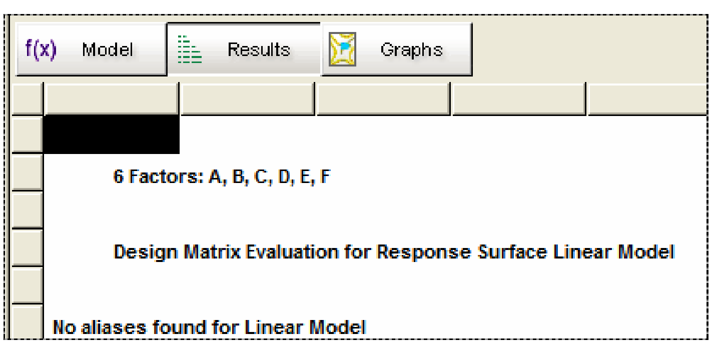
Results of evaluation for quadratic polynomial

This model is badly aliased. For example, the effect of A is confounded with -24.5CD, etc. Go back to ***Model*** and reduce the **Order** to **Linear**.



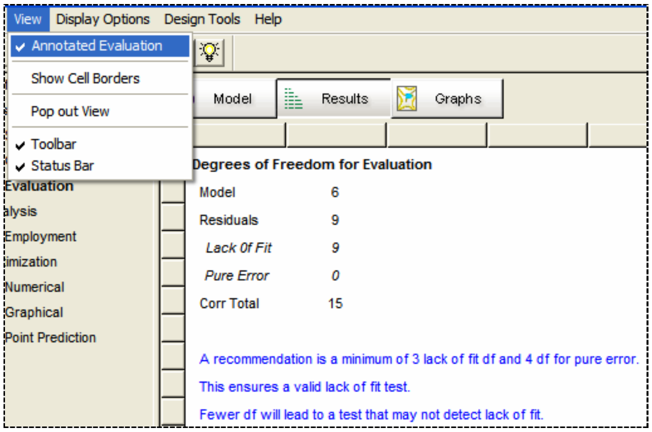
Re-setting the order to linear

Press ***Results*** and note that "No aliases are found". Much better!



Results of evaluation for linear model

Scroll down to the degrees of freedom (df) table. Looking over the annotations provided by the software (activated via View, Annotations), notice that this design flunks the recommendation for pure error df. Of course this really is not a designed experiment, but rather historical data collected at happenstance.



Annotations for degrees of freedom

Study the next section of the evaluation by Design-Expert. Do any of the statistics pass the tests suggested for a good design? No!

				Power at 5 % alpha level for effect of		
Term	StdErr**	VIF	Ri-Squared	0.5 Std. Dev.	1 Std. Dev.	2 Std. Dev.
A	4.72	135.53	0.9926	5.0 %	5.1 %	5.4 %
B	17.61	1788.51	0.9994	5.0 %	5.0 %	5.0 %
C	2.35	33.62	0.9703	5.1 %	5.4 %	6.7 %
D	0.75	3.59	0.7214	6.0 %	9.2 %	22.2 %
E	8.33	399.15	0.9975	5.0 %	5.0 %	5.1 %
F	11.21	758.98	0.9987	5.0 %	5.0 %	5.1 %

**Basis Std. Dev. = 1.0

Standard errors should be similar within type of coefficient. Smaller is better.

Ideal VIF is 1.0. VIF's above 10 are cause for alarm,
indicating coefficients are poorly estimated due to multicollinearity.

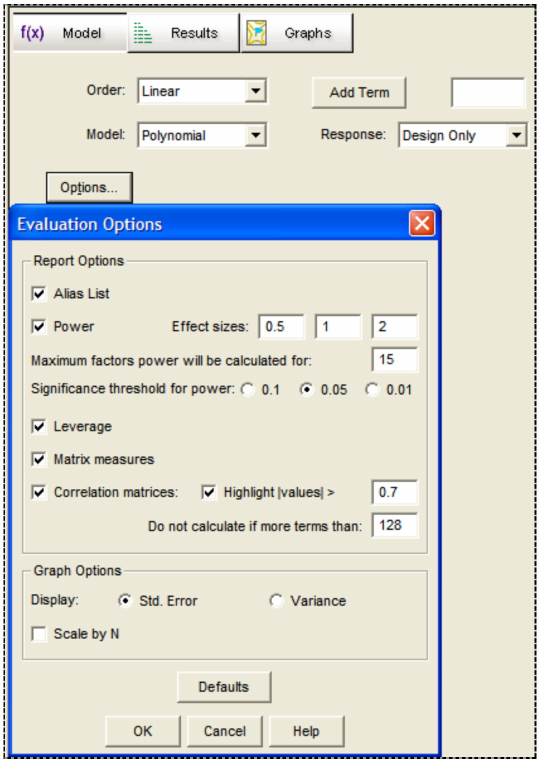
Ideal R-squared is 0.0. High R-squared means terms are correlated with each other,
possibly leading to poor models.

Power should be approximately 80% for the effect you want to detect.
Be sure to set the Model (on previous screen) to be an estimate of the terms you expect to be significant.

Details on model terms, including power

Scroll down to the leverage report, which come out surprisingly good – none exceed twice the average.

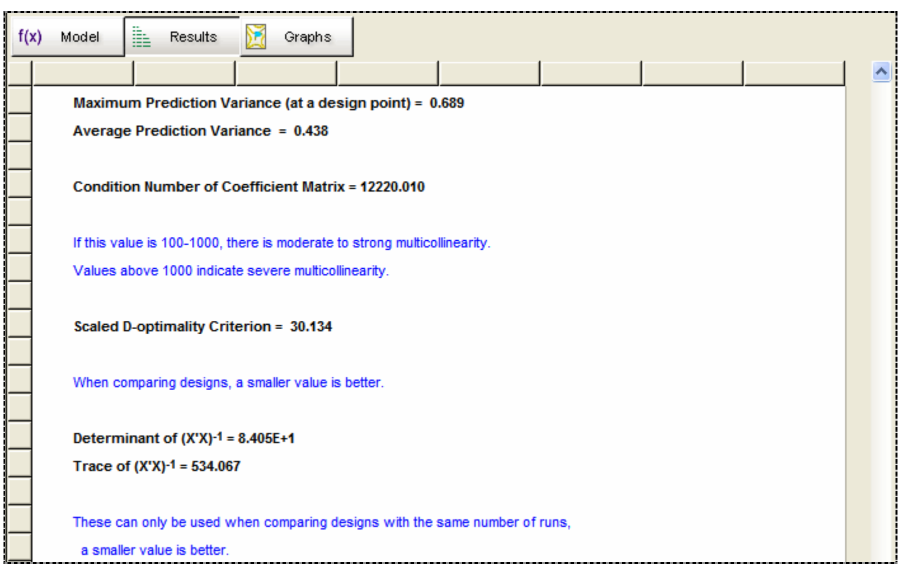
More statistics become available by going back to Model, selecting Options and turn on the Matrix Measure and Correlation Matrices.



Turning on more options for report

Click **OK** and look at the **Results**.

Scroll down and look for the new statistics.



Matrix measures for design evaluation

Notice that the condition number (12,220) far exceeds the level considered to represent severe multicollinearity for a design matrix (1000 or less). A look at the specific correlations reveals why.

Correlation Matrix of Regression Coefficients

	Intercept	A	B	C	D	E	F
Intercept	1.000						
A	-0.527	1.000					
B	0.523	-0.649	1.000				
C	0.518	-0.555	0.946	1.000			
D	0.557	-0.349	0.469	0.619	1.000		
E	-0.082	0.659	-0.833	-0.758	-0.189	1.000	
F	-0.608	0.186	-0.802	-0.824	-0.549	0.388	1.000

Correlation Matrix of Factors [Pearson's r]

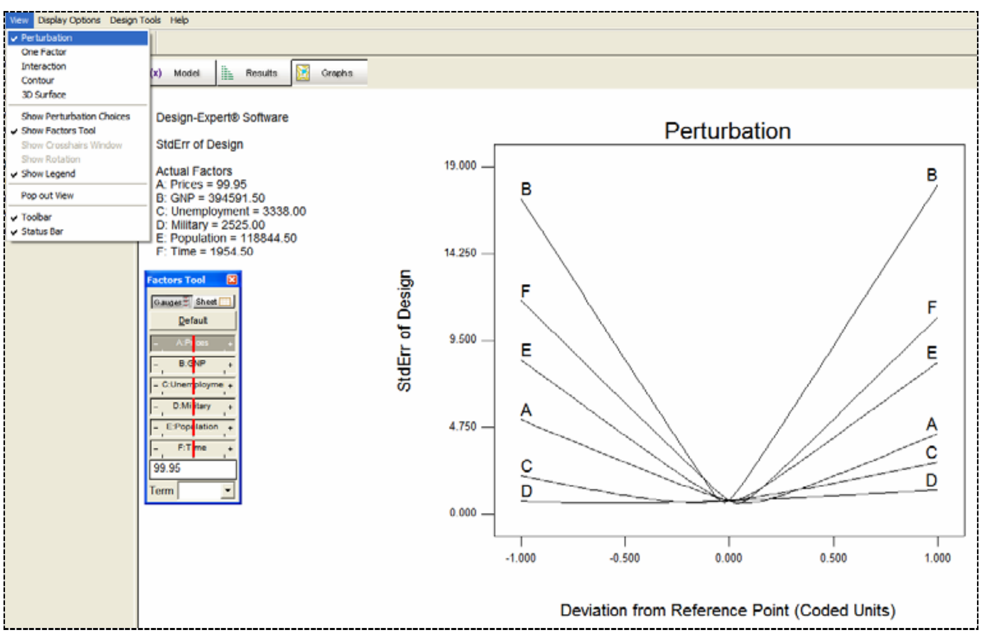
	A	B	C	D	E	F
A	1.00					
B	0.99	1.00				
C	0.62	0.60	1.00			
D	0.46	0.45	-0.18	1.00		
E	0.98	0.99	0.69	0.36	1.00	
F	0.99	1.00	0.67	0.42	0.99	1.00

Off-diagonal values close to zero are better.

Correlation matrices

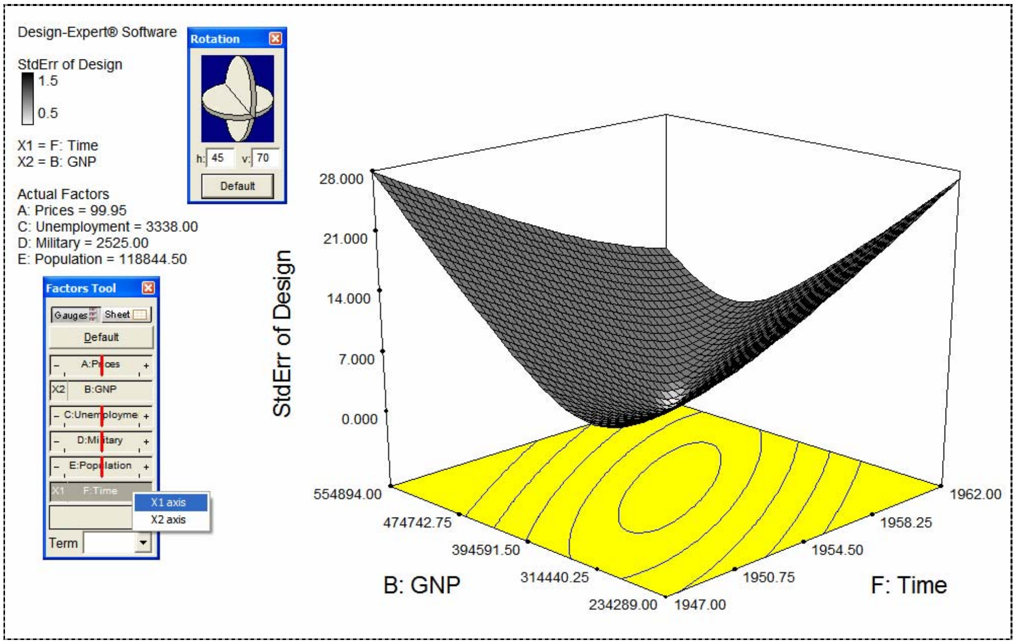
Notice the many values highlighted for being unacceptably high. No wonder Longley picked this data to test regression software!

Now, just for fun, press the ***Graphs*** button and select **View**, **Perturbation**.



Perturbation plot for standard error

Notice the factors B and F exhibit the most dramatic tracks for standard error. Select **View**, **3D Surface** and on the **Factors Tool** do a right-click on factor **F:Time** and make it the **X1 axis**.



3D view of standard error for factors B and F

There's no sense doing anything more. By now it's clear that this 'design' fails all the tests for a good experiment, but that's generally the nature of the beast for happenstance data.