Design of Experiments Using Statgraphics Centurion

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Web site: www.statgraphics.com

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Design of Experiments Wizard

- Phase 1: Creating an experiment
- Phase 2: Analyzing the results
- Phase 3: Further experimentation

Phase 1: Creating an experiment

- Phase 1: Creating an experiment
  - Step 1: Define responses
  - Step 2: Define experimental factors
  - Step 3: Select design
  - Step 4: Specify model
  - Step 5: Select runs
  - Step 6: Evaluate design
  - Step 7: Save design
- Phase 2: Analyzing the results
- Phase 3: Further experimentation

Phase 2: Analyzing the results

- Phase 1: Creating an experiment
- Phase 2: Analyzing the results
  - Step 8: Analyze data
  - Step 9: Optimize responses
  - Step 10: Save results
- Phase 3: Further experimentation

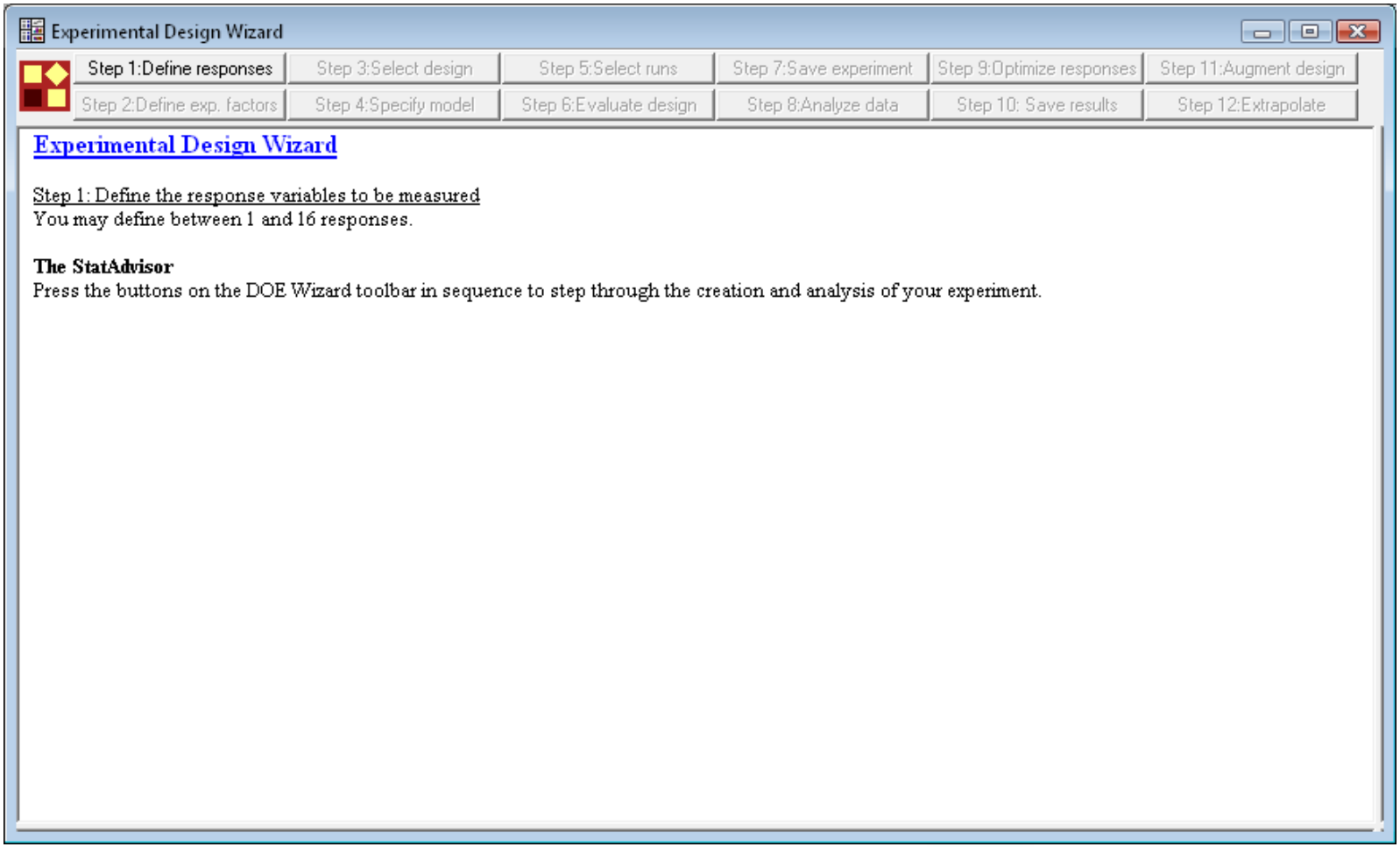
Phase 3: Further experimentation

- Phase 1: Creating an experiment
- Phase 2: Analyzing the results
- Phase 3: Further experimentation
  - Step 11: Augment design
  - Step 12: Extrapolate

Example – from Response Surface Methodology by Myers and Montgomery

Find the settings of *time*, *temperature* and *catalyst* that maximize the *conversion percentage* of a chemical process while keeping the *thermal activity* as close as possible to 57.5.

DOE Wizard – Main Window



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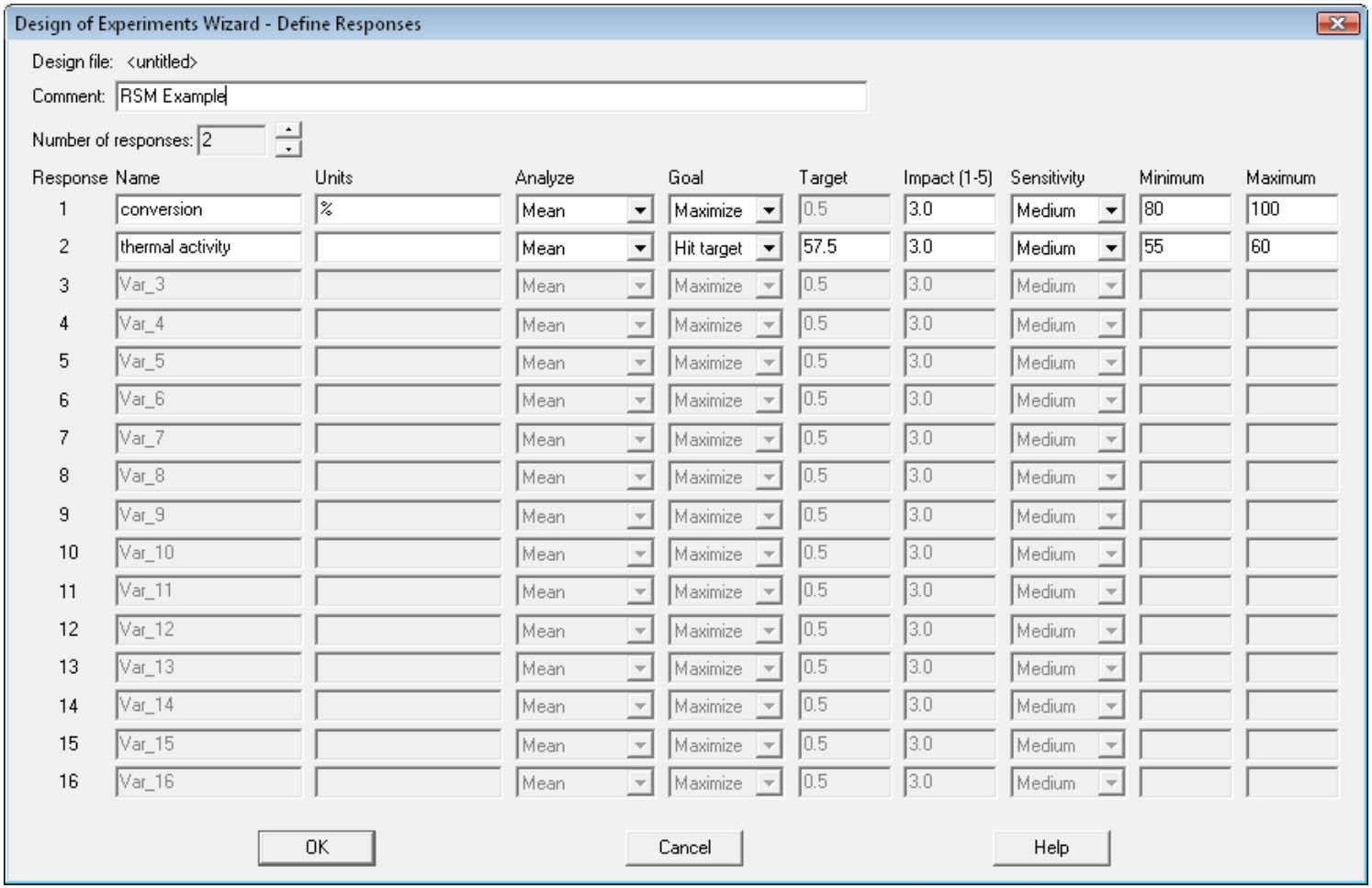
Step 1: Define responses



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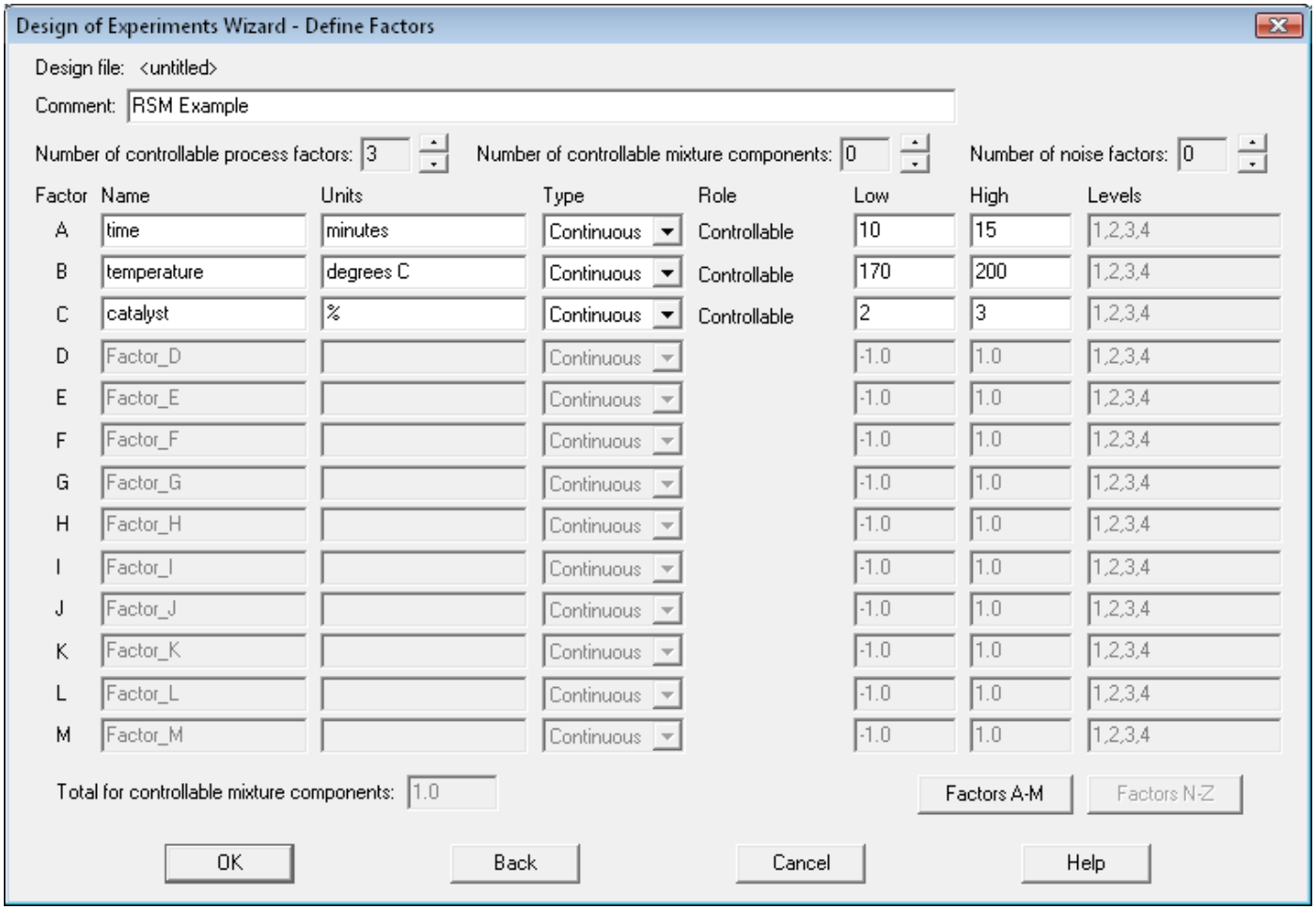
Step 2: Define experimental factors



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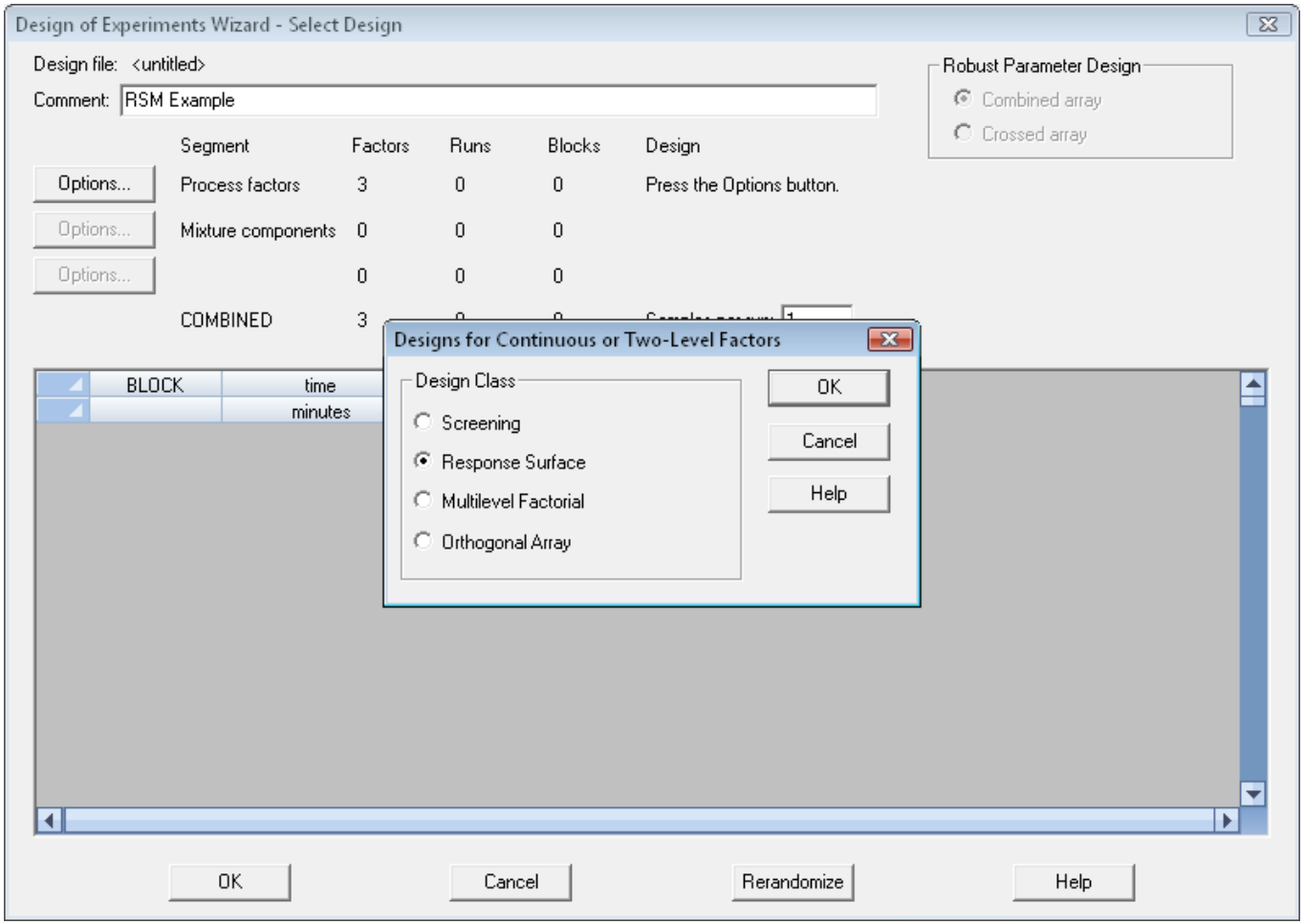
Step 3: Select design



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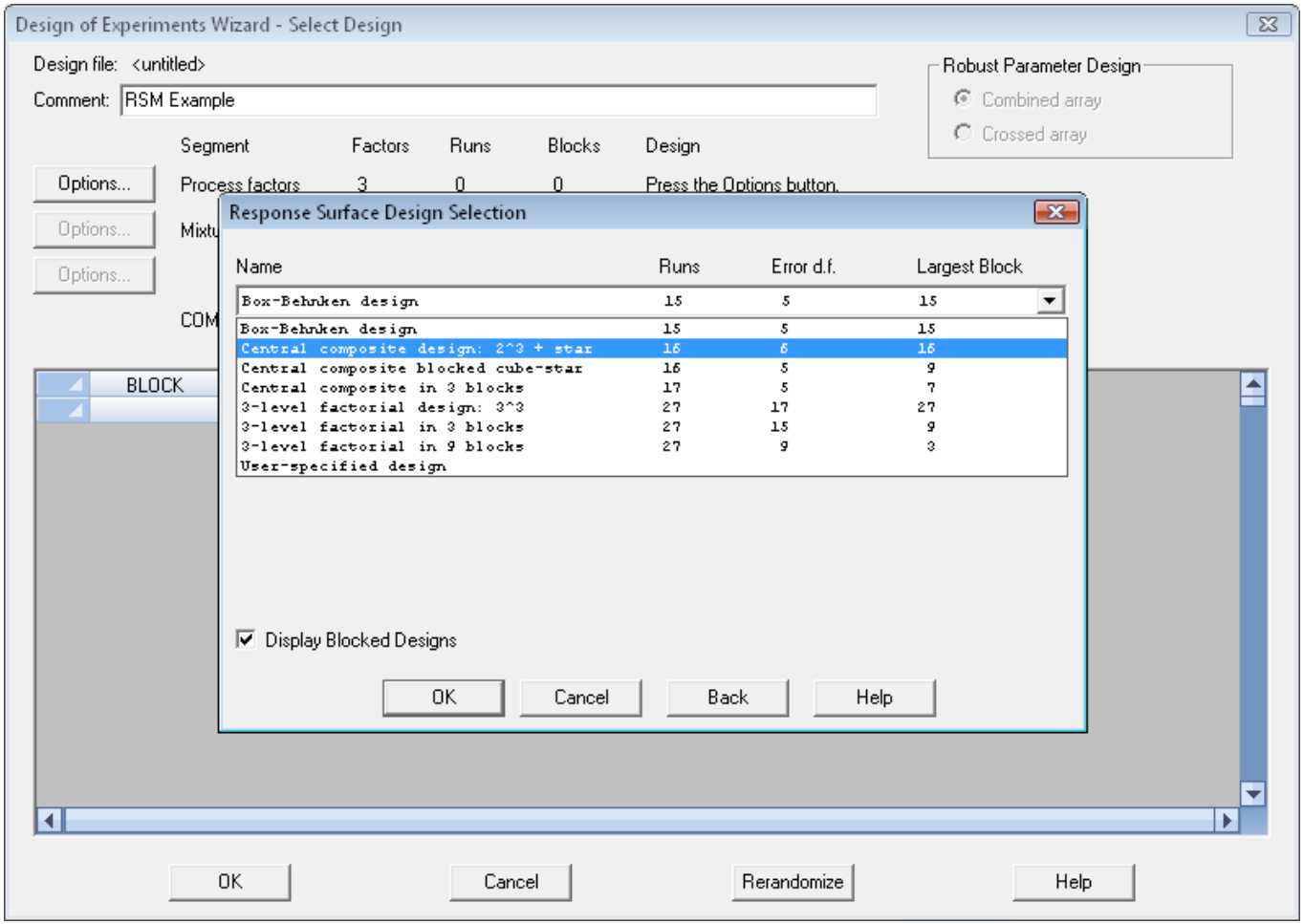
Step 3: Select design (cont.)



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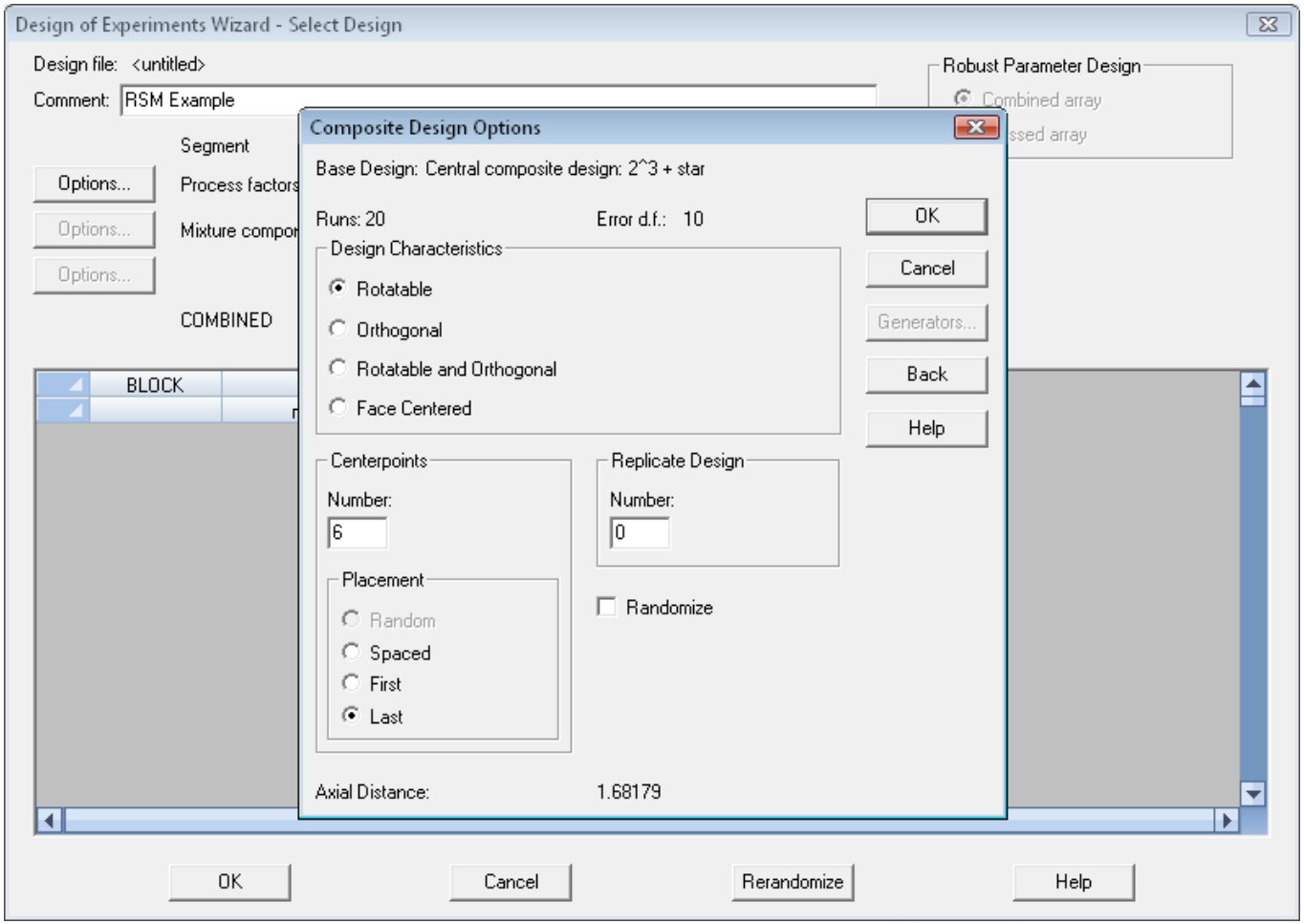
Step 3: Select design (cont.)



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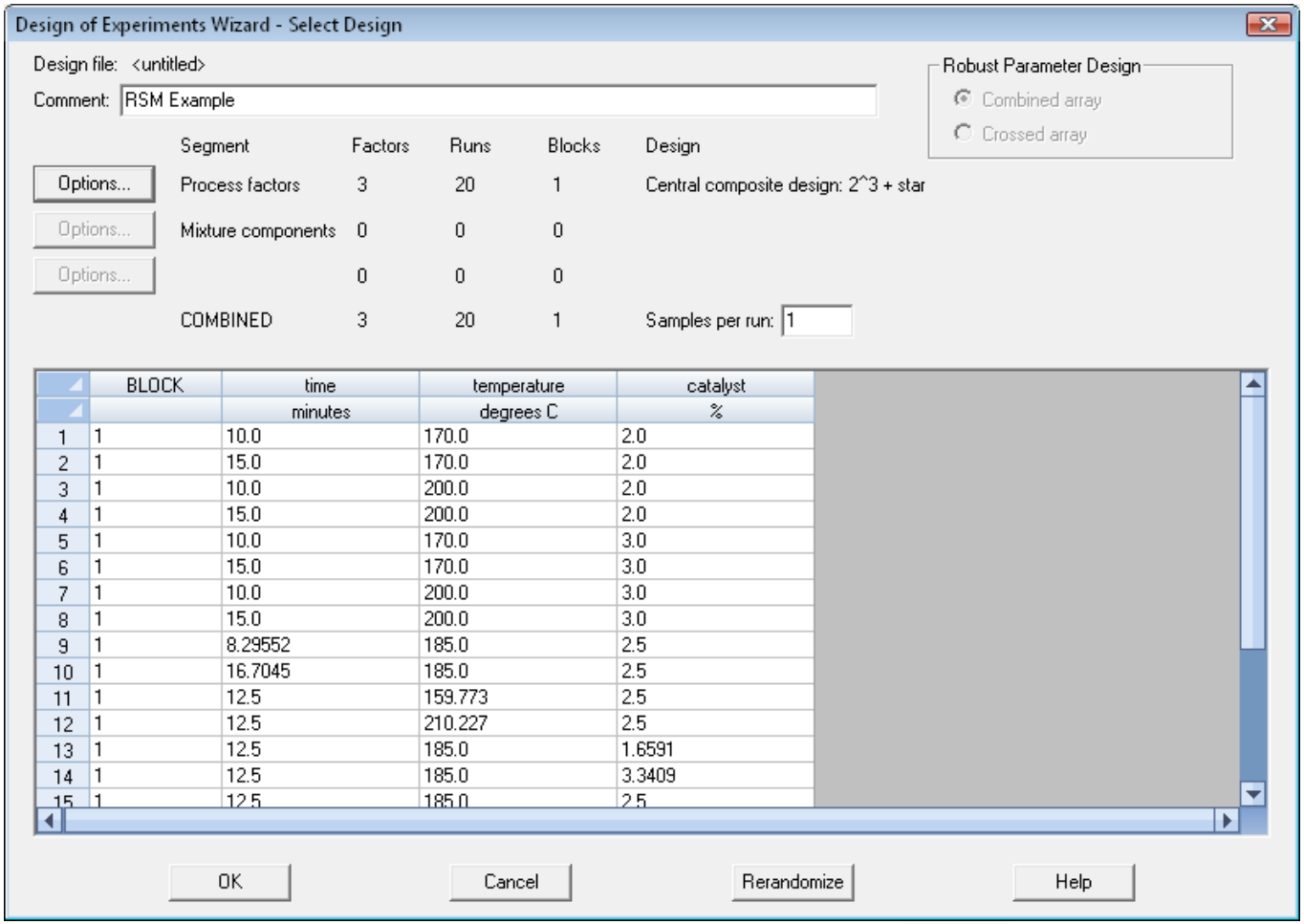
Step 3: Select design (cont.)



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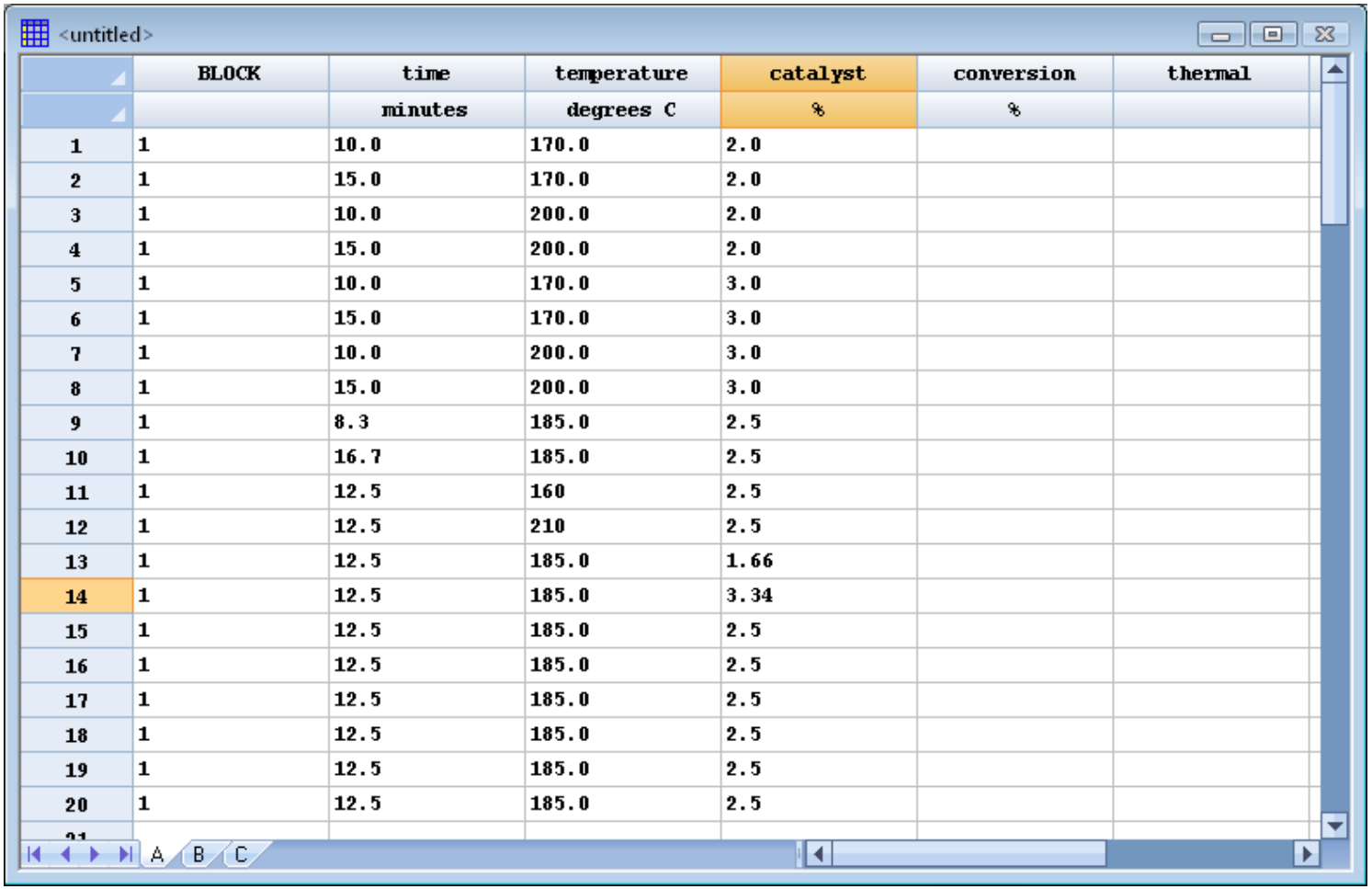
Datasheet



	BLOCK	time	temperature	catalyst	conversion	thermal
		minutes	degrees C	%	%	
1	1	10.0	170.0	2.0		
2	1	15.0	170.0	2.0		
3	1	10.0	200.0	2.0		
4	1	15.0	200.0	2.0		
5	1	10.0	170.0	3.0		
6	1	15.0	170.0	3.0		
7	1	10.0	200.0	3.0		
8	1	15.0	200.0	3.0		
9	1	8.3	185.0	2.5		
10	1	16.7	185.0	2.5		
11	1	12.5	160	2.5		
12	1	12.5	210	2.5		
13	1	12.5	185.0	1.66		
14	1	12.5	185.0	3.34		
15	1	12.5	185.0	2.5		
16	1	12.5	185.0	2.5		
17	1	12.5	185.0	2.5		
18	1	12.5	185.0	2.5		
19	1	12.5	185.0	2.5		
20	1	12.5	185.0	2.5		

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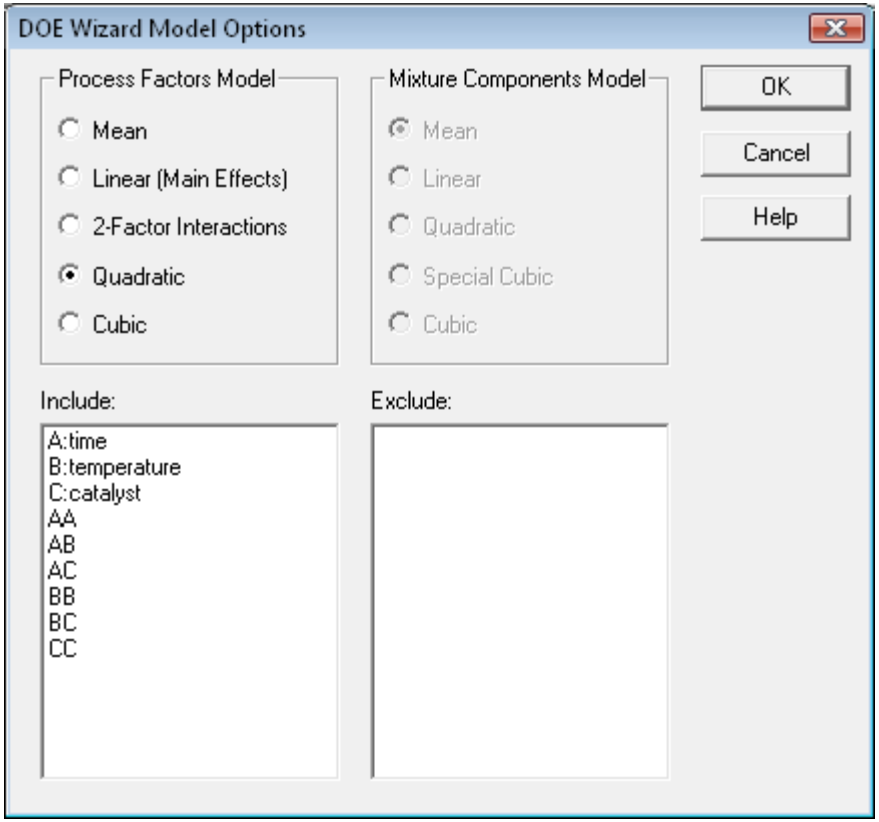
Step 4: Select model



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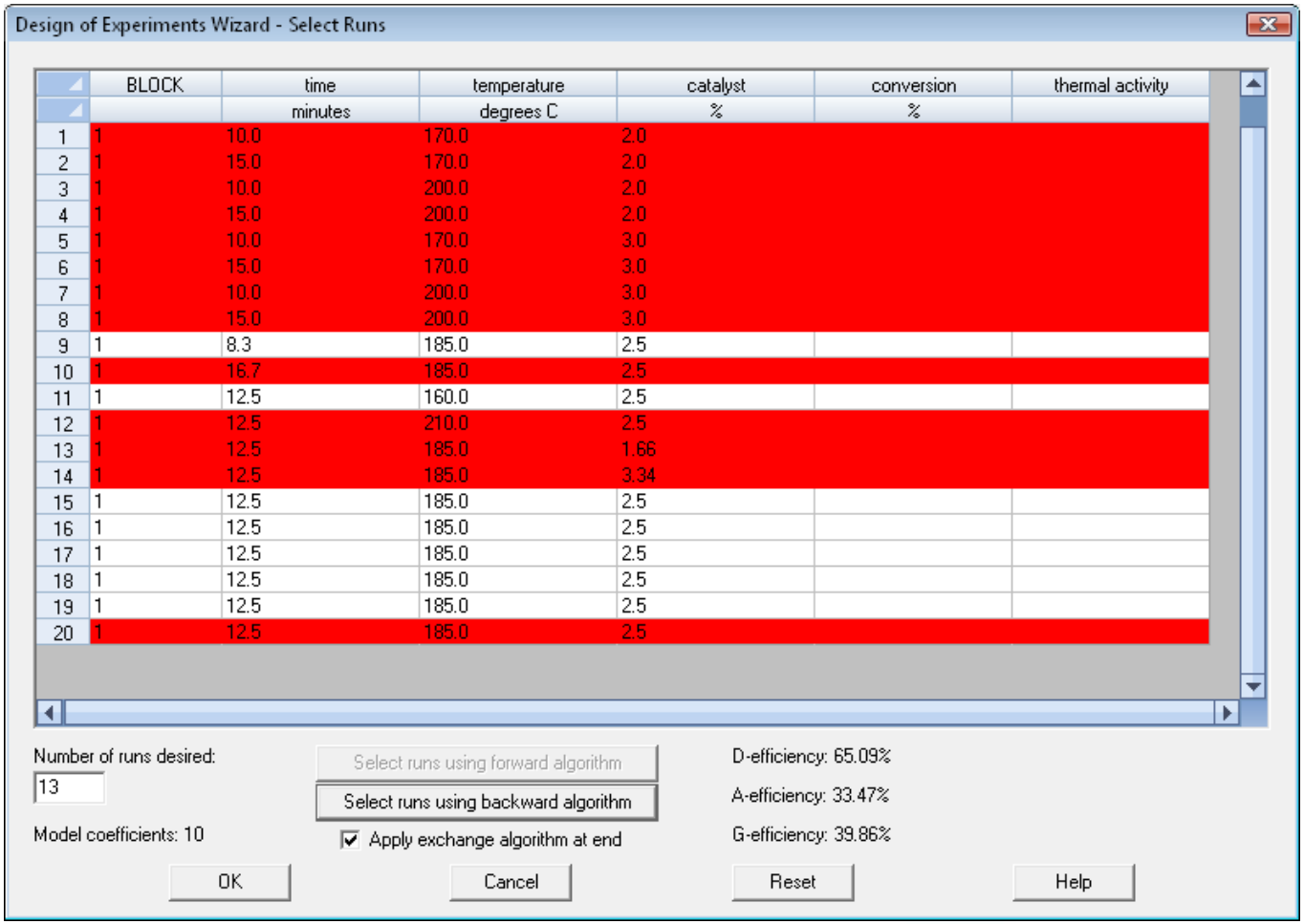
Step 5: Select runs (D-optimal design only)



	BLOCK	time	temperature	catalyst	conversion	thermal activity
		minutes	degrees C	%	%	
1	1	10.0	170.0	2.0		
2	1	15.0	170.0	2.0		
3	1	10.0	200.0	2.0		
4	1	15.0	200.0	2.0		
5	1	10.0	170.0	3.0		
6	1	15.0	170.0	3.0		
7	1	10.0	200.0	3.0		
8	1	15.0	200.0	3.0		
9	1	8.3	185.0	2.5		
10	1	16.7	185.0	2.5		
11	1	12.5	160.0	2.5		
12	1	12.5	210.0	2.5		
13	1	12.5	185.0	1.66		
14	1	12.5	185.0	3.34		
15	1	12.5	185.0	2.5		
16	1	12.5	185.0	2.5		
17	1	12.5	185.0	2.5		
18	1	12.5	185.0	2.5		
19	1	12.5	185.0	2.5		
20	1	12.5	185.0	2.5		

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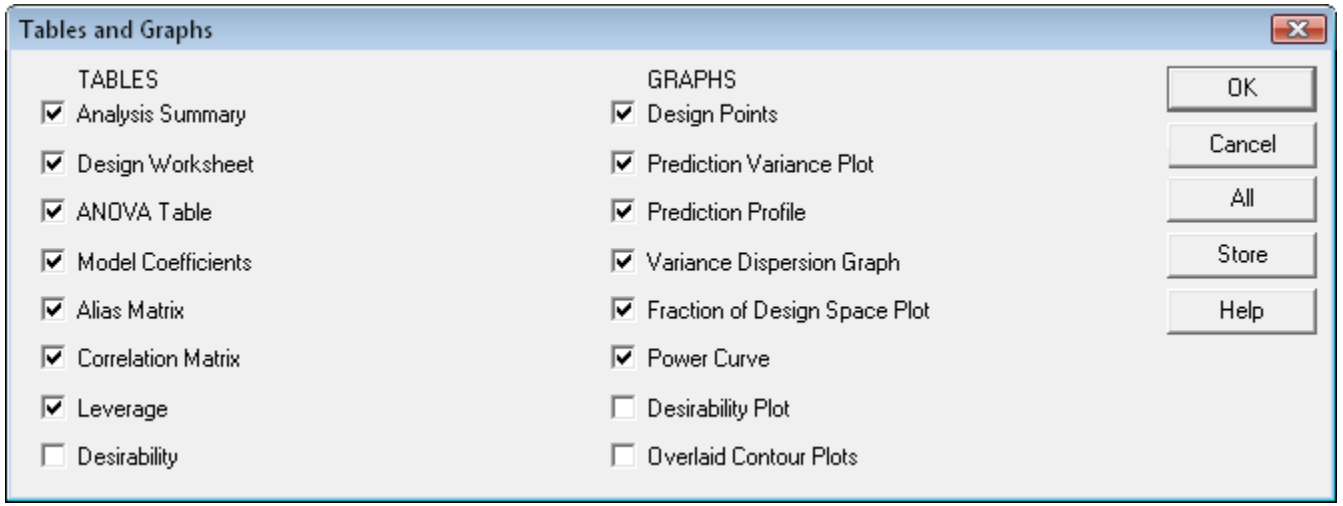
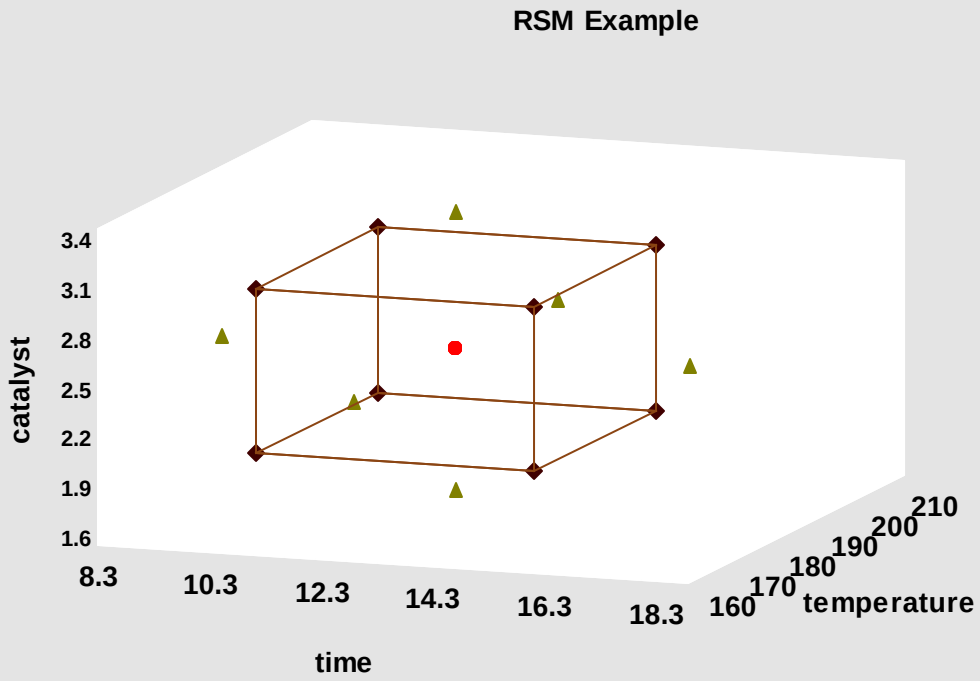
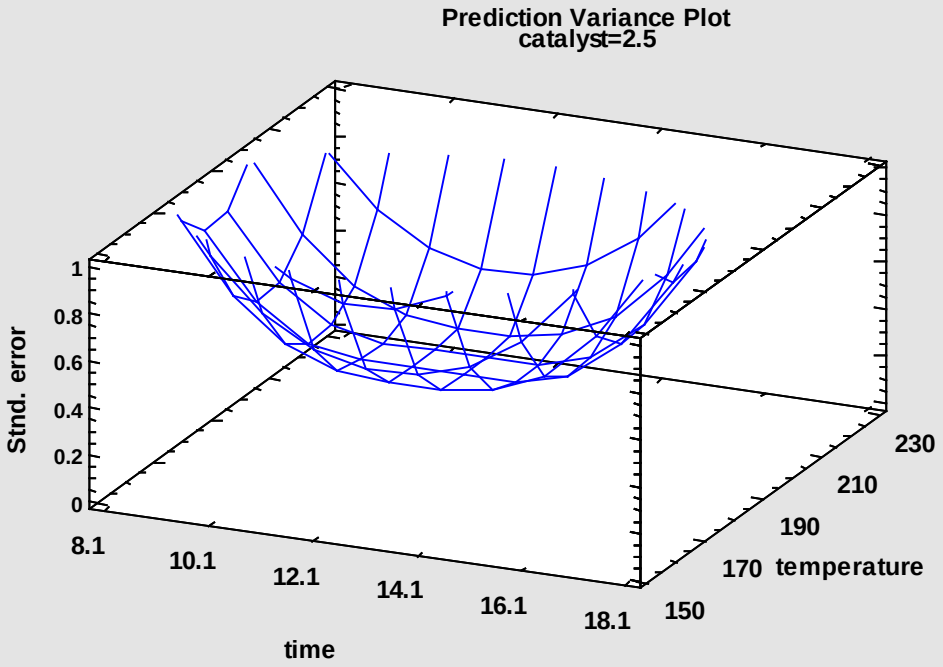
Step 6: Evaluate design



Plot of design space



Prediction variance plot



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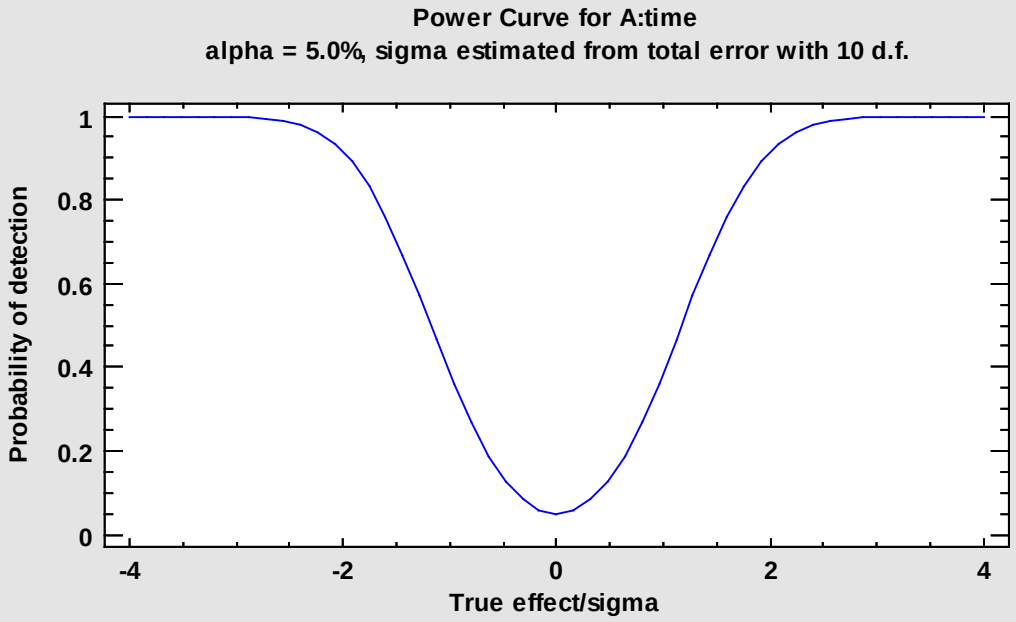
Power curve



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Do the experiment!
Then enter the results:

Conversion & activity.sgx

	BLOCK	time	temperature	catalyst	conversion	thermal activity
		minutes	degrees C	%	%	
1	1	10.0	170.0	2.0	74	53.2
2	1	15.0	170.0	2.0	51	62.9
3	1	10.0	200.0	2.0	88	53.4
4	1	15.0	200.0	2.0	70	62.6
5	1	10.0	170.0	3.0	71	57.3
6	1	15.0	170.0	3.0	90	67.9
7	1	10.0	200.0	3.0	66	59.8
8	1	15.0	200.0	3.0	97	67.8
9	1	8.3	185.0	2.5	76	59.1
10	1	16.7	185.0	2.5	79	65.9
11	1	12.5	160	2.5	85	60
12	1	12.5	210	2.5	97	60.7
13	1	12.5	185.0	1.66	55	57.4
14	1	12.5	185.0	3.34	81	63.2
15	1	12.5	185.0	2.5	81	59.2
16	1	12.5	185.0	2.5	75	60.4
17	1	12.5	185.0	2.5	76	59.1
18	1	12.5	185.0	2.5	83	60.6
19	1	12.5	185.0	2.5	80	60.8
20	1	12.5	185.0	2.5	91	58.9

Conversion & activity | B | C

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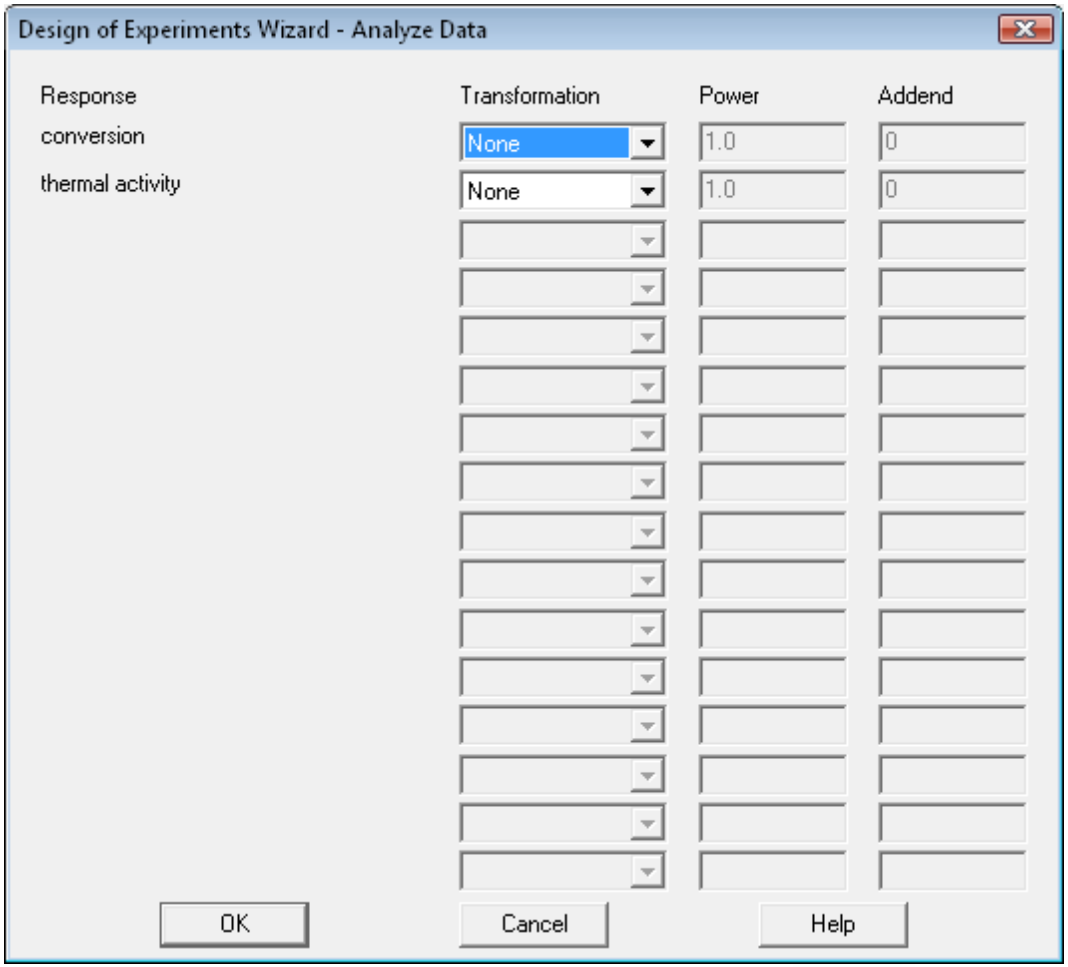
Step 8: Analyze data



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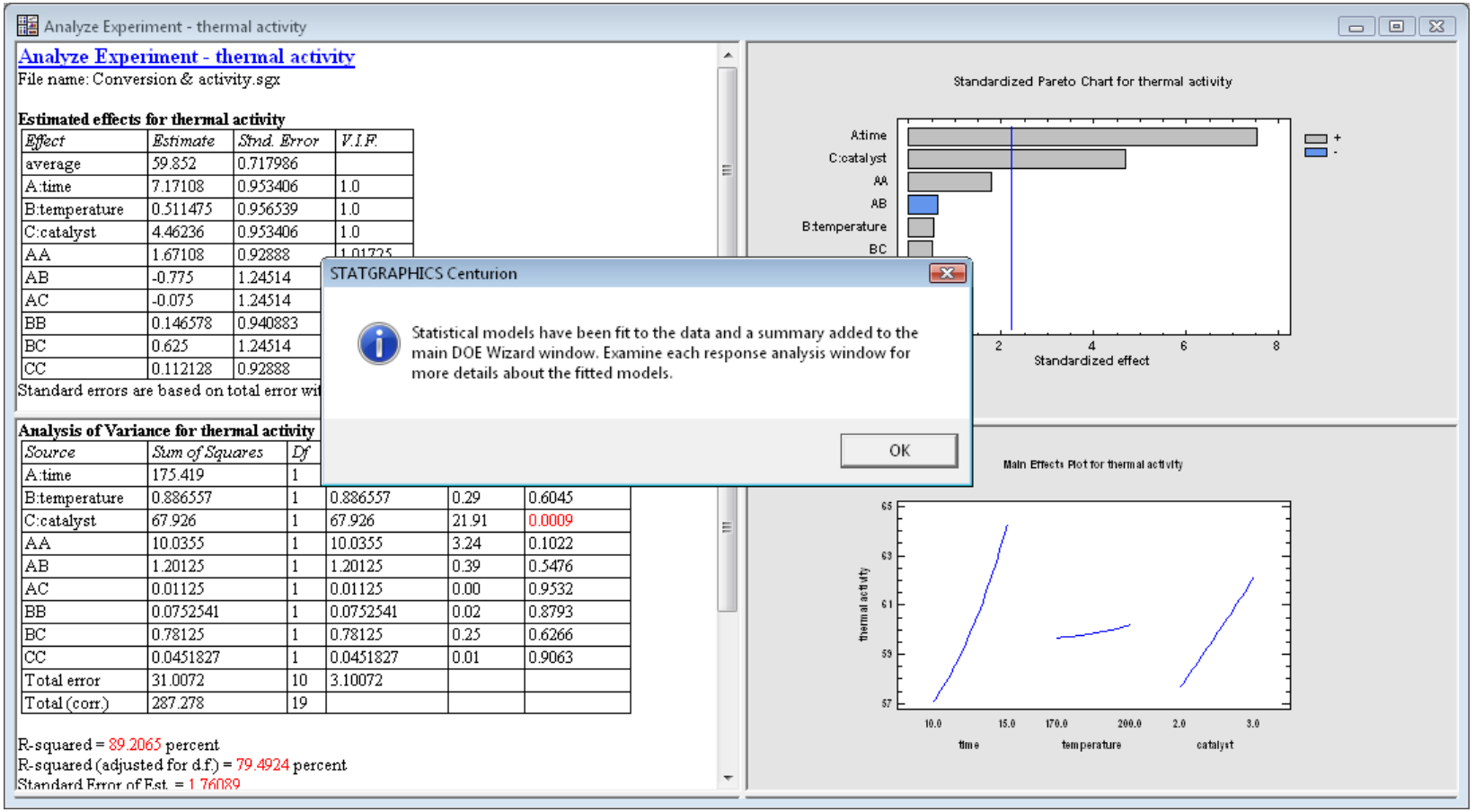
Step 8: Analyze data (cont.)



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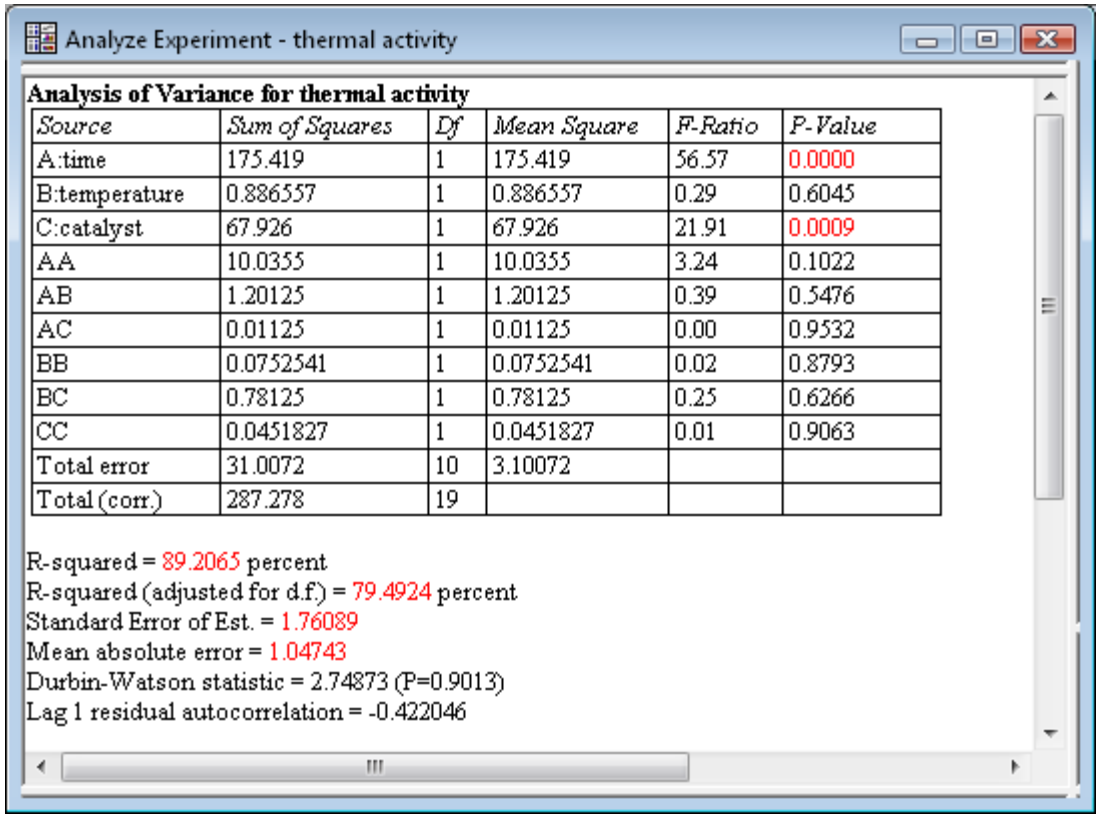
ANOVA table



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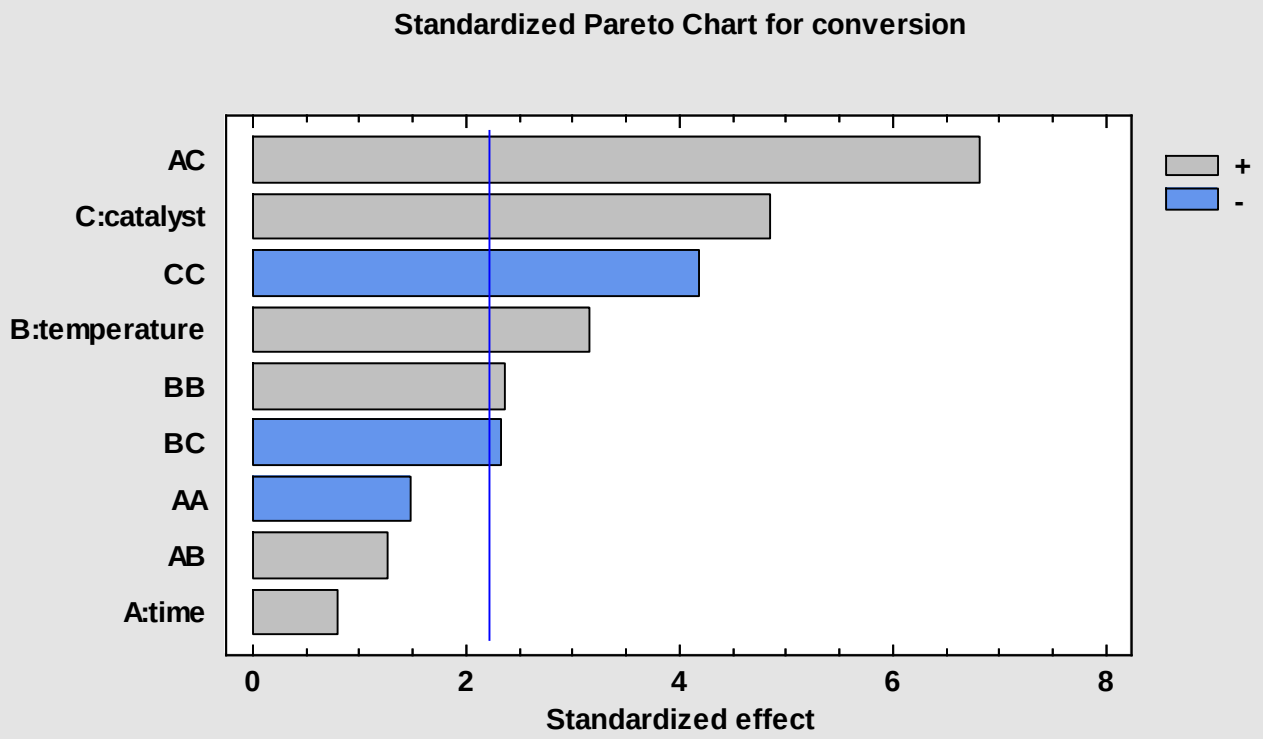
Pareto chart



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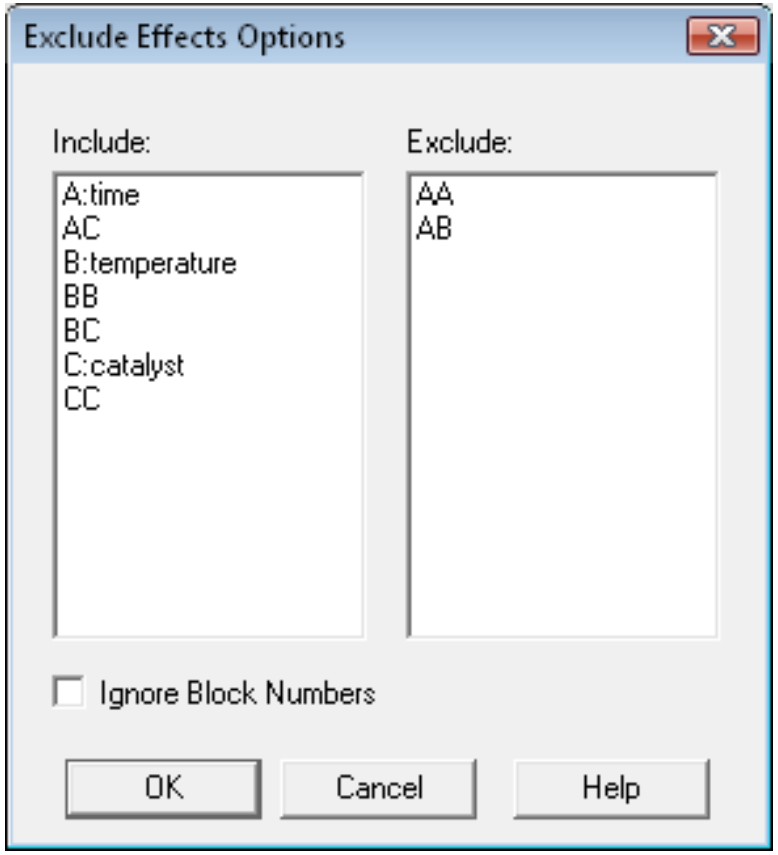
Exclude effects



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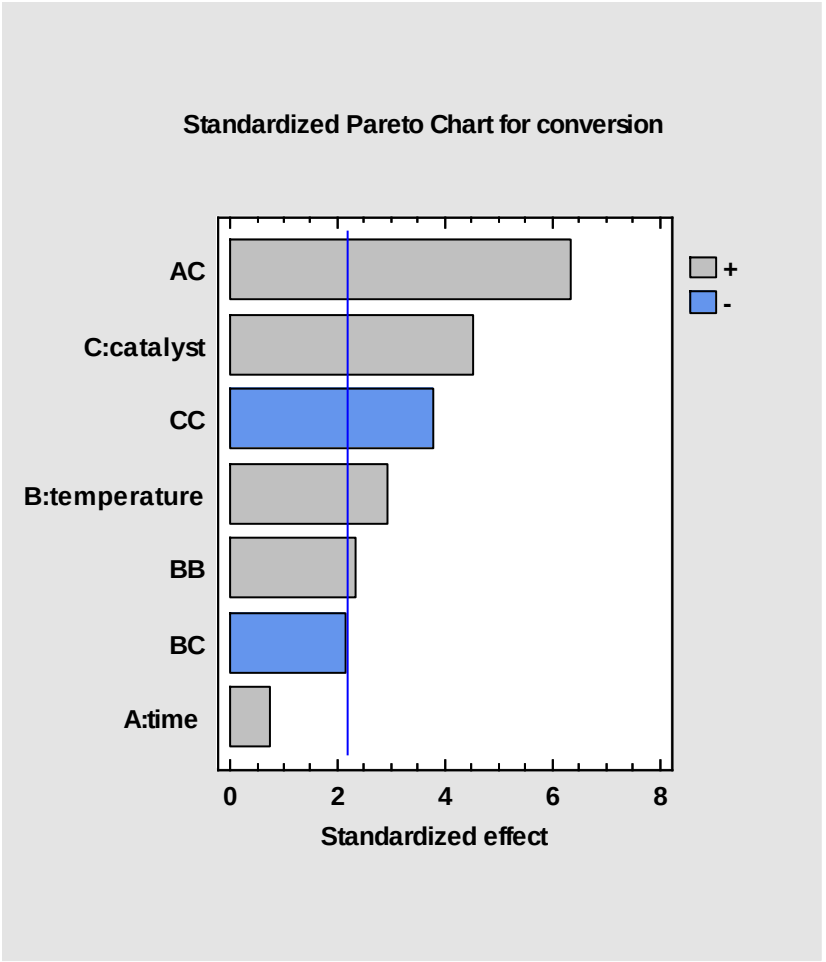
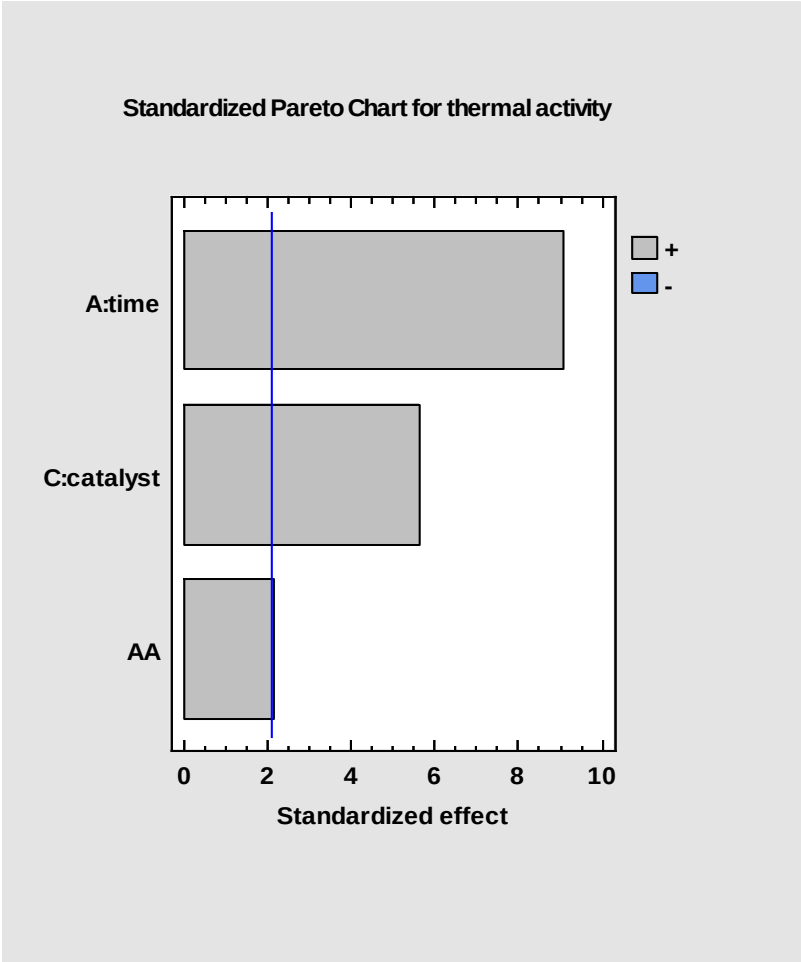
Final models





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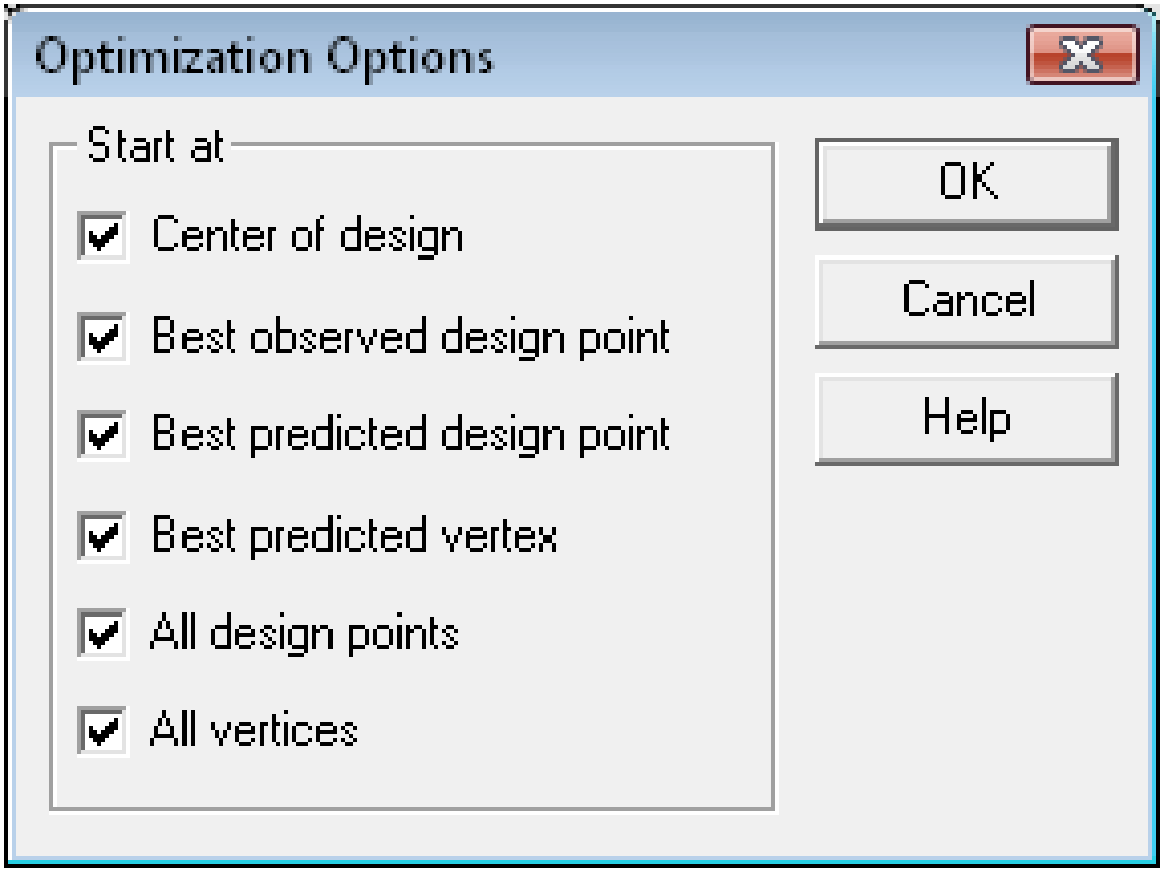
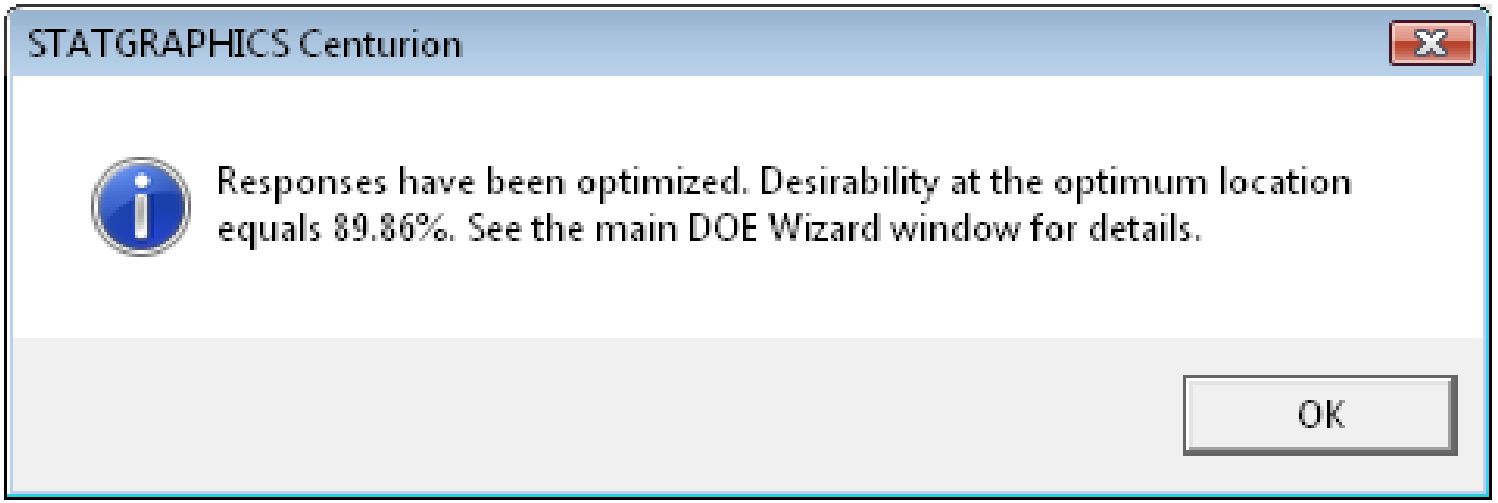
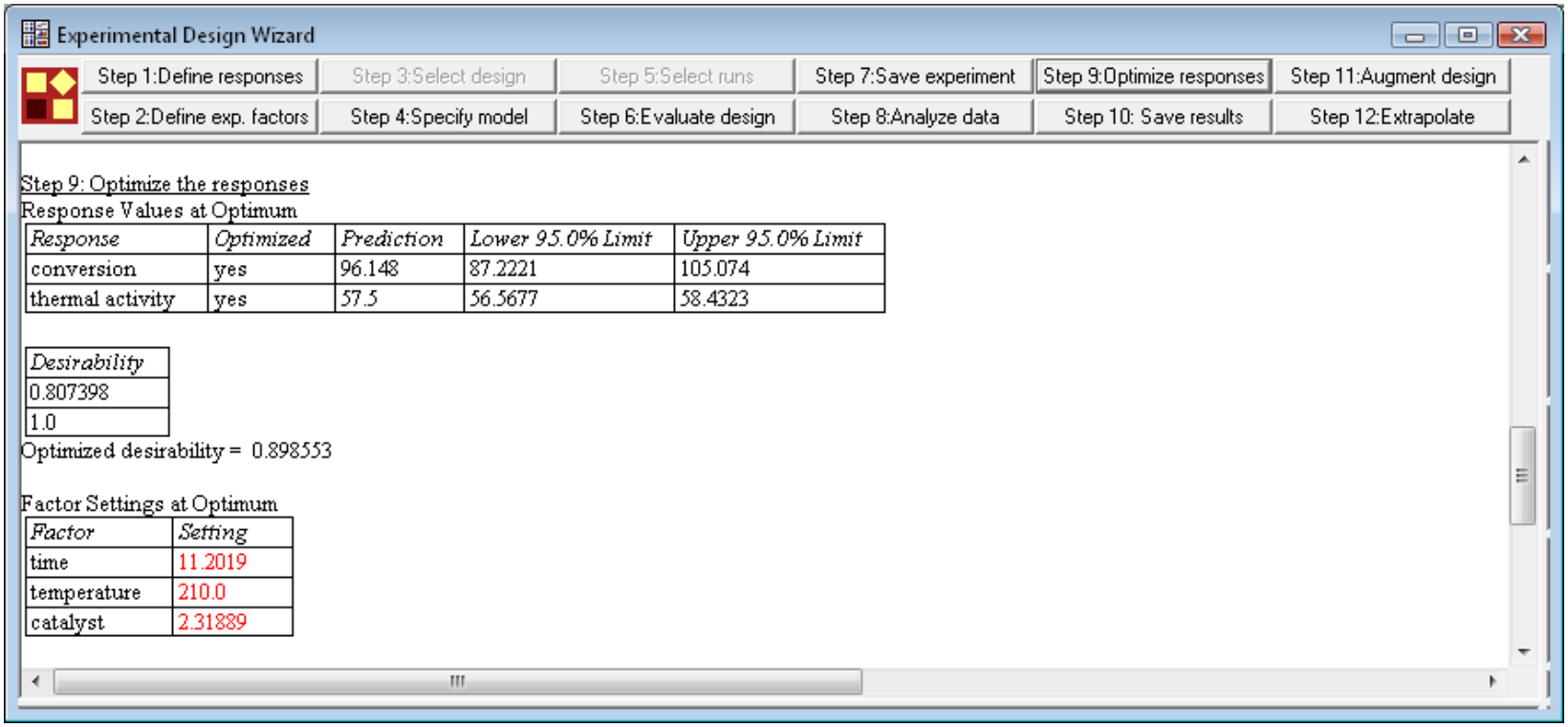
Step 9: Optimize responses



Step 9: Optimize responses (cont.)



Step 9: Optimize responses (cont.)



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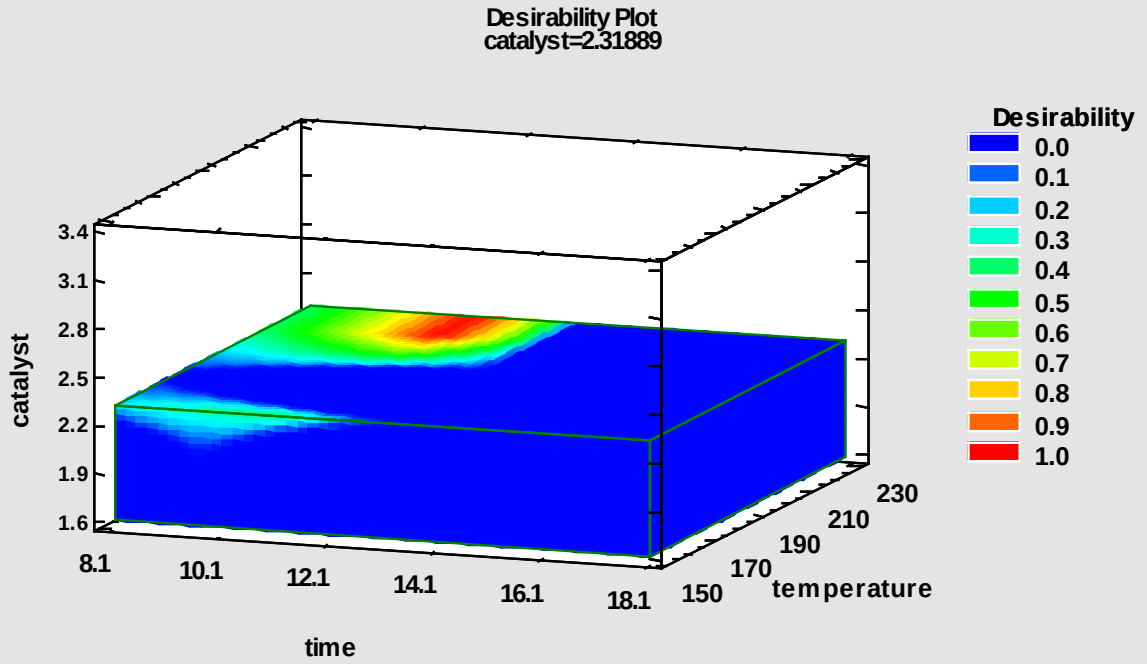
3-D contour plot



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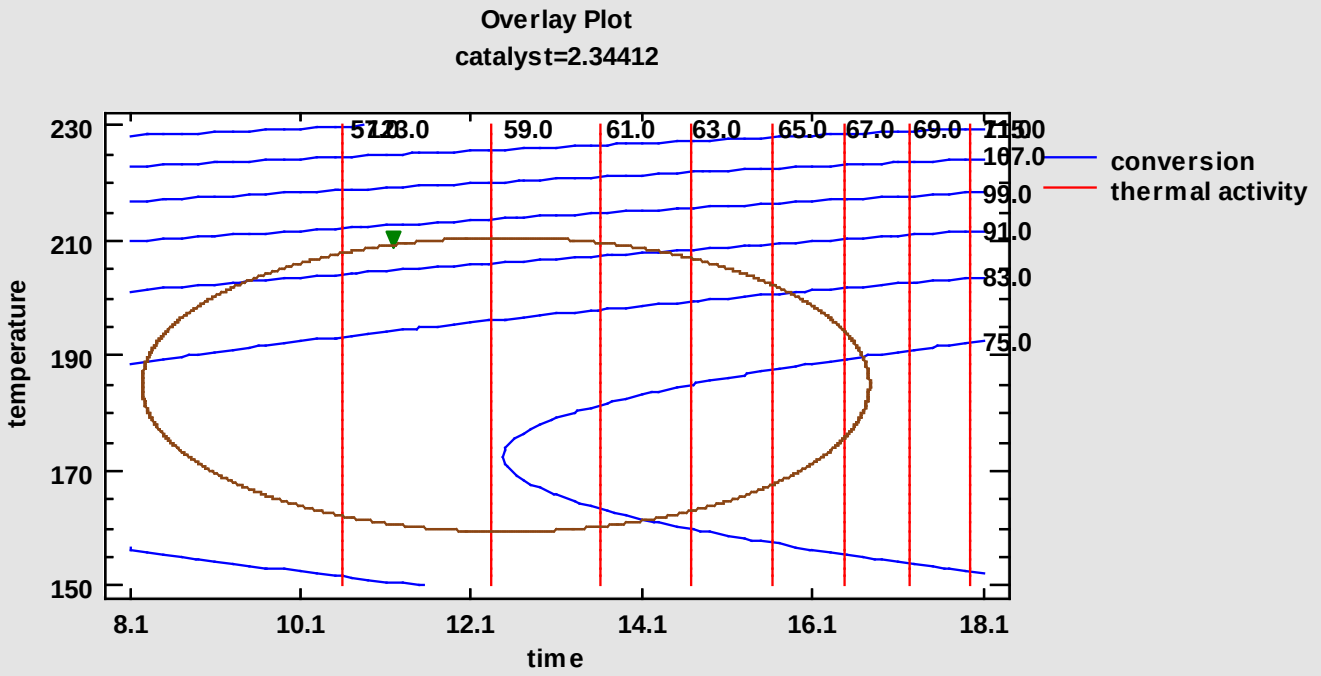
Overlaid contour plots



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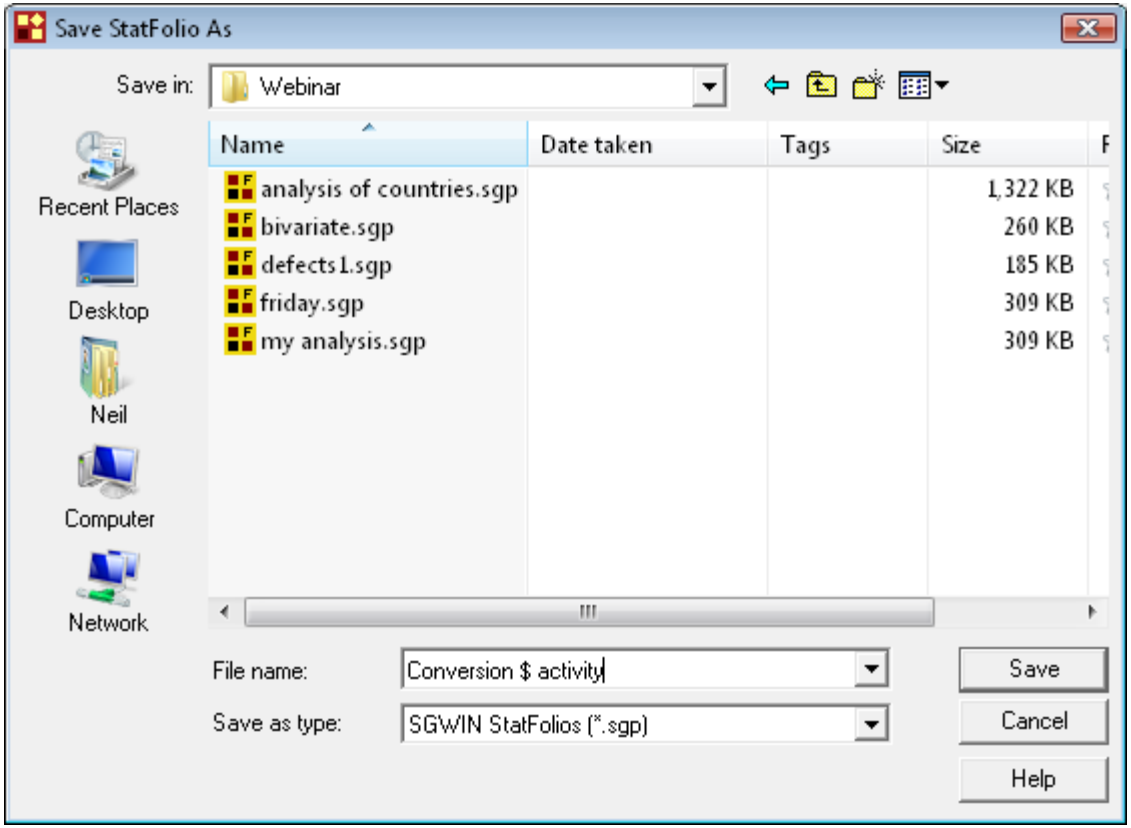
Step 10: Save results



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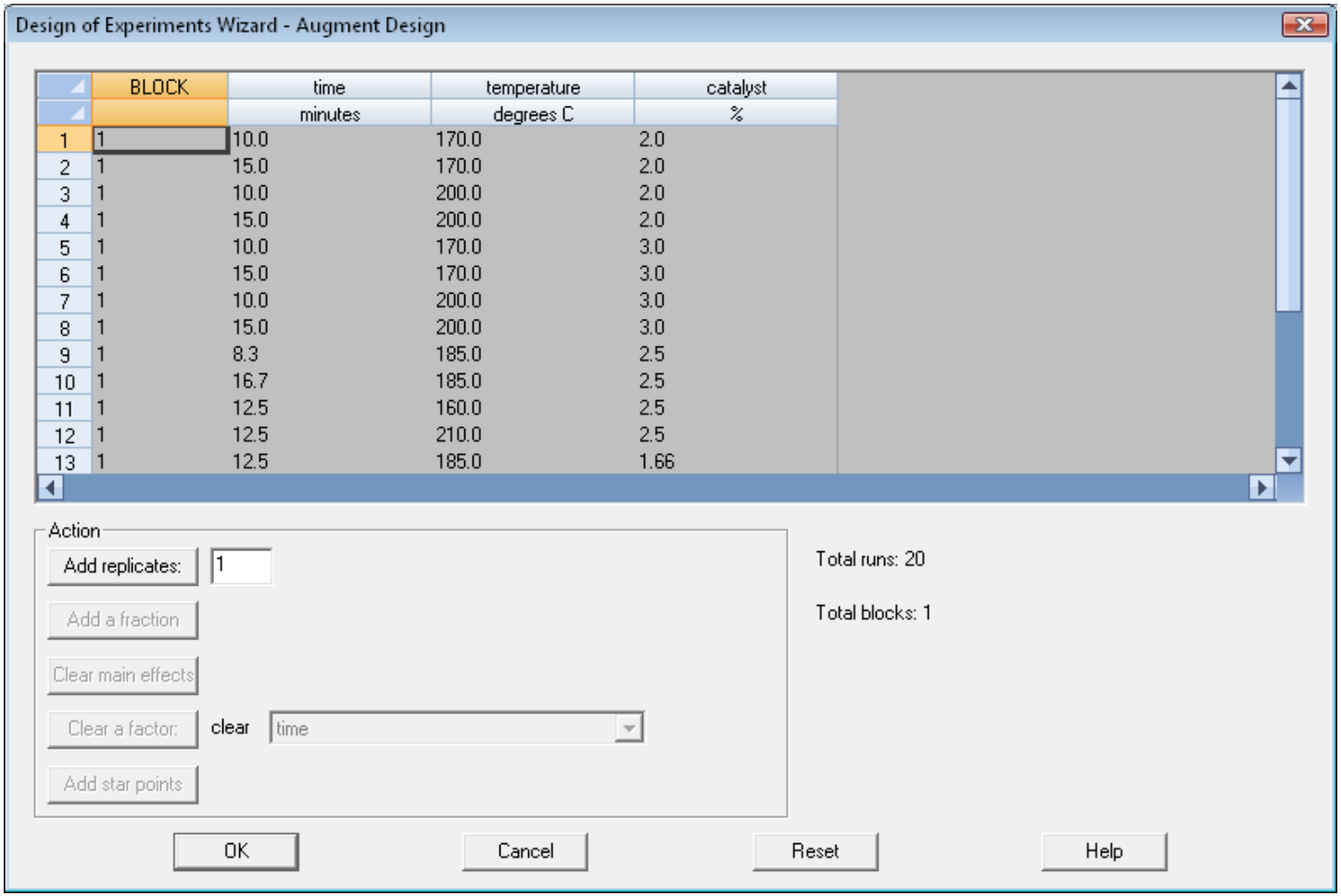
Step 11: Augment design



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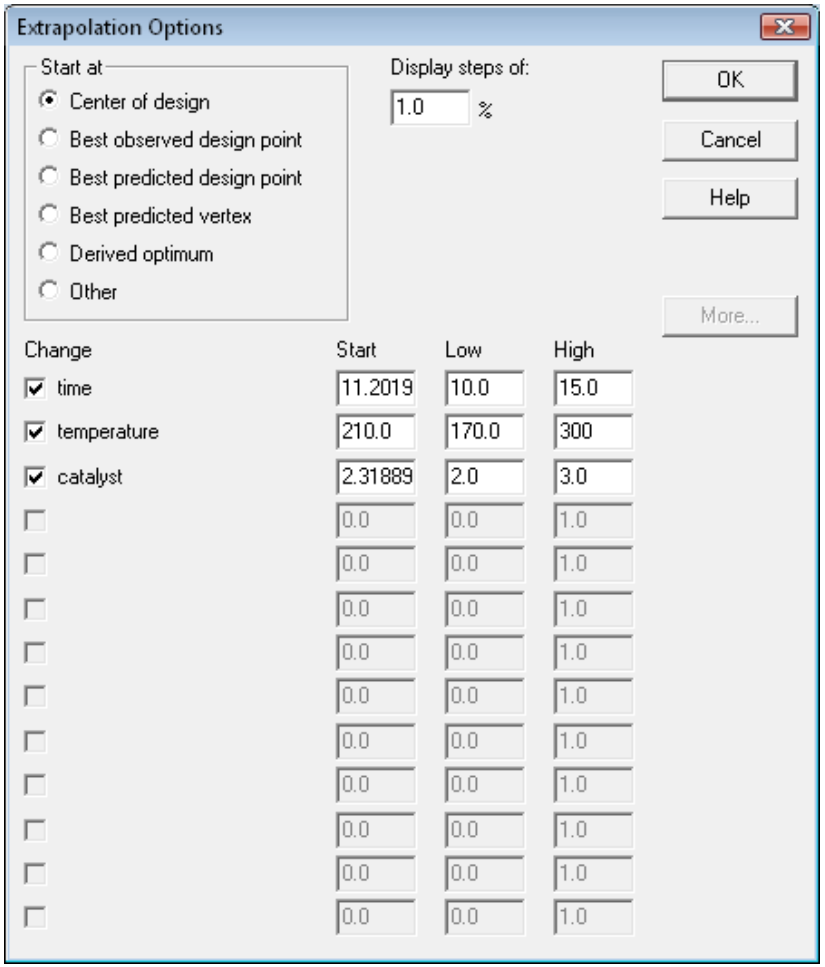
Step 12: Extrapolate



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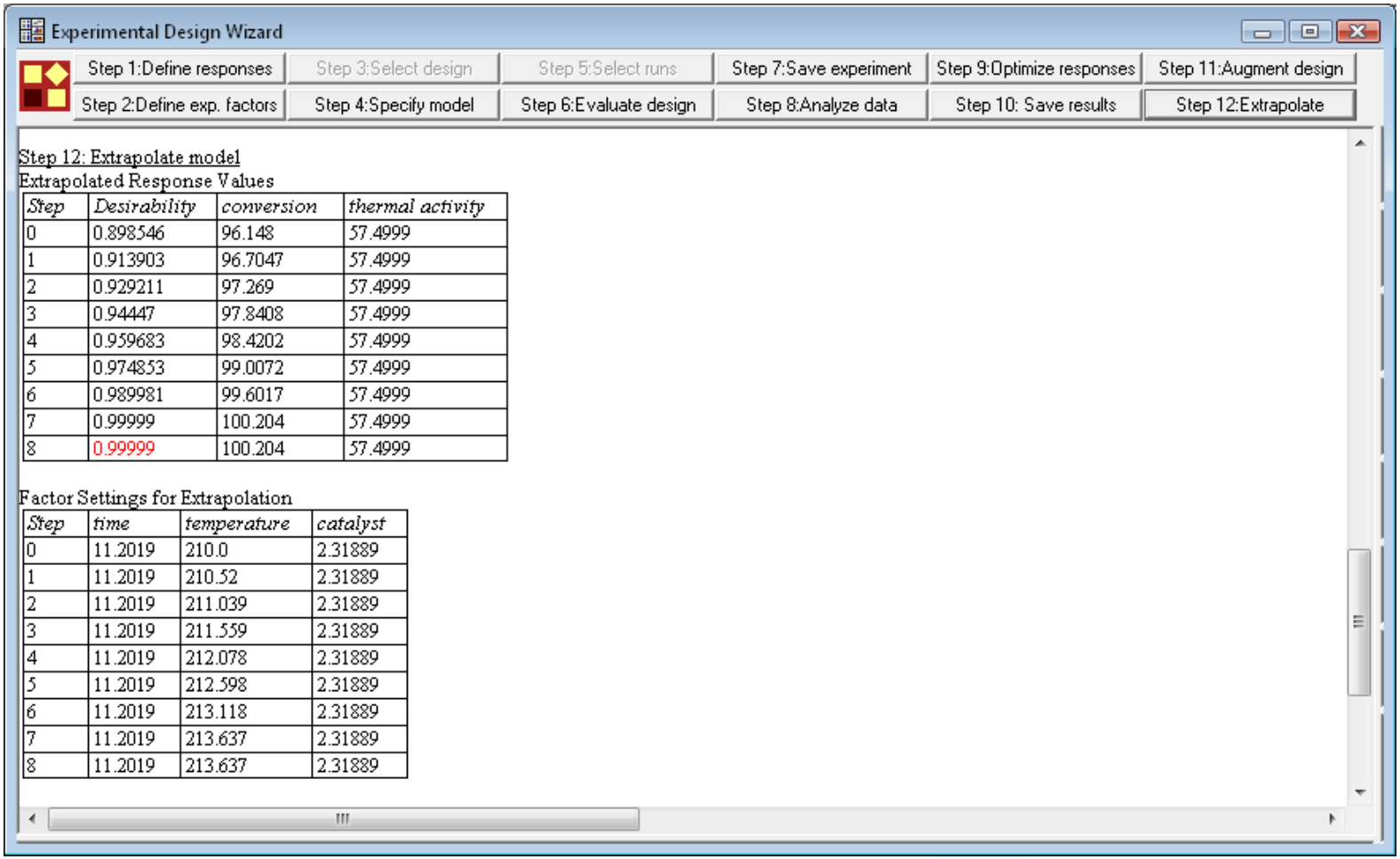
Step 12: Extrapolate (cont.)



Step 12: Extrapolate model

Extrapolated Response Values

Step	*Desirability*	*conversion*	*thermal activity*
0	0.898546	96.148	57.4999
1	0.913903	96.7047	57.4999
2	0.929211	97.269	57.4999
3	0.94447	97.8408	57.4999
4	0.959683	98.4202	57.4999
5	0.974853	99.0072	57.4999
6	0.989981	99.6017	57.4999
7	0.99999	100.204	57.4999
8	0.99999	100.204	57.4999

Factor Settings for Extrapolation

Step	*time*	*temperature*	*catalyst*
0	11.2019	210.0	2.31889
1	11.2019	210.52	2.31889
2	11.2019	211.039	2.31889
3	11.2019	211.559	2.31889
4	11.2019	212.078	2.31889
5	11.2019	212.598	2.31889
6	11.2019	213.118	2.31889
7	11.2019	213.637	2.31889
8	11.2019	213.637	2.31889

More... (next webinar)

- Creating and using RPDs (Robust Parameter Designs)
- Analyzing designs with both process and mixture components
- Using D-optimal designs to fix a botched experiment

More Information

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