



## 2020 Online DOE Summit

*Pat Whitcomb*



### My Lifelong Journey with DOE!

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## Agenda

- **DOE User:**
  - General Mills Chemicals (1973 – 1977)
  - Henkel Corporation (1977 – 1985)
- **DOE Provider:**
  - Stat-Ease – The early years (1982 – 1994)
  - Stat-Ease – The middle years (1995 – 2011)
  - StatEase – The recent years (2012 – 2020)
  - DesignExpert version 13 (*preview*)

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## General Mills Chemicals (1973 – 1977)



- Graduate with bachelor's degree in chemical engineering. Hired as a “Summer” Engineer, planned to return to school for a Master’s degree in Food Science.
- Ran my first DOE (a  $2^{k-p}$  fractional factorial) in the pilot plant lab. I was hooked!
- I was offered a full-time job and paid schooling if I switched my Master’s to Chemical Engineering. I accepted.
- Finished my required classes long before finishing my thesis. Took a number of statistic classes for my own interest.
- 1977 completed Master’s in ChE with focus in Rheology.

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## Henkel Corporation (1977 – 1985)



- General Mills sells their chemical division to Henkel Corporation.
- Became leading advocate of DOE helping others in research & development, quality control, technical service, marketing, and administrative groups improve productivity and quality through application of statistical methods and Deming's philosophy.
- Spent a year as Plant Manager of Frank Veterinary Laboratories.
- Became Quality Assurance Manager with responsibility for Quality Control labs at 12 manufacturing sites.
- 1982 started Stat-Ease (with Henkel's blessing) to consult with Cosmetics Division that was sold off by Henkel.

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## Stat-Ease – The early years (1982 – 1994)

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- 1984 purchase desktop PC and begin programming Design-Ease. Tryg Helseth does the bulk of the programming. DE is intended for those I convert to DOE, but for whom computations are a barrier.
- April 1985 laid off by Henkel. Supported by wife (Patty) I work in basement, incorporate Stat-Ease and begin selling Design-Ease in June.
- April 1985 Tryg takes job as programmer at insurance company while continuing to work on Design-Ease.
- 1986 Henkel moves R&D and other people out of Minnesota. Design-Ease 1.10 is released in November.

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## Stat-Ease – The early years (1982 – 1994)

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- 1987 glowing review of Design-Ease ("DE") published in *Journal of Quality Technology* and version 1.20 of Design-Ease is released in October.
- May 1988 Tryg Helseth quits programmer job at insurance company and joins me in the basement.
- 1988 version 1.01 of Design-Expert ("DX") debuts.
- 1989 teach DOE workshop at Sylvania in Towanda Pennsylvania. Tryg is in the back programming what we'll need for the next day's teach.

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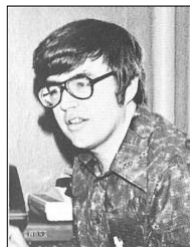
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## Stat-Ease – The early years (1982 – 1994)

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- December 1988 Mark Anderson joins us in the basement. Mark had been on my Stat-Ease business advisory board from the beginning.



- 1989 we hire an office manager and Patty kicks us out of the basement.

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## Stat-Ease – The middle years (1995 – 2011)



- 1997 Version 5 of DX combines DE4 and DX4 and converts to Windows, DE becomes a subset of DX.
- September 1998 Hank Anderson (who is in high school) hired as part time bookkeeper.
- 2000 Mark and Pat co-author *DOE Simplified*.
- 2004 Mark and Pat co-author *RSM Simplified*.
- 2007 Mark and Pat co-author *DOE Simplified, 2<sup>nd</sup> Edition*.

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## StatEase – The recent years (2012 – 2020)

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- May 2012 PhD student Martin Bezener (*recipient of the “Pat Whitcomb and Patty Napier Fellowship in Statistics”*) hired part time.
- 2013 Version 9 of DX and DE released in December, the first versions with Hank Anderson as Lead Developer.
- 2015 Pat and Mark co-author *DOE Simplified*, 3<sup>rd</sup> Edition.
- 2016 Mark and Pat co-author *RSM Simplified*, 2<sup>nd</sup> Edition.
- 2017 Mark becomes President, Hank Vice President, Martin Vice President & Treasurer and Cathy Secretary.
- 2018 Mark, Pat, and Martin co-author *Formulation Simplified*.

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## StatEase – The recent years (2012 – 2020)

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- 2018 Version 11 of DX for Mac released in July; first release for a Mac operating system since 1994.
- 2019 Version 12 of DX released.
  - Logistic regression for experiments with binary response data.
  - Kowalski-Cornell-Vining (KCV) models to reduce the number of runs required for experiments combining mixture components and process factors.
- 2020 Hank becomes President, Martin Vice President & Treasurer and Cathy Hickman Secretary.

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## DesignExpert version 13 Preview of New Features



- ✓ Poisson Regression
  - Responses with count data can be analyzed with Poisson Regression.
- ✓ Analysis
  - You can now create multiple analyses for a single response.
  - Logistic regression analyses now have a classification tab.
- ✓ Python Integration
  - You can now create Python scripts to interact with Design-Expert.
- ✓ Design
  - Importing historical data has been made much easier, just paste in your data.
  - You can now round factor values by right-clicking the column header.
  - Editable constraints in the constraint node.
  - A design space augment wizard to expand an existing design.
  - Latin Hypercube designs.
- ✓ Graphs
  - Control multiple graphs at the same time with the factors tool.
  - There is a Box and Whiskers plot available in the Graph Columns node.

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## DesignExpert version 13 Poisson Regression



- DesignExpert version 12 added Logistic regression for binary data. Version 13 adds **Poisson regression** for count data.

Six levels of factor A (0.0, 0.5, 0.75, 1.0, 1.25 and 1.5) and two levels of factor B (A and B). Response is a count of organisms<sup>1</sup>:

Run	Factor 1 Ajjet fuel g/l	Factor 2 B:strain	Response 1 Organisms count
1	0	A	82
2	0	B	58
3	0	A	106
4	0	B	58
5	0	A	63
6	0	B	62
7	0	A	99

- Data from Table 4.7, *Generalized Linear Models (With Applications in engineering and Science)*; Myers, Montgomery and Vining; 2002, John Wiley & Sons, Inc., New York.

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## DesignExpert version 13 Poisson Regression



The screenshot shows the 'Configuration analysis for response Organisms' dialog box. The 'Analysis name' is 'Organisms (Poisson)'. Under 'Analyze type', 'polynomial' is selected. Under 'Coding for Analysis', 'Actual' is selected. In the 'Transformation' section, 'Poisson Regression' is selected and highlighted with a red box. To the right, there are two preview windows: 'Example Residuals vs. Predicted' showing a scatter plot of residuals, and 'Square Root (λ = 0.5)' showing the formula  $y' = \sqrt{y+k}$  with the note 'Use when the response is a count. Required:  $y + k \geq 0$ '. Below these windows, it states 'Response ranges from 1 to 106. Ratio of max to min is 106.' and 'A ratio greater than 10 usually indicates a transformation is required. For ratios less than 3 the power transforms have little effect.'

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# DesignExpert version 13 Poisson Regression



Navigation Pane: Design (Actual), Information, Notes, Summary, Graph Columns, Evaluation, Constraints, Analysis, Fit Organizations (Poisson), Optimization, Numerical, Graphical, Post Analysis, Point Prediction, Confirmation, Coefficients Table

Poisson Regression (Type III)

Response 1: Organisms  
Link: log  
inverse Link: exp

ML (Maximum Likelihood) analysis  
 $\chi^2$  Log Likelihood Ratio p-values

Source	df	$\chi^2$	p-value
Model	2	1273.00	< 0.0001
A: jet fuel	1	1240.39	< 0.0001
B: strain	1	32.62	< 0.0001

P-values less than 0.0500 indicate model terms are significant. In this case A, B are significant model terms. Values greater than 0.1000 indicate the model terms are not significant. If there are many insignificant model terms (not counting those required to support hierarchy), model reduction may improve your model.

Fit Statistics

Pseudo R <sup>2</sup> Type	R <sup>2</sup>	Mean	24.89
McFadden	0.7564	Parameters (p)	3
Adj. McFadden	0.7328	Iterations	4

Coefficients

Final Equation in Terms of Actual Factors

Factor	Coefficient
Ln(Mean(Organisms))	=
strain	+4.45464
jet fuel	-1.54308
strain	B
jet fuel	+4.17967
jet fuel	-1.54308

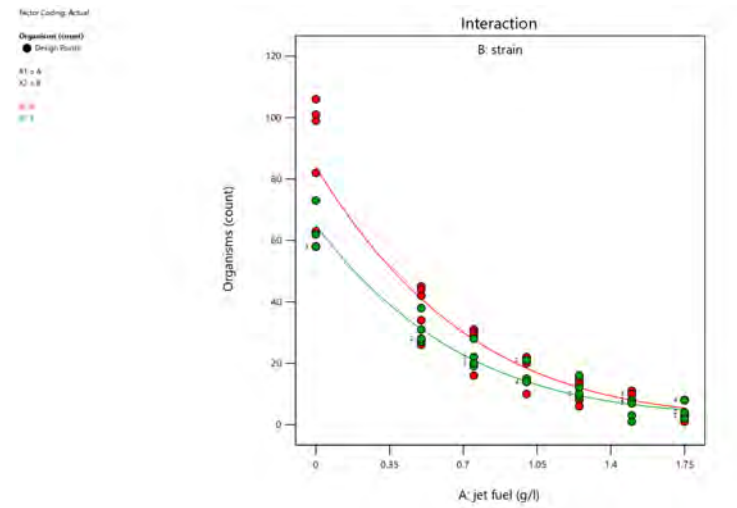
The equation in terms of actual factors can be used to make predictions about the response for given levels of each factor. Here, the levels should be specified in the original units for each factor. This equation should not be used to determine the relative impact of each factor because the coefficients are scaled to accommodate the units of each factor and the intercept is not at the center of the design space.

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# DesignExpert version 13 Poisson Regression



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## Multiple Analyses for a Single Response Square Root Transform (Organisms)



Navigation Pane

Design (Actual)

- Information
  - Notes
  - Summary
  - Graph Columns
  - Evaluation
  - Constraints
- Analysis
  - R1-Organisms**
  - Organisms (Poisson)
- Optimization
  - Numerical
  - Graphical
- Post Analysis
  - Point Prediction
  - Confirmation
  - Coefficients Table

Configuration new analysis for response Organisms:

Analysis name: **Organisms (SqRt)**

Transformation:

- None
- Square Root**
- Natural Log
- Base 10 Log
- Inverse Square Root
- Inverse
- Power
- Logit
- Arcsine Square Root

Constant, k:

Logistic Regression

Poisson Regression

Response ranges from 1 to 106.  
Ratio of max to min is 106.

A ratio greater than 10 usually indicates a transformation is required. For ratios less than 3 the power transforms have little effect:

Example Residuals vs. Predicted

Example Data

Square Root ( $\lambda = 0.5$ )

$$y' = \sqrt{y + k}$$

Use when the response is a count.  
Required:  $y + k \geq 0$

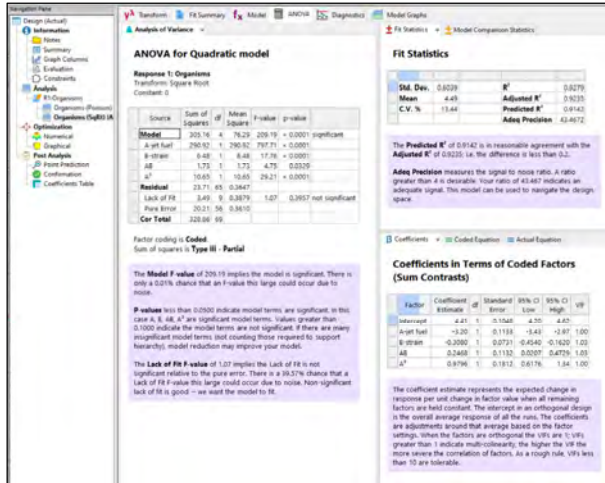
Create Analysis

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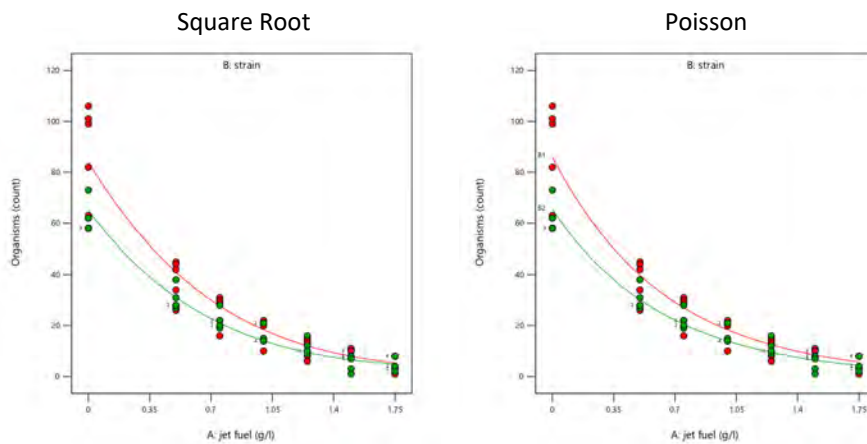
24

# Multiple Analyses for a Single Response Square Root Transform (Organisms)



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# Multiple Analyses for a Single Response Square Root Transform (Organisms)



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## OLS versus GLM



Both the OLS model with the Square Root transformation and the GLM Poisson models fit well. Why use Poisson?

- Parsimony: generally Poisson models have fewer coefficients. *(Organisms example: Poisson model 2 df, OLS model 4 df)*
- Poisson model predictions tend to have less error. *(We will quantify prediction errors using a Python script later in this presentation.)*
- Using OLS with the square root transformation can result in negative predictions and inverse transformation errors.

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## DesignExpert version 13 Preview of New Features



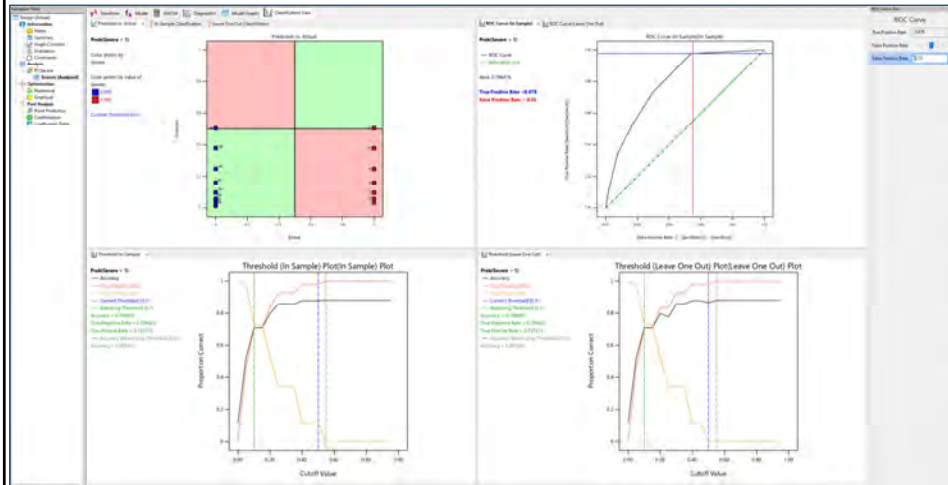
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## Logistic Regression Classification Tab



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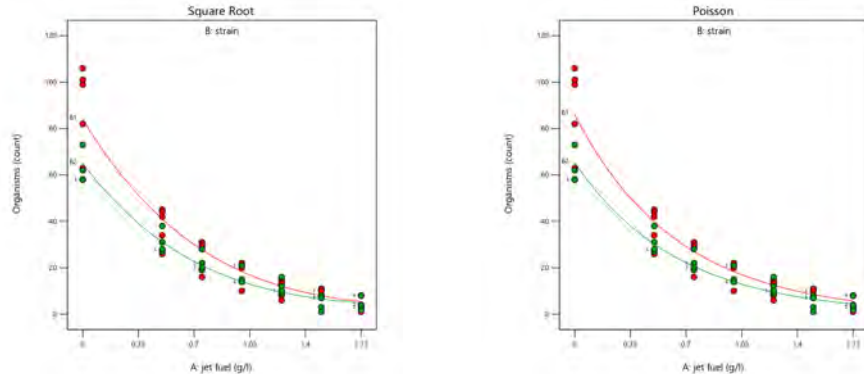
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Organisms Example: Let's compare error in prediction.



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Compute  $SS_{residuals}$  in Actual Scale



```

1 from scipy import stats
2 import sys
3 import numpy as np
4 from math import sqrt
5 from statistics import mean
6
7 # Fit the square root model
8 X = np.array([0.0, 0.25, 0.5, 0.75, 1.0, 1.25, 1.5, 1.75])
9 Y = np.array([100, 80, 60, 45, 35, 25, 15, 10])
10
11 # Fit the Poisson model
12 X = np.array([0.0, 0.25, 0.5, 0.75, 1.0, 1.25, 1.5, 1.75])
13 Y = np.array([100, 80, 60, 45, 35, 25, 15, 10])
14
15 # Compute residuals for the square root model
16 sqrt_model = stats.linregress(X, Y)
17 sqrt_pred = sqrt_model[0] + sqrt_model[1] * X
18 sqrt_res = Y - sqrt_pred
19
20 # Compute residuals for the Poisson model
21 poisson_model = stats.linregress(X, Y)
22 poisson_pred = poisson_model[0] + poisson_model[1] * X
23 poisson_res = Y - poisson_pred
24
25 # Compute sum of squares of residuals
26 sqrt_ss = sum(sqrt_res**2)
27 poisson_ss = sum(poisson_res**2)
28
29 # Print results
30 print("SS_Square Root = %d" % sqrt_ss)
31 print("SS_Poisson = %d" % poisson_ss)

```

Script

SS\_Poisson = 2568  
SS\_Square Root = 2711

- The left half of the Script window is the Python code.
- It has syntax highlighting, line numbers, and auto-indentation, so it is suitable for writing code directly in the window.
- Or you can use your own editor, when you run the script it will detect any changes to the file and reload it.
- The right half of the screen is the output of the script.
- You can choose which installation of Python you want DX to use, so you can use whatever Python packages you like.

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## Import Data Set Design Copy from Xcel paste to DX13



Run	EA	MMA	TEC	Coating	Dissolve 1 hr	Dissolve 12 hr
w/v %	w/v %	w/v %	ml	cumulative %	cumulative %	
1	11	11	9	17.5	51.6	69.6
2	13.5	13.5	4	15	37.9	99.3
3	13.5	13.5	4	20	9.8	87.3
4	7	20	4	25	1.1	48
5	20	7	4	17.5	42	77.3
6	7	15	9	15	76.9	80.9
7	10	7	14	25	13.3	42.1
8	10	7	14	15	82.6	100
9	7	20	4	15	64.8	88.3
10	10	7	14	20	49.5	76.7
11	7	20	4	20	39.1	57
12	7	20	4	25	1.9	40.7
13	20	7	4	25	25.6	54
14	11	11	9	22.5	32.6	54.1
15	10	7	14	15	75.4	91.7
16	15	7	9	20	41.1	79.9
17	7	15	9	25	15.5	20.2
18	7	20	4	17.5	57	74
19	20	7	4	15	59.2	93.5
20	20	7	4	22.5	31.2	54.6
21	13.5	13.5	4	25	4	55.1
22	7	15	9	20	47.3	64
23	15	7	9	25	14	42.9
24	15	7	9	15	77.9	100
25	20	7	4	20	40.2	74.3
26	10	7	14	20	53.7	69.9
27	10	7	14	25	27.2	43.8
28	13.5	13.5	4	25	3.1	54.1

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# Import Data Set Design

## Need to specify columns



- Standard Designs
- Factorial
  - Randomized
  - Regular Two-Level
  - Min-Run Characterize
  - Min-Run Screen
  - Multilevel Categorical
  - Optimal (Custom)
- Miscellaneous
- Split-Plot
- Response Surface
- Mixture
- Space Filling
- Custom Designs
  - Optimal (Combined)
  - User-Defined
  - Blank Spreadsheet
  - Simple Sample
  - Import Data Set

### Import Data Set Design

Design for importing data that already exists. Copy and Paste data into the blank spreadsheet. Specify Factors, Responses and Mixtures.

11	11	9	17.5	51.6	69.6
13.5	13.5	4	15	37.9	99.3
13.5	13.5	4	20	9.8	87.3
7	20	4	25	1.1	40
20	7	4	17.5	42	77.3
7	15	9	15	76.9	80.9
10	7	14	25	13.3	42.1
10	7	14	15	82.6	100
7	20	4	15	64.8	88.3
10	7	14	20	49.5	76.7
7	20	4	20	39.1	37
7	20	4	25	1.9	40.7
20	7	4	25	25.6	54
11	11	9	22.5	32.6	54.1
10	7	14	15	75.4	91.7
15	7	9	20	41.1	79.9
7	15	9	25	15.5	20.2
7	20	4	17.5	37	74
20	7	4	15	59.2	93.5
20	7	4	22.5	31.2	54.6
13.5	13.5	4	25	4	55.1
7	15	9	20	47.3	64
15	7	9	25	14	42.9
15	7	9	15	77.9	100
20	7	4	20	40.2	74.3
10	7	14	20	53.7	69.9
10	7	14	25	27.2	43.8
13.5	13.5	4	25	3.1	54.1

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# Import Data Set Design

## Specify mixture components



- Standard Designs
- Factorial
  - Randomized
  - Regular Two-Level
  - Min-Run Characterize
  - Min-Run Screen
  - Multilevel Categorical
  - Optimal (Custom)
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10	7	14	25	13.3	42.1
10	7	14	15	82.6	100
7	20	4	15	64.8	88.3
10	7	14	20	49.5	76.7
7	20	4	20	39.1	37
7	20	4	25	1.9	40.7
20	7	4	25	25.6	54
11	11	9	22.5	32.6	54.1
10	7	14	15	75.4	91.7
15	7	9	20	41.1	79.9
7	15	9	25	15.5	20.2
7	20	4	17.5	37	74
20	7	4	15	59.2	93.5
20	7	4	22.5	31.2	54.6
13.5	13.5	4	25	4	55.1
7	15	9	20	47.3	64
15	7	9	25	14	42.9
15	7	9	15	77.9	100
20	7	4	20	40.2	74.3
10	7	14	20	53.7	69.9
10	7	14	25	27.2	43.8
13.5	13.5	4	25	3.1	54.1

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# Import Data Set Design

## Specify numeric factor and responses



Run	Component 1	Component 2	Component 3	Factor 4	Response 1	Response 2
1	11.000	11.000	9.000	17.500	51.6	69.6
2	13.500	13.500	4.000	15.000	37.9	99.3
3	13.500	13.500	4.000	20.000	9.8	87.3
4	7.000	20.000	4.000	25.000	1.1	48
5	20.000	7.000	4.000	17.500	42	77.3
6	7.000	15.000	9.000	15.000	76.9	80.9
7	10.000	7.000	14.000	25.000	19.3	42.1
8	10.000	7.000	14.000	15.000	82.6	100
9	7.000	20.000	4.000	15.000	64.8	88.3
10	10.000	7.000	14.000	20.000	49.5	76.7
11	7.000	20.000	4.000	20.000	39.1	57
12	7.000	20.000	4.000	25.000	1.9	40.7
13	20.000	7.000	4.000	25.000	25.6	54
14	11.000	11.000	9.000	22.500	32.6	54.1
15	10.000	7.000	14.000	15.000	75.4	91.7
16	15.000	7.000	9.000	20.000	41.1	79.9
17	7.000	15.000	9.000	25.000	15.5	20.2
18	7.000	20.000	4.000	17.500	37	74
19	20.000	7.000	4.000	15.000	59.2	93.5
20	20.000	7.000	4.000	22.500	31.2	54.6
21	13.500	13.500	4.000	25.000	4	55.1
22	7.000	15.000	9.000	20.000	47.3	64
23	15.000	7.000	9.000	25.000	14	42.9
24	15.000	7.000	9.000	15.000	77.9	100
25	20.000	7.000	4.000	20.000	40.2	74.3
26	10.000	7.000	14.000	20.000	53.7	69.9
27	10.000	7.000	14.000	25.000	27.2	43.8
28	13.500	13.500	4.000	25.000	3.1	54.1

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# Import Data Set Design

## Import Complete



Run	Component 1	Component 2	Component 3	Factor 4	Response 1	Response 2
1	11,000	11,000	9,000	17,500	51.6	69.6
2	13,500	13,500	4,000	15,000	37.9	99.3
3	13,500	13,500	4,000	20,000	9.8	87.3
4	7,000	20,000	4,000	25,000	1.1	48
5	20,000	7,000	4,000	17,500	42	77.3
6	7,000	15,000	9,000	15,000	76.9	80.9
7	10,000	7,000	14,000	25,000	19.3	42.1
8	10,000	7,000	14,000	15,000	82.6	100
9	7,000	20,000	4,000	15,000	64.8	88.3
10	10,000	7,000	14,000	20,000	49.5	76.7
11	7,000	20,000	4,000	20,000	39.1	57
12	7,000	20,000	4,000	25,000	1.9	40.7
13	20,000	7,000	4,000	25,000	25.6	54
14	11,000	11,000	9,000	22,500	32.6	54.1
15	10,000	7,000	14,000	15,000	75.4	91.7
16	15,000	7,000	9,000	20,000	41.1	79.9
17	7,000	15,000	9,000	25,000	15.5	20.2
18	7,000	20,000	4,000	17,500	37	74
19	20,000	7,000	4,000	15,000	59.2	93.5
20	20,000	7,000	4,000	22,500	31.2	54.6
21	13,500	13,500	4,000	25,000	4	55.1
22	7,000	15,000	9,000	20,000	47.3	64
23	15,000	7,000	9,000	25,000	14	42.9
24	15,000	7,000	9,000	15,000	77.9	100
25	20,000	7,000	4,000	20,000	40.2	74.3
26	10,000	7,000	14,000	20,000	53.7	69.9
27	10,000	7,000	14,000	25,000	27.2	43.8
28	13,500	13,500	4,000	25,000	3.1	54.1

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  - A design space augment wizard to expand an existing design.
  - Latin Hypercube designs.
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  - Control multiple graphs at the same time with the factors tool.
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## Round factor values by right-clicking the column header (*page 1 of 2*)



The screenshot shows the DesignExpert software interface. A data table is displayed with columns for 'Std', 'Run', and several 'Component...' factors (A:X1, B:X2, C:Z, etc.). A context menu is open over the 'Component...' column header, with the 'Round Components...' option highlighted in red. A 'Rounding Dialog' box is also visible, showing 'Significant Digits' set to 3.

Std	Run	Component... A:X1	Component... B:X2	Component... C:Z	Component... D:W	Component... E:V	Component... F:U	Component... G:X7	Component... H:X8	Response 1 Y
3	1	0.1	0.5							34
7	2	0.1	0.5							22
2	3	0.15	0.5							17
12	4	0.1	0.1							115
18	5	0.239835	0.223901	0.04						54
9	6	0.45	0.05							42
5	7	0.1	0.05							114
17	8	0.239835	0.223901	0.0472527	0.0472527	0.276923				37
16	9	0.1	0.5	0	0.1	0				79
4	10	0.1	0.5	0	0	0				42
14	11	0.45	0.2	0	0.1	0				118
6	12	0.45	0.15	0.1	0.1	0				48
19	13	0.239835	0.223901	0.0472527	0.0472527	0.276923				9
8	14	0.45	0.05	0.1	0.05	0				13
21	15	0.239835	0.223901	0.0472527	0.0472527	0.276923	0.116484	0.0241758	0.0241758	37
11	16	0.1	0.05	0	0.1	0.55	0.2	0	0	79
20	17	0.239835	0.223901	0.0472527	0.0472527	0.276923	0.116484	0.0241758	0.0241758	42
1	18	0.1	0.05	0.1	0.1	0.55	0.05	0	0.05	118
13	19	0.45	0.05	0	0	0.45	0.05	0	0	48
15	20	0.45	0.1	0.1	0	0.1	0.2	0.05	0	9
10	21	0.2	0.5	0	0.1	0.1	0.05	0	0.05	13

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## Round factor values by right-clicking the column header (page 2 of 2)



Std	Run	Component... A:X1	Component... B:X2	Component... C:X3	Component... D:X4	Component... E:X5	Component... F:X6	Component... G:X7	Component... H:X8	Response 1 Y
3	1	0.1	0.5	0.1	0	0.2	0.05	0	0.05	34
7	2	0.1	0.5	0	0	0.2	0.2	0	0	22
2	3	0.15	0.5	0	0	0.1	0.2	0	0.05	17
12	4	0.1	0.1	0.1	0	0.6	0.05	0.05	0	115
18	5	0.2398	0.2239	0.0473	0.0472	0.2769	0.1165	0.0242	0.0242	54
9	6	0.45	0.05	0	0	0.4	0.05	0	0.05	42
5	7	0.1	0.05	0	0	0.55	0.2	0.05	0.05	114
17	8	0.2398	0.2239	0.0473	0.0472	0.2769	0.1165	0.0242	0.0242	35
16	9	0.1	0.5	0	0.1	0.2	0.05	0.05	0	29
4	10	0.1	0.5	0	0	0.1	0.2	0.05	0.05	29
14	11	0.45	0.2	0	0.1	0.1	0.05	0.05	0.05	20
6	12	0.45	0.15	0.1	0.1	0.1	0.05	0.05	0	11
19	13	0.2398	0.2239	0.0473	0.0472	0.2769	0.1165	0.0242	0.0242	35
8	14	0.45	0.05	0.1	0.05	0.1	0.2	0	0.05	21
21	15	0.2398	0.2239	0.0473	0.0472	0.2769	0.1165	0.0242	0.0242	37
11	16	0.1	0.05	0	0.1	0.55	0.2	0	0	79
20	17	0.2398	0.2239	0.0473	0.0472	0.2769	0.1165	0.0242	0.0242	42
1	18	0.1	0.05	0.1	0.1	0.55	0.05	0	0.05	118
13	19	0.45	0.05	0	0	0.45	0.05	0	0	48
15	20	0.45	0.1	0.1	0	0.1	0.2	0.05	0	9
10	21	0.2	0.5	0	0.1	0.1	0.05	0	0.05	13

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## Editable constraints in the constraint node: Edit the MLC



Design Constraints

Process Coding: Actual

Low Limit	Constraint	High Limit
400.000	≤ 4.000 * A - B	

Edit Constraints

Enter constraints in 'Actual' values.

Example:  $0.05 \leq 1.4A - 2.5B + C \leq 0.80$

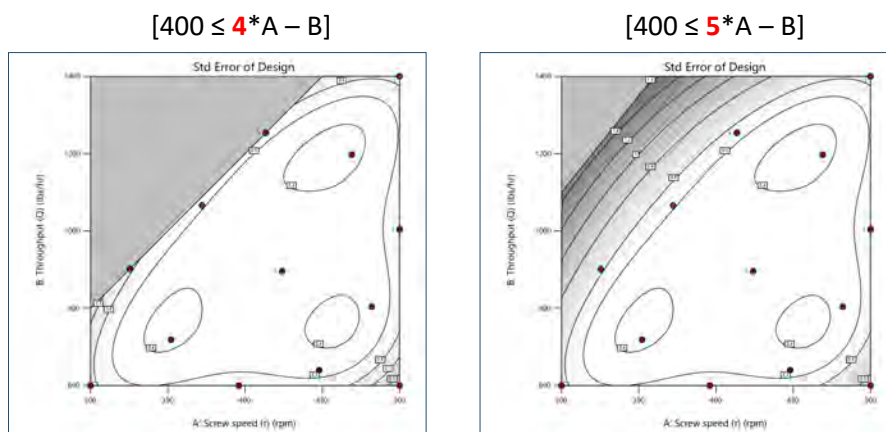
Hide 's' Columns

Low Limit	Constraint	High Limit
400	≤ +5 A - B	
	≤	
	≤	
	≤	

Edit the MLC from  $[400 \leq 4 * A - B]$  to  $[400 \leq 5 * A - B]$

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## Editable constraints in the constraint node: Edit the MLC



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## Design Space Augment Wizard To Expand an Existing Design



### Coming Soon

The Design Space Augmentation feature is not implemented yet.

Design Space Augmentation is basically the joining of  
editable constraints with the augment dialogs.

We are still fine tuning the new editable constraints.

**Begin beta testing in July**

**Release in 4<sup>th</sup> Quarter**

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## Latin Hypercube Designs



The screenshot shows the DesignExpert software interface. The main window is titled "Latin Hypercube Design". It contains a menu bar (File, Edit, View, Display Options, Design Tools, Help) and a toolbar. On the left is a tree view of design types: Standard Designs (Factorial, Response Surface, Mixture, Space Filling), and Custom Designs (Optimal (Custom), Optimal (Combined), User-Defined, Blank Spreadsheet, Simple Sample, Import Data Set). The "Latin Hypercube" option under "Space Filling" is selected. The main panel displays the configuration for a Latin Hypercube Design, including a description, a numeric factors input (set to 2), and a table of factors.

Design built using Latin Hypercube Sampling. Specify how many process factors. Set Rows to the number levels for all factors.

Numeric factors:  (1 to 50)  Horizontal  Vertical

Name	Units	Low	High
A [Numeric] X		0	1
B [Numeric] Y		0	1

Rows:  (5 to 10000)

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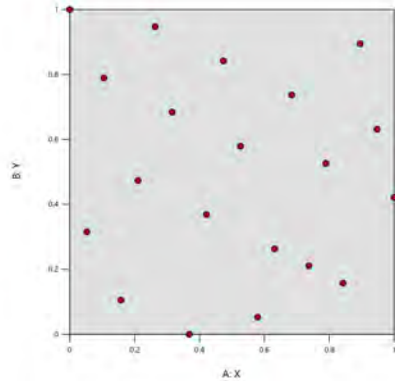
48



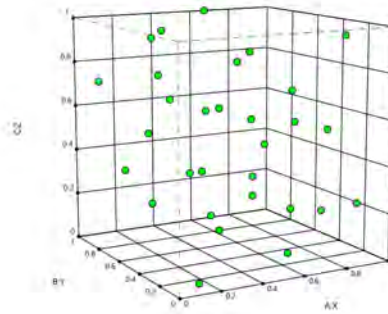
## Latin Hypercube Designs



2 factors 20 runs



3 factors 30 runs



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## DesignExpert version 13 Preview of New Features



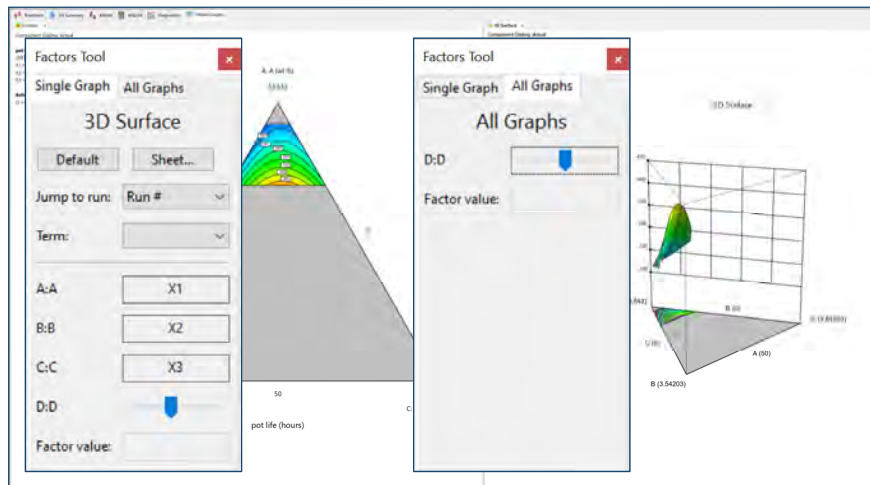
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Control multiple graphs at the same time with the factors tool.



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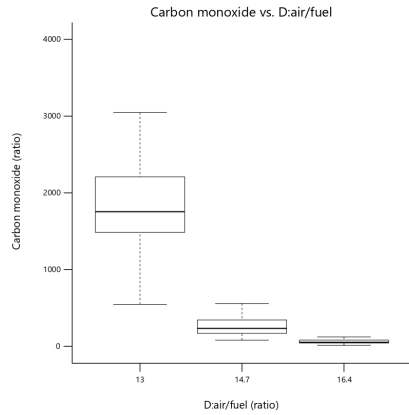
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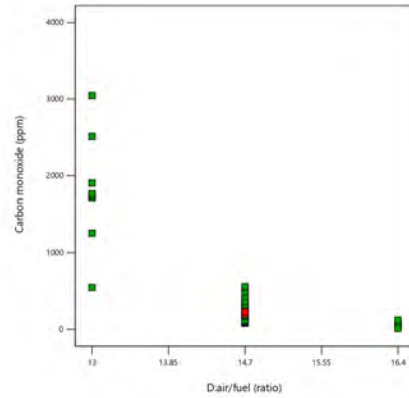
# Box and Whiskers Plot



### Box and Whiskers Plot



### Scatter Plot



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**Thank you for attending!**

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