Stat Teaser

ABOUT STAT-EASE® SOFTWARE, TRAINING, AND CONSULTING FOR DOE • DECEMBER 1999
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Workshop Schedule

• Experiment Design Made Easy

January 18-20: Dallas, TX
February 15-17: Atlanta, GA
March 21-23: Minneapolis, MN
May 16-18: Seattle, WA (New Site)

Covers the practical aspects of Design of Experiments (DOE). Learn about simple, but powerful, two-level factorial designs.

• Response Surface Methods for Process Optimization

February 8-10: Dallas, TX (New Site)
June 6-8: Minneapolis, MN

Find the optimum settings for your process. Generate 3D maps to identify the peak area and overlay plots to find your sweet spot.

• Mixture Design for Optimal Formulations

January 25-27: Atlanta, GA (New Site)
April 4-6: Minneapolis, MN
June 6-8: Cambridge, UK (New Site)

Standard factorial designs don't work well for formulations. Learn all the skills you need for mixture designs in this course.

• Robust Design: DOE Tools for Reducing Variation

December 7-9: Rochester, NY (New Site)
April 25-27: Minneapolis, MN

Use DOE to create products and processes that are robust to varying conditions. Factorial & RSM proficiency is required.

• Real-Life DOE

March 7-8: Minneapolis, MN

Not your normal textbook data - analyze real data sets and learn how to deal with messy problems! Working knowledge of factorial designs is required.

Attendance limited to 20. Reserve your place by calling Sherry, ext. 18, at **(800) 801-7191**

A Case to Test Your Metal

Shari's Challenge...

For those of you expecting to be entertained by "Mark's Experiment", he has temporarily run out of weed whackers to play with. (But, winter is approaching and I expect he'll get out the snow blower before long!)

In his place, I offer you a challenging case study to test your analysis skills, presented here with the original data. Go ahead and set up the design and see if you can make heads or tails out of it. Then, turn to page 3 for our analysis. (Don't peek ahead of time!) Here's what you need to know to get started:

A client of Stat-Ease examined his aluminum casting process using a fractional factorial design. He studied 5 factors in 16 experiments. The response was the fraction defective. To his dismay, none of the factors seemed to make any difference! Your task is to find the significant factor(s) and discover how to reduce the number of defects.

Using Design-Ease® or Design-Expert® software, set up the design with the factor names and levels given in Table 1 below. Next sort it into Standard Order and enter the response data. Then, complete the analysis. Good Luck! (Hint: Think about transformations and outliers.)

Factor Info:

A: Hot Oil (°F) - 350 to 450
B: Trip (mm) - 390 to 410
C: Metal Temp (°F) - 1260 to 1300
D: Fast Shot (mm) - 1.60 to 2.20
E: Dwell (sec) - 3.5 to 5.5

Response: Fraction Defective

std	a: hot oil °F	b: trip mm	c: metal °F	d: fast shot mm	e: dwell sec	defects fraction
1	350	390	1260	1.6	5.5	0.14
2	450	390	1260	1.6	3.5	0.98
3	350	410	1260	1.6	3.5	0.36
4	450	410	1260	1.6	5.5	0.42
5	350	390	1300	1.6	3.5	1.00
6	450	390	1300	1.6	5.5	0.90
7	350	410	1300	1.6	5.5	0.28
8	450	410	1300	1.6	3.5	0.14
9	350	390	1260	2.2	3.5	0.22
10	450	390	1260	2.2	5.5	0.26
11	350	410	1260	2.2	5.5	0.38
12	450	410	1260	2.2	3.5	0.12
13	350	390	1300	2.2	5.5	0.30
14	450	390	1300	2.2	3.5	0.06
15	350	410	1300	2.2	3.5	0.22
16	450	410	1300	2.2	5.5	0.38

Table 1: Data for a Challenging Analysis Problem

Where Can You Find Us?

December 1999

- **Utica ASQ Section - 1-day DOE**
  Dec 10, Utica, NY
  Talk - Pat Whitcomb

- **Rock Valley College**
  Nov 30-Dec 2, Rockford, IL
  EDME Workshop (Sold Out!)

January 2000

- **MD&M West Conference**
  Jan 18, Anaheim, CA
  Talk - Mark Anderson

- **Rock Valley College**
  Jan 11-13, Rockford, IL
  EDME Workshop (Sold Out!)

March

- **Nat'l Manf. Week,** Booth #7180
  Mar 13-16, Chicago, IL

- **American Physical Society**
  Mar 21-23, Minneapolis, MN

- **MN Quality Conference**
  Mar 27-28, Minneapolis, MN
  Talk - Pat Whitcomb
  Talk - Shari Kraber

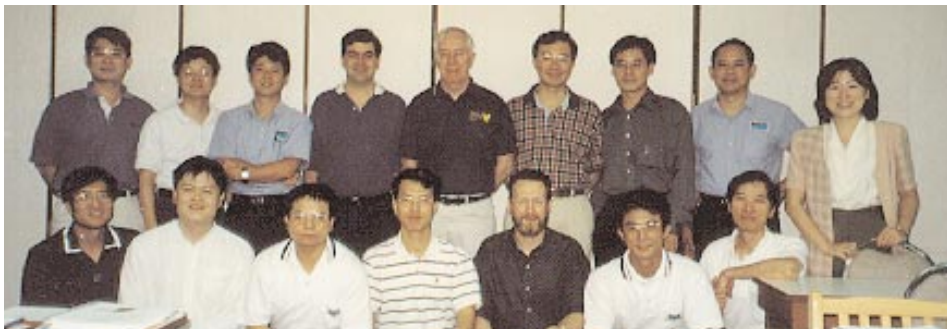
May

- **Annual Quality Congress**
  May 8-10, Indianapolis, IN
  Booth #701

Invite us to your national or regional conference. E-mail us at mark@statease.com.

Stat-Ease - Traveling to a Location Near You!

Stat-Ease is expanding its course offerings to get closer to you! We have added to our instructor base so we can now offer public workshops in places like Atlanta, Dallas, Detroit, Philadelphia, Seattle, and for the first time ever, the United Kingdom!



President Pat Whitcomb (front row, 3rd from right) and class in Taiwan.

Look for our introductory class - **Experiment Design Made Easy** in Dallas, Atlanta, Minneapolis, Seattle, Detroit and Philadelphia this coming year. If you are new to experimentation or data analysis, this class is where it all begins!

Our intermediate courses, **Response Surface Methodology** and **Mixture Design,** will be available in Atlanta, Dallas, Philadelphia and Cambridge, England. Visit Minnesota, land of 10,000 lakes, for our advanced courses, **Real-Life DOE** and **Robust Design: DOE Tools for reducing variation.**

If you are unsure which workshop will meet your needs, call Stat-Ease and ask to speak with one of our instructors. They will be happy to steer you towards the appropriate class.

Unable to travel? Are there many people at your organization who could benefit from DOE training? If so, arrange for an in-house class. All of our workshops can be brought directly to you and even tailored to meet your organization's needs. (We now offer a 1-day class called **DOE Simplified - An Introduction**. Call us for a quote.)

In 1999, Stat-Ease provided in-house training for organizations all over the world. We traveled across the United States and ventured out to Belgium, Taiwan, Japan and Canada.

For our complete Year 2000 public workshop schedule, visit our website at **www.statease.com**. Call Sherry at **(800) 801-7191 x18** for more information.

Meet the Instructor - John Guerin

John Guerin is a popular Stat-Ease instructor who brings to his students the benefits of both his scientific and business management experience. John has a Ph.D. in Physical Chemistry from the University of Pennsylvania, and he continues to live in the Philadelphia area. He worked in the chemical industry for 23 years, using experimental design techniques to develop products in adhesives, cosmetic chemicals, dispersants, drilling additives, mining chemicals and printing ink raw materials.

At home, John professes to be a frustrated chemist and enjoys cooking as the solution! His initial focus was on very spicy Cajun, Chinese and Tex Mex food, but he has branched out into less fiery cuisines.

John also enjoys amatuer archeology. By studying old maps and visiting local historical societies, he identifies and searches likely ruin sites. He has found colonial tools, pewter tableware, spent musket balls and 19th century medicine bottles. When looking to get away, John and Barbara, his wife of 30 years, enjoy spending time at their summer home on the New Jersey shore in Sea Isle City.

In addition to his work for Stat-Ease, John operates his own business, Turning Points Management Consulting. He specializes in the application of DOE techniques as well as business management tools.

A Case to Test Your Metal (Results)

(Cont. from page 1)

To start the analysis, it is important to understand the nature of the response. This response is "fraction defective." Responses such as this originate from the binomial distribution since there are only two complimentary alternatives - pass or fail. This type of response is generally best analyzed by using the ArcSine Square Root transformation. Apply this transformation to the data before continuing with the analysis.

After choosing the transformation, look at the Effects plot. Do your plots ever look like this? Where are the significant effects? When all the effects fall on a straight line from the origin, nothing stands out, (points falling off the line are normally

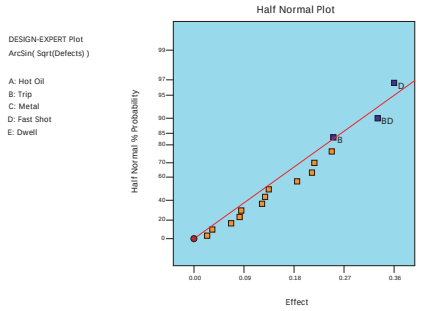


Figure 1: The effects plot with a couple points selected in order to check for outliers.

selected as significant effects). This can indicate several situations:

1. None of the factors had an effect on the response that was greater than the noise in the process. We hope this isn't the case, but it can happen if the factor ranges haven't been set wide enough apart or the wrong factors were chosen. (In this experiment we can look at the response data and see that it varies from 0.06 to 1.00 fraction defective. This range is too large to be explained by noise.)

2. An outlier is inflating the noise so much that the factor effects can't be seen. Let's explore this possibility.

How do you look for an outlier? First, choose a couple of the most extreme effects on the half normal plot (see Figure 1). You will have to ignore the ANOVA and go straight to the diagnostics. Notice that there is a point that stands out on all the diagnostic plots. On the outlier-t plot (see Figure 2) the point is identified as stan-

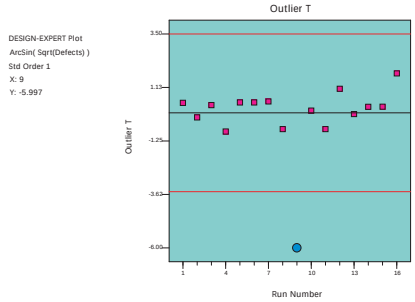


Figure 2: Outlier-t plot

dard order 1 (order number will differ due to randomization).

What do you do when you detect an outlier? Don't be too quick to throw it away! Think about what happened during that run. Did anything unusual occur? Did the machine break down or was there an unexpected raw material change? In this case the operator confirmed that there had been problems with this particular run. So, we have a legitimate reason to try analyzing the data without that point.

Return to the design layout, find standard order 1 and go over to the response column. Write the data point down so you remember it and then delete it. (I don't delete the entire run because then I might forget that I chose to eliminate data. The empty response serves as a reminder.)

Re-analyze the design. Now you should find that the effects of B, D and the BD interac-

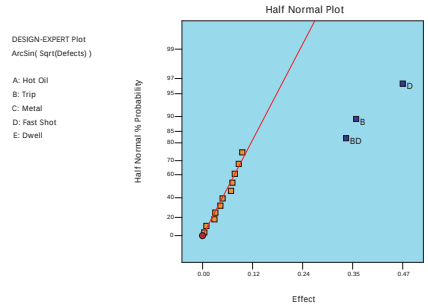


Figure 3: The effects plot after the outlier is removed.

tion stand out significantly. (See Figure 3.) What a difference an outlier makes!

Following through with the rest of the analysis and interpretation, you should look at the interaction graph and find the levels of B and D that minimize the frac-

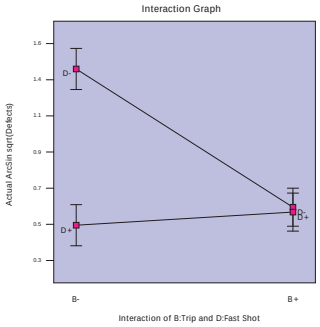


Figure 4: Final interaction graph

tion defective. The high (+) level of D (Fast Shot) leads to a big reduction in defects. (See Figure 4).

Congratulations! We made it through the analysis! Real world data can be tough. Don't give up even if it looks like there's no information. Try different analyses and you might find something that works. Of course, always use your subject matter knowledge and follow up all conclusions with confirmation runs. Good luck to you!

- Shari Kraber, shari@statease.com

Call for Case Studies for the 2000 Stat-Ease DOE Conference.

Have you successfully used Design-Ease or Design-Expert software at your organization? If so, are you interested in presenting your case study at our next DOE conference, July 27-28, 2000? By sharing your experiences, you'll help advance the practice of DOE in all industries. Please share your stories with us!

Submit ideas to Shari Kraber at shari@statease.com or fax (612) 378-2152. Include a brief summary of the DOE process and what you have learned or gained from the experience (cost savings are good, but not required). Presenters will receive **free** conference registration.

NWA Adds Stat-Ease Software to Quality Solutions

Stat-Ease welcomes Northwest Analytical, Inc. (NWA) as a new strategic partner. Under this agreement, NWA will offer Design-Ease® and Design-Expert® software for sale to its customers. Stat-Ease will continue to sell to its own customer base and will provide DOE technical support and training to NWA customers.

NWA's own quality software tools allow companies to monitor and analyze their production processes. The company's products are widely accepted in quality control applications in chemical and pharmaceutical production, electronics, food processing, packaging and discrete manufacturing.

Adding Stat-Ease's products to NWA's family of software products will provide a more complete solution for NWA's customers. They now have DOE capability for complete process analysis from process design to ongoing process studies.

NWA is a software developer providing analytical tools for understanding processes and improving quality in the production of goods and delivery of services. The NWA quality management software includes NWA Quality Analyst (comprehensive statistical process control charting and analysis), NWA Quality Monitor (work station software for plant floor statistical process control) and NWA Quality Analyst Web Server (web-based statistical process control reporting and analysis).

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