



Stat Teaser

ABOUT STAT-EASE® SOFTWARE, TRAINING, AND CONSULTING FOR DOE • JUNE 1998
Phone (612) 378-9449 • Toll-Free (800) 801-7191 • E-mail info@statease.com • Website www.statease.com

Workshop Schedule

• Experiment Design Made Easy

August 4-7, 1998: Minneapolis, MN
September 22-25, 1998: Minneapolis, MN
November 10-13, 1998: Philadelphia, PA
December 8-11, 1998: Anaheim, CA
Covers the practical aspects of Design of Experiments (DOE). Learn about simple but very powerful two-level factorial designs.

• Response Surface Methods for Process Optimization

June 23-26, 1998: Minneapolis, MN
October 6-9, 1998: Minneapolis, MN
This workshop builds factorial DOEs into Response Surface Methods (RSM), which produce maps to help find the optimum and/or robust conditions for your process.

• Mixture Design for Optimal Formulations

July 14-17, 1998: Minneapolis, MN
November 3-6, 1998: Minneapolis, MN
If you do product formulation, you know that standard factorial designs just don't work. You need the mixture design skills presented here.

• Robust Design for Quality Improvement

December 7-9, 1998: Anaheim, CA
Learn to meet your tightest specifications with minimal variation. Push the envelope with saturated fractional factorials.

Attendance limited to 24. Reserve your place by calling Carol, ext. 18, at

(800) 801-7191

Now scheduling **ON-SITE** classes for fall - call for a quote and to reserve a time slot!

Breaking the Barcode to Capture Valuable Names

Mark's Experiment

by Mark J. Anderson

It's a war out there in the marketing world. Recently hundreds of competitive companies converged in Chicago at the 1998 Quality Expo. A legion of road warriors lined up to collect their laser guns, a weapon for capturing names of potential customers.

My partner Tryg and I scrambled to set up the Stat-Ease display booth before the hordes of quality professionals broke through the starting gates. We were gratified to see several prospects seeking DOE details. But when we pressed the trigger on the laser gun, it would not read the barcode. We blasted the nametags from near and far, at all angles, but nothing would crack the code.

The people who rented us the gun for \$175(!) blamed the problem on fluctuations in power and/or unusually bright overhead lighting. Tryg crawled under the curtained table (effectively reducing the light) and got in some good shots, but he scared off customers when he suddenly ap-

peared out the front of the display with the gun, so we gave up on this approach. It was time to bring in the heavy weapon: 2-level factorial design of experiments (DOE).



Mark Anderson "blasts" a name tag.

Tryg and I held an impromptu brainstorming session. We decided to test the following factors:

A. Leave the coded name-tag in the plastic holder, or take it out to reduce glare.

B. Aim the gun from 6, 8 or 10

inches (15, 20 or 25 cm).

C. Zoom the gun in, hold it still, or zoom it out while shooting the laser beam.

This design was laid out with the aid of DESIGN-EXPERT® software by selecting a 2-level factorial with centerpoints. DESIGN-EASE® software could also have been used with the same results. The response was the fraction of success in reading the barcode from 10 shots of the laser gun (per combination of factors).

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Center Points in Central Composite Designs

Pat's Stat Tips

by Pat Whitcomb

Many people wonder if it is really necessary to run all the center points that are suggested (usually 5 or 6) when you set up a central composite design. A central composite design (CCD) is a type of response surface design that will give you very good predictions in the middle of the design space. The choice of how many center points to run influences how well this design will function.

Three things need to be considered when choosing the number of center points in a central composite design.

1) Replicated center points are used to estimate pure error for the lack of fit test. Lack of fit indicates how well the model you have chosen fits the data. With fewer than five or six replicates, the lack of fit test has very low power. You can compare the critical F-values (with a 5% risk level) for a three factor CCD with 6 center points, versus a design with 3 center points. The 6 center point design will require a critical F-value for lack of fit of 5.05, while the 3 center point design uses a critical F-value of 19.30. This means that the design with only 3 center points is less likely to show a significant lack of fit, even if it is there, making the test almost meaningless.

2) If you have chosen to block the central

composite design for some reason (such as having more runs than you can complete in a single day), the number of center points recommended will achieve (to the extent possible) simultaneous orthogonal blocks and rotatability. These design properties are very desirable. Block orthogonality means that the effect of the blocks is independent of the effects of the factors. Rotatability implies that the variation in the response prediction will be constant at a given distance from the center of the design. Reducing the number of center points will adversely affect these properties.

3) The default number of center points provides near uniform precision designs. This means that the error is nearly constant inside a sphere with a radius equal to 1 coded unit. Thus, your predictions in this region are equally good. Too few center points inflate the error. This effect (a "bump" in the middle of the graph) can be seen by viewing the standard error plot, as shown in Figures 1 & 2. (To see this graph, click on **Design Evaluation, Graph** and then **View, 3D Surface** after setting up a design.) Although it can seem tedious to run all of these replicates, the number of center points does ensure that the analysis of the design can be done well, and that the design is statistically sound.

-- Pat (pat@statease.com)

Figure 1 - Six Center Points

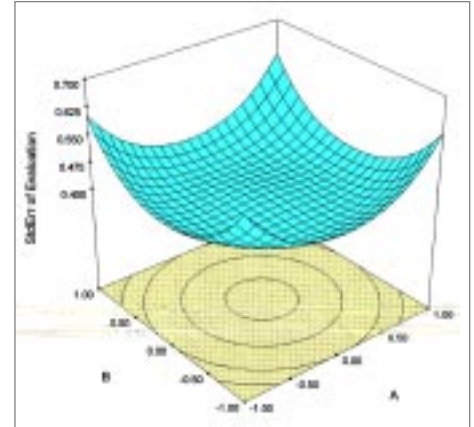
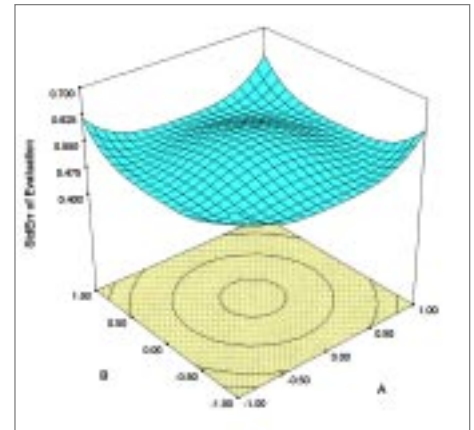


Figure 2 - Three Center Points



Response Surface Methodology Class Successful!!



Students at the "Response Surface Methods (RSM) for Process Optimization" workshop do a tutorial on Design-Expert® software. Pictured in the foreground are Gunter Malik of John Deere (Iowa) and Raquel Wager of Forma Scientific (Ohio).

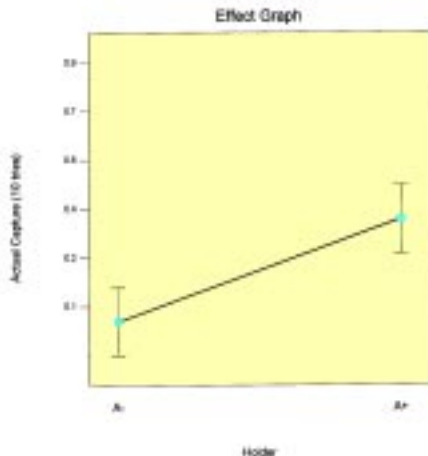
Stat-Ease's RSM class provides high-powered statistical tools for reaching peak performance. At the workshop you will learn how to:

- Set up Central Composite, Box-Behnken and other RSM designs
- Generate contour maps
- Optimize multiple responses
- Use Evolutionary Operation (EVOP)

This workshop is held several times a year in Minneapolis, and can also be presented at your site. Check out our website, www.statease.com, for more details.

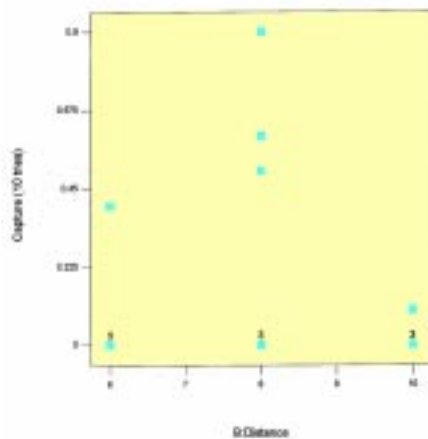
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Figure 1- Main Effect



The results show a clear (no pun intended) advantage to taking the name-tag out of the plastic holder (Factor A at its plus level). This is shown in the main effect plot (Figure 1). The analysis showed significant curvature. This obviously comes from the distance factor, as shown via the

Figure 2- Distance Factor



View, Graph Columns feature in version 5 of either software package (Fig 2).

Distance turned out to be a critical factor, with a peak at 8 inches (20 cm). Using this information, we were able to

solve our problem. Upon our return to Minneapolis, Tryg and I triumphantly waved long streamers of demographic data. Thanks to DOE, we accomplished our marketing mission!

-- Mark (mark@statease.com)

Year 2000 - No Problem!!

Stat-Ease has reviewed and tested Design-Ease 3 for Macintosh, Design-Ease 5 for Windows, and Design-Expert 5 for Windows for Year 2000 compliance. These products will continue to function correctly on and beyond the year 2000 and will not produce erroneous results as a result of changing centuries.

These products do not perform date arithmetic. Dates are only used to display the copyright date in the **About** box and the current date that is printed on reports. The year is displayed in four digits in the version 5 Windows products. Design-Ease for Macintosh only has the copyright dates in the splash screen and **About** box. It does not print a date with the reports.

You can be assured that our products are Year 2000 Compliant!! Please contact us if you have any questions or require a copy of our compliance letter.

Where Can You Find Us?

July '98

- BioMedical Focus '98, July 20-21, Minneapolis, MN: **"DOE on Paraffin Blend for Therapeutic Bath"**

August '98

- Joint Statistical Meetings, Aug 9-13, Dallas, TX (Booth #838): **"Teaching Aids for DOE"** and **"DOE on Paraffin Blend for Therapeutic Bath"**

September '98

- Int'l Tire Exhibition Conference, Sept 14-17, Akron, OH: **"Finding Your Sweet Spot in Compounding and Manufacturing with Response Surface Methods"**
- SME AutoFact '98, Sept 28 - Oct 1 Detroit, MI (Booth #406)

November '98

- Medical Design and Manufacturing Conference, Nov 3-4, Mpls, MN (Booth #447)

Invite us to your regional or national conference! Write to mark@statease.com.

Needed-DOE Speaker

The Fort Wayne, IN, section of ASQ is seeking a person knowledgeable in classical DOE methods to present 2-3 sessions at their November 7 Quality Conference.

If you are interested, please contact Mark at (612) 378-9449 x13 for further information.

Attention DOE Teachers at Universities and Colleges



A 180-day time-limited version of Design-Expert software on CD-ROM is now available for purchase through John Wiley & Sons Publishing. It is bundled along with Douglas Montgomery's *Design & Analysis of Experiments*, 4th Edition, for a suggested list price of \$97.95. The CD includes "on-line" tutorials and Adobe's Acrobat Reader, with tutorials keyed to Montgomery's book. The CD is also available separately for a suggested list price of \$29.95. For more information, instructors should contact Wayne Anderson at John Wiley at (212) 850-6300. Students should contact their university bookstore.

Reprints and Notes Request Fax-Back Form

- Case Study 4:** “**Find the Most Favorable Formulations**” (by Mark J. Anderson and Patrick J. Whitcomb, Stat-Ease, Inc., Minneapolis, MN) Reprinted from CHEMICAL ENGINEERING PROGRESS, April 1998. Coming up with the best product formulation means assessing a variety of blends. Design of experiments can speed the process - but, as the authors stress, the usual factorial methods are not suited to the task because they don't take into account the unique aspects of mixtures. Instead, the authors detail the right approach to use.
- Case Study 5:** “**Statistical Design of Experiments for Quality Improvement of Fertilizer Products**” (by M.J. Anderson, P.K. Bhattacharjee, P.J. Whitcomb) AIChE Spring 1998 Proceedings. Factorial design maximizes nitrogen content in fertilizer, making it less susceptible to impurities in lower-grade phosphates.
- Case Study 10:** “**Applying DOE to Microwave Popcorn**” (by Mark J. Anderson and Hank P. Anderson, Stat-Ease, Inc., Minneapolis, MN) Reprinted from PI QUALITY, Jul/Aug 1993, Revised Feb 1998. Factorial experimentation identifies the critical factors and leads to optimal settings for multiple responses.
- Case Study 20:** “**Design of Experiments Finds Vital Factors in Complex Processes**” (by Doug Stohr, Engineering Manager, Taber Bushnell, Inc., Minneapolis, MN) Reprinted from METALFORMING MAGAZINE, December 1997. A series of DOE's identifies the most significant factors for a welding process and then shows the optimal operating conditions.
- Case Study 31:** “**Robust Design - Reducing Transmitted Variation: Finding the Plateaus Using Response Surface Methods**” (By Patrick J. Whitcomb and Mark J. Anderson) ASQC 1996 Quality Congress. Overview of the propagation of error approach for robust design. It demonstrates the practical application of response surface methods, augmented by propagation of error, to solve a tough manufacturing problem and improve product quality.
- Book:** “**Experiment Design Made Easy - Annotated Instructor Notes**” (By Stat-Ease, Inc., copyright 1997.) All the overheads used in the workshop are here, plus notes normally available only to our instructors. This book doesn't substitute for the actual workshop, but we believe you'll gain valuable DOE insights. Also included: DESIGN-EXPERT software (time-limited), tutorial book, Handbook for Experimenters, answer sheets, case studies, simulations, and a \$100 coupon to attend any workshop! Cost is **\$95** if you have purchased Stat-Ease software or attended a workshop, **\$195** if not.

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