stateaser

Workshop Schedule

DOE Simplified
February 21: Dallas, TX
April 18: Detroit, MI
May 30: Minneapolis, MN
An overview of Design of Experiments from A to Z, based on the popular book. $195

Statistics for Technical Professionals New!
March 26-27: Minneapolis, MN
Revitalize the statistical skills you need to stay competitive. $895

Experiment Design Made Easy
January 8-10: Charlotte, NC
February 5-7: San Jose, CA
April 9-11: Minneapolis, MN
May 7-9: Detroit, MI
June 4-6: Minneapolis, MN
Study the practical aspects of DOE. Learn about simple, but powerful, two-level factorial designs. $1295*

Response Surface Methods for Process Optimization
April 16-18: Minneapolis, MN
Maximize profitability by discovering optimal process settings. $1295*

Mixture Design for Optimal Formulations
February 5-7: Philadelphia, PA
May 14-16: Minneapolis, MN
Learn high-powered statistical tools aimed at finding the ideal recipe for your mixture. $1295*

Robust Design: DOE Tools for Reducing Variation
March 12-14: Minneapolis, MN
June 11-13: Minneapolis, MN
Use DOE to create products and processes robust to varying conditions. A must for six sigma. *Factorial and RSM proficiency are required.* $1295*

*Register and pay by December 31, 2001 to attend at the 2001 workshop price of $1195.

Attendance limited to 20. Reserve your place by calling Sherry at 800.801.7191 x18.

Stat-Ease®
statistics made easy™

Popcorn Shootout

When good popcorn gets made properly, nothing could be finer. But perversely, bad popcorn leads to much grinding of teeth, literally and figuratively.

Mark's Experiment
by Mark J. Anderson

My frustrations over popcorn go well beyond the normal. Some may say that, like Ahab of "Moby Dick," I am obsessive in my search for the great white kernel. My search for perfect popcorn is well-documented.* However, these chronicles gloss over the more dangerous forays I've made into the extremes of time and temperature. As a reminder to be a bit less bold in setting factor levels, a coal-black clinker of fused popcorn resides in a jar near my desk.

Therefore, you can imagine my consternation at discovering a substantial quantity of unpopped kernels, as well as burned popcorn from a bag made in the company microwave. It turns out that my staff purchased a bulk-quantity of a cheap popcorn brand (I will refer to this as "A2"). Every night for many months, I gnashed my teeth on bag after bag of this stuff. Finally we ran out. I had whined plenty enough that our buyer made a point to get a more expensive brand of popcorn (let's call them "OR" and "PS"), but it required a special trip to a higher-class store. However, eventually the cheap stuff (A2) re-appeared in the Stat-Ease pantry. I decided to give it a second chance. Surprise - I liked it! Evidently we had just gotten a bad batch previously.

So now the question arose, what brand of popcorn should we buy next? Obviously, we

needed to do an experiment. I thought this would be easy to set up, but I discovered that things get complicated in matters of taste. Fortunately, my partner Pat Whitcomb took an interest in my project and proved to be an outstanding sounding board for a number of design dilemmas. We eventually settled on the following protocol:

1. Buy multibag ($\geq$6) cartons of "regular" (not light or heavy on butter) versions of A2, OR and PS microwave popcorn.
2. In random order pop one bag of each brand in the company microwave using the popcorn setting to program a standard time and power setting.
3. Ask someone who doesn't like popcorn (hard to find!), and therefore won't mind being excluded from tasting, to randomly pour the three brands into plastic containers labeled "A," "B" and "C."
4. Ask each of the volunteer testers

Christmas Trees on my Effects Plot?

Shari's FAQ

As a Stat-Ease statistical consultant, I am often asked, **"What are the green triangles (Christmas trees) on my half-normal plot of effects?"**

Factorial design analysis uses the half-normal plot to choose significant effects. Green triangles appear only when you have done replicates somewhere in the design, including the center point. If you click on a green triangle, nothing happens. Unlike the orange squares, which are factor effect estimates, the green triangles are noise effect estimates, or "pure error".

The green triangles represent the amount of variation in the replicates, with the number of triangles corresponding to the degrees of freedom (df) for the center points. For example, five center points would have four df, hence four triangles appear. The triangles are positioned within the factor effects to reflect the relative size of the noise effect. Ideally, the green triangles will land in the lower left corner, near zero. (See Figure 1.) In this position, they are a useful guide for determining where the red line should be placed. (It should be placed along the straightest line formed by the
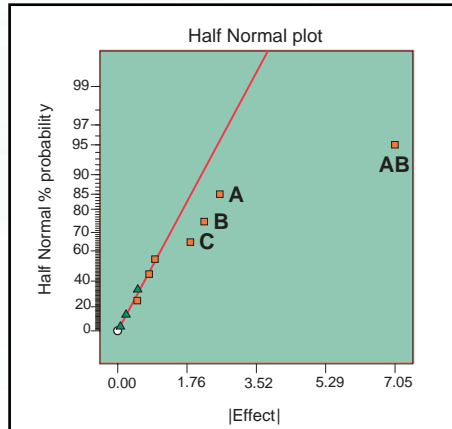

Figure 1: Triangles identify pure error from replicates

majority of triangles and squares from zero.) Factor effects off that line are most likely significant. Consider the triangles as an extra piece of information that increases your ability to find significant effects.

Once in a while we encounter an effects plot that looks like Figure 2. **"What does it mean when the green triangles are out of place - on the upper right side instead of the lower left?"**

This indicates that the variation between the replicates is greater than the factor effects! Since this error is part of the normal process variation, you cannot say that any of the terms are statistically significant. At this point

you should first check the replicate data to make sure it was both measured and recorded correctly. Then, carefully consider the sources of process variation to determine how the variation could be reduced. For a response like this, either reduce the noise or greatly increase the factor ranges in order to discover the significant effects.

- Shari Kraber

For statistical details, read "Use of Replication in Almost Unreplicated Factorials" by Larntz and Whitcomb. Circle 695 on back page.

For more frequently asked questions, sign up for Mark's monthly e-mail, "DOE FAQ Alert". (See the back page.)
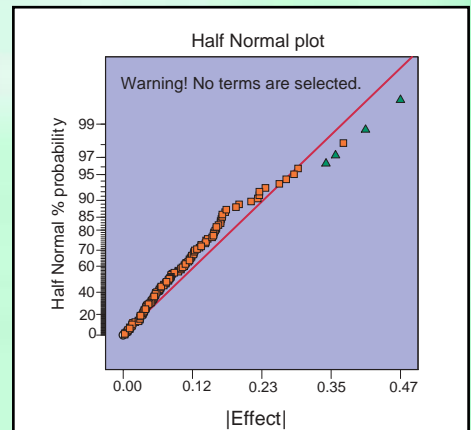

Figure 2: Pure error is greater than factor effects.

Boost your Efforts with Stat-Ease Consulting

Let Stat-Ease help you dramatically improve your products, processes or formulations with its contract consulting services.

Perhaps you need help designing the best experiment to meet your needs. Or maybe you want assistance with a complex analysis that is critical to your operation. Our consultants can work on a project with you from start to finish to help you achieve your goals. Take advantage of Stat-Ease statistical

services whenever internal resources are limited.

We can help in the following ways:
- Plan a study or experiment
- Analyze data already collected
- Check the appropriateness of your own analysis
- Provide training in statistics and DOE

Call anytime to discuss your needs - large or small - with Pat, Shari or Mark. (You'll find their biographies at

www.statease.com/consult.html.)

Stat-Ease consulting rates are $150/hr. The initial consultation to determine what your needs are, is of course, entirely free of charge. We are based in Minneapolis, MN and have consultants located across the United States. Much of the work can be handled by e-mail and telephone, but we are also happy to travel to your location if necessary.

(myself included) to randomly taste the A, B and C brands and then rank them 1 (best), 2 or 3 (worst). (Previous popcorn studies, which focused more on process factors, applied a 1-10 scale to taste, with no forced ranking. However, in this simple comparative evaluation of brands, we wanted to put pressure on the tasters to state their favorite. We hoped to generate a clear winner from the DOE.)

5. Repeat steps 2-4 six times.

The analysis of the resulting data presented a whole new set of problems for me to ponder. Once again my partner Pat came up with a number of good suggestions, proving the old adage that two heads are better than one. (I am an expert on DOE only in the sense that I know enough to know when I don't know enough… at least I think I do.) Clearly, what we had was a fully replicated (6 bags), blocked (6 different days) design. The tasters themselves could not be blocked out because they (the Stat-Ease employees) are the customers for the popcorn. Very possibly, some people might disagree significantly on which brand they'd prefer. To avoid controversy (and possibly food fights), maybe we would need to buy multiple brands.

The results (Figure 1) show that A2 (the
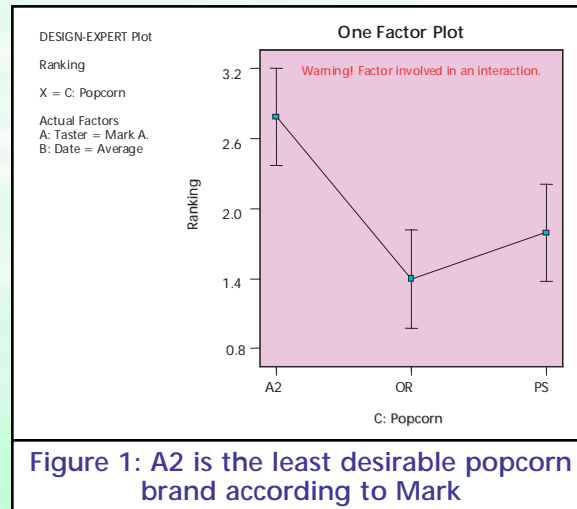
cheap stuff) should not be purchased, at least so far as I'm concerned.

The majority of individuals in our office also disliked A2, but their results did not come out nearly as confidently as mine. Notice how the least significant difference (LSD) bars for OR and PS clearly fall below the LSD for the A2 in Figure 1. This indicates a significant difference at the 95% confidence level. The bars for the OR and PS overlap, so it cannot be concluded that there's any significant preference for one or the other of these more expensive popcorn brands. The same finding held true for the group as a whole, so I conclude that it will be best if we stock either OR or PS, or better yet both, in the Stat-Ease pantry.

Looking back on the experience of doing

Figure 1: A2 is the least desirable popcorn brand according to Mark

this taste test, I would say it was a qualified success, because:

1. It was an entertaining and educational experience for me and my colleagues

2. I convinced my staff not to buy any more A2

3. I did not destroy the company microwave.

However, as you can see by my use of coded names for the popcorn brands, I dare not go out on a limb and say that I developed any conclusive evidence favoring one brand of popcorn over another. That's something that you must decide for yourself. I hope you will do this in a scientific way using the principles of DOE. But whatever you do, please be careful - microwaves may be more powerful than you think.

- Mark J. Anderson

PS. Another thing you should not try with the microwave: Re-heating fast food that's wrapped in metallic-looking paper. I tried this the other day to see what would happen. Imagine compressing a vicious thunderstorm into a volume the size of a breadbox. It was very impressive to see, but bad for the equipment.

* "Applying DOE to Microwave Popcorn," PI Quality, July 1993. Free reprints are available upon request. Circle **14** on the back page.

News in Brief........

Register Now to Avoid a Workshop Price Increase!

Workshop fees for the three-day classes are increasing in 2002. **Save $100** on a 2002 workshop by registering and pre-paying by December 31, 2001. Save another $100 by using the coupon inside the front cover of your Design-Expert® or Design-Ease® software manual. Groups of 4 or more attending a single workshop can save $200 each. Register

online or by contacting Sherry at **612.378.9449 x18**. You'll find complete descriptions of all our workshops at **www.statease.com**.

Call for Papers!

Stat-Ease is sponsoring a two-paper session on **"The Use of DOE in Non-Manufacturing Environments"** at the Spring Research Conference, sponsored by the Quality and Productivity (Q&P) section of the American Statistical Association (ASA) . The conference will be held on June 5-7 in Phoenix, Arizona.

If you, or someone you know, has applied DOE in a non-traditional setting such as marketing, financial services, or other business areas, and are willing to share your story, please contact Shari Kraber at shari@statease.com. You may also call her at 1.612.378.9449.

The conference is a great opportunity to meet other professionals and learn about new applications of statistics and DOE.

Sign up for the *DOE FAQ Alert* by faxing this page to us at 1.612.378.2152. (Or sign up at **www.statease.com/currdoealert.html**).

____ YES, I would like to receive Mark's monthly e-mail, the DOE FAQ Alert.   ____ NO, thank you anyway.

My e-mail address is: _____

Thank you for reading the *Stat-Teaser* newsletter. We are happy to send it to you. If you would like to continue to receive the newsletter by mail, please do nothing. If, however, you would prefer to receive the *Stat-Teaser* by e-mail notification or not at all, please take a moment to let us know so we can reduce unnecessary printing and postage costs. Thank you for your help.

____ E-mail me notification of the newsletter. I will view it on the web. (Print e-mail address above.)   ____ Please remove me from your mailing list.

Qty	Software and Book Order Form - Fax to 1.612.378.2152	Unit Cost	Ext. Cost
	Design-Expert 6.0 [Single license—for quantity discounts (3+ copies) or network licenses, call for a quote]	$995.00	
	Upgrade to DX6 from DX5 Old Serial # required:	$295.00	
	Upgrade to DX6 from DX4 or earlier Old Serial # required:	$395.00	
	DOE Simplified Book (Comes with a 180-day CD-ROM of Design-Ease 6 software)	$39.95	
	DOE Reprints Please circle the reprint #'s you want: 14 695	FREE	FREE
	Shipping within the USA—Add $15.00 for each software package & $5.00 for each book. All others, please call for a quote.		
	Total		

Payment Information

☐ **Credit Card:** ___Visa ___MC ___Am. Express
  Card Number _____ Exp. Date _____
  Name on Card (please print) _____
  Authorized Signature _____

☐ **P.O. Number (North American orders only)**
  Bill To Address (if different from the ship to address)
  _____

Ship To (if different from address label)
Name _____
Company _____
Address 1 _____
Address 2 _____
City, State, ZIP _____
Country _____

☐ **Check enclosed**, Make payable and mail to: Stat-Ease, Inc., 2021 E. Hennepin Ave., #191, Minneapolis, MN 55413