



# Stat Teaser

ABOUT STAT-EASE® SOFTWARE, TRAINING, AND CONSULTING FOR DOE • SEPTEMBER 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

**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 powerful two-level factorial designs.

### • Response Surface Methods for Process Optimization

**October 6-9, 1998:** Minneapolis, MN

**February 9-12, 1999:** Minneapolis, MN

This workshop builds factorial DOE's into Response Surface Method (RSM) Designs, which produce maps to help find the optimum and/or robust conditions for your process.

### • Mixture Design for Optimal Formulations

**November 3-6, 1998:** Minneapolis, MN

**March 16-19, 1999:** Houston, TX

If you do product formulation, you know that standard factorial designs just don't work. Learn all the skills you need for mixture design in this course.

### • 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 & winter - call for a quote and to reserve a time slot!

## Mix Tricks to Max Wax: A Feel Good Application of DOE

In another life I am a partner and R&D consultant for a family-

owned durable medical device company based in Stillwater, Minnesota. They manufacture a paraffin therapy bath which holds one gallon of molten wax. Arthritic patients dip their hands repeatedly in the heated bath to help loosen their joints. The wax then slowly solidifies as a glove, producing further therapeutic benefits via the heat of fusion. Oils are blended in the wax to facilitate removal of the glove and to reduce the overall melt point to a comfortable level. These oils provide another benefit - a wonderful moisturizing of the skin, which makes the paraffin bath popular in salons and spas.

To enhance the perceived benefit to skin, I developed a specialized formula with vitamin E and peach scents and colors. After more than ten years on the market, this formula continues to be very successful. However, the company has now shifted from a custom blender to in-house production. The manufacturing people wondered how much the source and amounts of ingredients could be varied before users would perceive differences. To get a feel for the sensitivity, I recommended a 1/8th fractional two-level factorial design on the

### Mark's Experiment

by Mark J. Anderson

ratios of wax and oil, and the amount of additives. Ideally we'd find nothing significant, thus proving the mixture to be robust to minor variations.



Paraffin Therapy Bath

However, if this did not prove to be the case, then the design could be folded over to detect any interactions.

The following factors were studied in a 2<sup>6-3</sup> (8 run) ruggedness design (resolution III).

- Ratio of component waxes  
(R1= W1/W2)
- Ratio of total wax to oil  
(R2= (W1+W2)/O)
- Supplier of wax
- Amount of dye
- Amount of perfume
- Amount of vitamin E

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# Workshop Notes



## California Here We Come!!!!

Stat-Ease will be hosting concurrent DOE courses in Anaheim, California, December 7-11.

Whoops! Have you fallen victim to the “use it or lose it” syndrome? Are you wishing you could retake that DOE class that you took years ago to refresh your skills? A little known fact from Stat-Ease is that former students can retake classes at a **50% discount!!** Our course materials are subject to continuous improvement so if you have attended a specific course before, you can retake it and update your skills while checking out our latest course material and perhaps new software. A limited number of discounted seats are available for each class. For more information, contact Carol at (800) 801-7191 ext. 18.

**Robust Design for Quality Improvement** will be held for 2 1/2 days, starting Monday, December 7. This course teaches you how to maximize performance while minimizing variation. Several different techniques are explored, including Taguchi parameter designs, dual response methods, and propagation of error (tolerance analysis.) Mastering these techniques allows you to design a process or product that is robust to outside influences, or the “noise” in your process.

**Experiment Design Made Easy** will start on Tuesday, December 8 and run for 3 1/2 days. This workshop teaches the basics of

DOE and provides a good foundation for your design of experiments education. Learn about simple but powerful two-level factorial experimentation. Discover how to minimize experimentation by using fractional factorials. Develop expertise in DOE techniques including blocking, use of transformations, and sequential experimentation using foldover designs.

Call Carol at (800) 801-7191 ext. 18 for more information or visit our website, [www.statease.com](http://www.statease.com).

### Typo or Freudian Slip?

A client recently was seeking information from Stat-Ease and e-mailed the following question: “How much will this course cost us?” Carol quickly replied: “You may curse us free of charge, but the course costs....”

## Meet the Instructor.....

Stat-Ease workshop students have enjoyed the creative teaching style of Tom Scripps since 1995. Here’s a little background on this popular instructor.

Tom lives in Evergreen, CO, very close to Denver. He met his wife, Barbara, on stage during one of the many theatrical productions they have performed in.

Barbara is a CPA and seems perfect for Tom as they move together through a life filled with math and drama. Their three children are destined to be mathematically inclined, but hopefully will share their parents expressive sides as well.

Since 1983, Tom has operated a successful consulting business, helping



### Stat-Ease Instructor Tom Scripps

organizations apply statistical methods for quality improvement through training, educational seminars and consulting services.

He developed and teaches a designed experiments course for ASQ (American Society of Quality) called “Process Modeling and Optimization.” Tom is also currently undertaking

the development of another ASQ course on process capability.

When Tom is not traveling, he is an avid amateur astronomer. Tom says that after the children are in bed he likes to “get away” from things by studying the stars through his collection of telescopes.

Both originally from the Midwest, Tom and Barbara are living the 90’s life-style with a hectic dual-career schedule. Keeping up with their own activities as well as their children’s is a challenge both handle with style and a sense of humor.

Stat-Ease is lucky to have such an entertaining and statistically savvy professional like Tom as one of our instructors!

-- continued from page 1

We cannot reveal the actual levels of each factor, but the amounts of vitamin E, color and scent were very small in relation to the wax and oil.

To measure response, an "expert" panel of 10 employees provided sensory evaluation of heating, oiliness, scent, and color. They rated the paraffin on a continuous scale from 1 (worst) to 5 (so-so) to 9 (best). The results were analyzed by individual (block) and then averaged.

Analysis of the experiment with Design-Ease® software revealed significant impacts on perceptions of users. For color and scent, the results were obvious: dye and perfume were the significant effects respectively. The panel liked higher levels of both. But for the other attributes (heat, glove and oiliness), the aliasing of main effects with the interactions in the resolution III design made it impossible to draw any definite conclusions. Therefore, I set up a foldover experiment. However, before doing the foldover, I eliminated dye and perfume as factors, thus giving us a full factorial of 16 runs in total for the remaining four factors. All of this is relatively easy to do with the aid of Design-Ease software.

Based on the results from the two-step DOE, I recommended:

- the cheapest supply of raw material wax (this factor was not significant)
- higher levels of color and scent (added benefit: this may better mask the variability of native colors and scents)
- a lower amount of vitamin E, a higher ratio of W1 wax to W2 wax and a higher ratio of total wax to oil.

The latter recommendation stems from a 3-way interaction on perception of oiliness, so you must keep the combination intact. A paired t-test done with 20 subjects showed a significant preference for the new for-

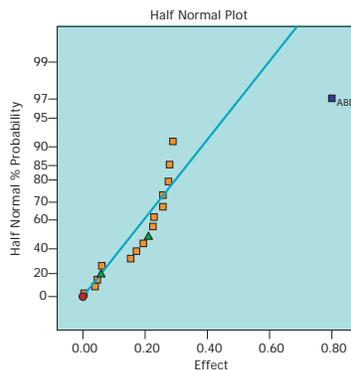


Figure 1: 3FI Revealed by Foldover

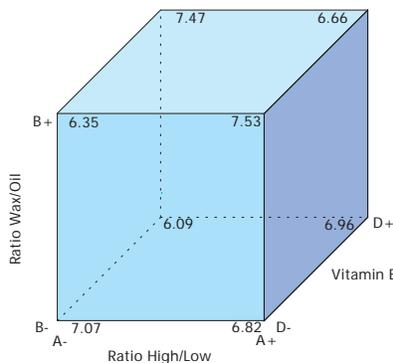


Figure 2: Cube Plot of 3FI (Oiliness)

mula. The end result is a better and cheaper paraffin blend!

--Mark (mark@statease.com)

## Appendix on Ratios

The use of ratios accounts for the impact of the proportionality of the wax components. However, to actually make up the blends, it was necessary to solve for the original ingredients in terms of the ratios. By accounting for the overall mixture constraint: (W1 + W2 + Oil = 1), the necessary equations can be derived from the two ratios:

$$W1 = R1R2/(1+R1+R2+R1R2)$$

$$W2 = R2/(1+R1+R2+R1R2)$$

$$Oil = (1+R1)/(1+R1+R2+R1R2)$$

This is the hardest part of the DOE, but fun if you're an engineer (like I am) and actually enjoy math. For more complex systems of ratios you can use mathematical software to solve the equations. To check their accuracy, I programmed the equations into a spreadsheet and made sure the percentages summed to 100. We cover the ratio approach in our "Mixture Design for Optimal Formulation" workshop. Call Carol at (800) 801-7191 x18 to sign up.

# Where Can You Find Us?

## September '98

### ● Int'l Tire Conference

Sept 14-15, Akron, OH

Talk - "Finding Your Sweet Spot in Compounding and Manufacturing with Response Surface Methods"

Workshop - EVOP (Evolutionary Operation)

### ● TAPPI (paper industry)

Sept. 22, Little Rock, AK

Talk - "Mixture Design for Optimal Formulation - A Case Study on Glass Fiber Mat"

### ● SME Autofact '98

Sept 29 - Oct 1, Detroit, MI (Booth 406)

Talk - "Design of Experiments Finds Vital Factors in Complex Processes"

## October '98

### ● Chemical Processing Expo

Oct 8, Kingston, TN (Booth 509)

Talk - "Design of Experiment Strategies"

### ● ASQ Fall Technical Conference

Oct 22-23, Corning, NY

Talk - "Use of Replication in Almost Unreplicated Factorials"

## November '98

### ● Medical Design and Manufacturing Conference

Nov 3-4, Mpls, MN (Booth 447)

Invite us to your regional or national conference. Send e-mail to mark@statease.com.

## Nice of you to say.....

"I just want to commend Tryg Helseth on the excellent job he did in helping me with a recent DX4 problem...He was very responsive and I very much appreciate his knowledge and helpfulness."

Rick Meyer

# Reprint Request Fax-Back Form

- Case Study 12: "Understanding Your Process"** (by Elizabeth Clarkson) Reprinted from DESKTOP ENGINEERING, July 1998. A statistician tests and reviews Design-Expert version 5 for its useability, graphics, model adequacy, and optimization capability.
  
- Case Study 18: "Prototype Circuit Board Maker DOE's Gold Plating"** (by Mark J. Anderson) Reprinted from JOB SHOP TECHNOLOGY, July 1998. A high-tech prototype shop runs two different factorial designed experiments to reduce rework and improve yields.
  
- Case Study 28: "Experiments Uncover Source of Valve Failures"** (by Nancy Chase) Reprinted from QUALITY, June 1998. A manufacturing company reduces overall product development time by testing design, environmental and manufacturing factors simultaneously.
  
- Case Study 34: "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 to 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.

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