



Stat Teaser

ABOUT STAT-EASE® SOFTWARE, TRAINING, AND CONSULTING FOR DOE • JANUARY 1999
 Phone (612) 378-9449 • Toll-Free (800) 801-7191 • E-mail info@statease.com • Website www.statease.com

Workshop Schedule

• **Experiment Design Made Easy**

January 26-29: Denver, CO
February 23-26: Atlanta, GA
April 13-16: Dallas, TX
May 11-14: Minneapolis, MN

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 9-11: Minneapolis, MN
June 1-3: 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**

March 16-18: Houston, TX
July 13-15: Minneapolis, MN

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**

April 20-22: Minneapolis, MN

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**

DOE Whips Non-Starting Weed Whacker

"Dad, I can't trim the lawn because the weed whacker won't start."

Mark's Experiment

by Mark J. Anderson

My 15 year-old daughter Emily invariably invokes this excuse after mowing the lawn. She inherited the job from her 2 older brothers. In addition to our suburban-size yard, Emily is also responsible for mowing the local preschool where her mother (my wife) teaches. I don't even bother asking anymore - I do the trimming while she does the mowing.

I have to admit that I've struggled with the weed whacker. It's a one-cylinder beast. After a lot of trial and error (and expletives not deleted), a procedure evolved that got the thing started, but with way too many pulls. As Emily has heard ad nauseum, her old man (that's me) tore his rotator cuff playing softball and lives with constant shoulder pain. Since nobody has shown any sympathy or inclination to help, I decided to tame the beastly weed whacker with the power of DOE.

Round 1: Response Surface Method (a failure)

The weed whacker (see picture) is relatively simple. The one-cylinder combustion engine runs on a mixture of gasoline and oil. One tank lasts a year or more, so I didn't mess with the fuel. Ignoring the spark plug and other engine parts, the performance then

becomes a function of three controls: primer pump, choke and gas. I jumped the gun a bit and initially designed a 3-level response surface method (RSM)



The Weed Whacker

design called a Box-Behnken. If my arm hadn't given out first, this would have required 17 set-ups of the three aforementioned controls. But after the first few runs, which resulted in utter failure, I realized that the weed whacker had won the battle. Even after 50 pulls it just would not start.

Finally I got to a 'successful set-up': 4 primer pumps, 50% choke and 100% gas. The darned thing did start, but only after 17 hard pulls. Emily is a real trooper (bias?), but even she wouldn't go beyond a half-dozen yanks of the starter cord. At this point I got really desperate and dug out the operating manual.

-- continued on page 3

Stat-Ease presents our NEW logo!!!



Stat-Ease is proud to present our new logo. After having the same basic logo for 13 years, we felt it was time to update our image.

The swoosh above the "S" represents an artistic interpretation of graph or contour lines. The purple color is just plain pretty, and Go Vikings!!

You'll see our updated image slowly unfolding over the next year with new literature and packaging. You'll also notice a new look to the newsletter. Stat-Ease is changing not only our logo,

but we have also been working hard to improve our already excellent software. You'll have the opportunity to learn all about it at Stat-Ease's [First Annual User Conference](#), July 29-30, 1999.

We will be demonstrating our newest software, offering presentations and valuable instruction from experts in the field, and providing an opportunity for you to network with and learn from other users and Stat-Ease staff.

Please help us plan a great conference by taking a few minutes to answer the

enclosed survey. We'll enter you in a drawing for a free copy of Design-Expert version 6 just for replying.

We hope you like the new look and welcome your comments.



Keys to Successful DOE's by Shari Kraber, CQE

The following is a brief summary of a paper presented at the 1998 Annual Quality Congress sponsored by the American Society of Quality. You may obtain a full copy of this paper from our website, www.statease.com.

Using DOE successfully depends on understanding 8 fundamental concepts:

- 1. Determine the objective:** The objective helps determine the correct design to use. Fractional factorials may be used to screen for significant factors. Response surface designs are used to optimize a process. Mixture designs are unique to optimizing formulation work.
- 2. Response measurement:** A measurement technique must have an adequate ability to discriminate between the differences in response data. This is one of the most frequent reasons for poor DOE results.
- 3. Replication:** Calculate your signal to noise ratio to determine how many runs are needed to detect an effect in your process.
- 4. Randomization:** Complete randomization of the runs protects you from analysis errors caused by unknown time-related factors being confused with factor effects you are trying to study.
- 5. Blocking to reduce variation:** Block things you are not trying to study, but that may cause additional variation in the response. This tool reduces error and allows effects to be detected more easily.
- 6. Alias structures:** Fractional factorial designs are great for minimizing runs, but be aware that valuable information may be lost because you can no longer estimate all the effects independently.
- 7. Iterative experimentation:** Smaller designs run sequentially allow you to build up process knowledge without risking a good deal of time and money on any one DOE.
- 8. Confirmation runs:** Always verify that the results indicated by the DOE are consistent under normal production circumstances.

-- continued from page 1

Round 2: Fractional Factorial Design (success!)

The manual made it clear that before starting the engine you must first prime it with 3 to 5 pumps, then set the choke at 100%, and pull several times to turn it over. I'd actually 'discovered' this trick after several years of frustration, but not being a motor-head, I thought I could outsmart the thing. The aborted RSM cured me of this notion. So I set myself in front of Design-Ease® software, and with a great deal of pain (with my poor, sore shoulder), I set up a 5-factor, 2-level DOE. I gratefully accepted the half-fraction high-resolution option to the full 32-run design, which still gave me a daunting, but do-able, 16 runs. Here's a list of the factors and levels:

- A. Prime pumps, 3 - 5
- B. Pulls at full choke, 3 - 5
- C. Gas during full choke pulls, 0 - 100 %
- D. Final choke setting, 0 - 50%
- E. Gas for start, 0 - 100%

The number of pulls needed to start the weed whacker ranged from 8 down to 1, proving it does pay to read the manual. (Fortunately, the vast majority of our users are infinitely smarter than I am and diligently read every bit of the excellent manual that comes with Design-Ease and Design-Expert® software.)

Statistical analysis revealed highly significant (>99%) effects due to factors C (best low) and E (best high). None of the other factors mattered, so I picked the most convenient level. Therefore the ideal procedure for minimizing pulls is:

- Prepare engine with 3 primer pumps and 3 pulls at 100% choke with 0% gas
- Start at 0% choke and 100% gas.

The engine then starts immediately on the first pull!

I finished the final DOE the last week of September after the first hard frost, so all the weeds died before I could whack them. When warm weather

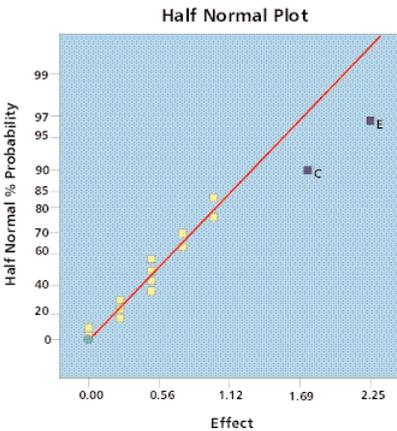


Figure 1: Effects Graph

finally returns to Minnesota, I will be armed and ready to do battle. In the meantime, I wonder if the snow-blower will start...? I might have to try whacking the snow instead.

--Mark (mark@statease.com)

Meet the Instructor..



Stat-Ease Instructor Carl McAfee

Carl McAfee brings an abundance of practical experience to the classroom when he teaches Stat-Ease's designed experiments courses. Carl's work experiences have shown him first-hand how DOE helps solve problems quickly and easily. He worked first for Dow Chemical and then for Chase Elastomer in new product development and polymer characterization.

Living in the Dallas/Fort Worth area, Carl has embarked on a new career as a private consultant specializing in technical, chemical and analytical services. He characterizes himself as a "scientist learning how to do business." This has offered him a broad range of new experiences over the last several years.

On a more personal note, his wife of 15 years, Debbie, supports his business as the Chief Financial Officer. (Yes, she tells him when to get out there and bring home the bacon!) Carl has 2 children, Carl Jr, age 12, and Christina, age 2. His passions are sailing, playing the piano and traveling around the world. He also has a flair for languages and is fluent in both French and German.

Stat-Ease is pleased to have instructors with hands-on industry experience like Carl McAfee. To learn more about Carl and his services, visit his website at www.prochemist.com.

Where Can You Find Us?

January '99

- **Quality Management**
Jan 20, Charlotte, NC
Talk - Mark Anderson

April '99

- **MN Quality Conference**
April 8-9, Mpls, MN
Talk - Shari Kraber

• **'99 Quality Expo**

April 27-29, Chicago, IL
Booth #20047
Talk - Mark Anderson

May '99

- **Annual Quality Congress**
May 24-26, Anaheim, CA
Booth #714
Talk - Mark Anderson

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

Reprint Request Fax-Back Form

- Case Study 5: "Design of Experiments Strategies"** (by Mark J. Anderson and Patrick Whitcomb) Reprinted from the CHEMICAL PROCESSING PROJECT ENGINEERING ANNUAL, August 1998. This article describes the two phases of experimental design (DOE) strategy, including the use of two-level factorial designs as screening tools to find the vital few factors and the use of response surface maps for an in-depth investigation of the surviving factors to determine optimum settings.

- Case Study 19: "Using DOE to Prevent Solvent Pop"** (by Steve Hazelwood) Reprinted from PAINT & COATINGS INDUSTRY, August 1998. A client who manufactures and paints heavy-duty equipment uses DOE to find the optimum factors for increasing paint film thickness without causing solvent pop or blistering.

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