



The Stat Teaser



Stat-Ease, Incorporated

"Statistics Made Easy"™

Winter 1995

Hockey Adds Breakthroughs and Break to Workshop

It's okay if you can't skate. And no, you don't need any protective padding. But be sure you bring your DOE questions to our *Experimental Design Made Easy* workshop offered nationwide.



Stat-Ease's enlightening variation of the classic tabletop hockey game faces off the last day of each introductory DOE workshop. It demonstrates how full and fractional factorial designs offer breakthrough solutions to each attendee's work process demons. (*If you only could have used this rationale as a kid when your parents wanted you to study.*)

Students study three to five factors in the exercise. (Each factor runs at a high and low level, resulting in a 2^3 to 2^{5-1} factorial design.) Take a moment to see below how one workshop team structured their experiment. They ran a fractional two-level design with five factors—conducting only 16 experiments. *Would you have set it up differently?*

Factors	High Level	Low Level
Shot Type	Wrist shot (puck rests against stick before shot)	Slap shot (puck is set at face-off line)
Stick Length	Long (14 cm)	Short (7 cm)
Windup	Full (4.5 cm)	Half (2.5 cm)
Puck Attitude (Optional)	Heads	Tails
Rink Surface (Optional)	Smooth	Rough

The students run tests to determine how far the puck slides under differing experimental conditions. The answers decide how future games are to be played so that all shots reach optimized distances. Considering the factors shown in the

table, can you accurately and without reservation predict the optimal response? (*Our students now can.*)

If you want to discover breakthrough DOE techniques, join us at an *Experimental Design Made Easy* workshop:

⇒ **March 14-17, 1995 (Anaheim, CA)**

⇒ **June 13-16, 1995 (Minneapolis, MN)**

All you need to bring are your questions and your process headaches. We'll bring the game. (*Please don't tell your folks.*)

If hockey *isn't* your game, or if you want to progress beyond a beginning DOE level, register for an advanced workshop:

Response Surface Methods for Process Optimization

◆ **April 25-28, 1995 (Minneapolis, MN)**

Mixture Design for Optimal Formulations

◆ **May 16-19, 1995 (Minneapolis, MN)**

Call and ask how these workshops extend your reach to product and process design optimization. (*Warning: Some of these workshops are already half full. Limit 20.*)

Oh Oh...

We apologize to you who last month received multiple copies of our workshop postcard mailing. We'd like to blame the snafu on the post office or our mailing service—but we can't. We simply goofed.

Million Dollar Award Bestowed on Stat-Ease

DESIGN-EASE® software for DOS, Mac and Windows recently surpassed \$1 million in sales. Stat-Ease Incorporated received recognition and an award for the milestone at this year's Minnesota Software Association/ICP Million Dollar Awards Ceremony.

The \$1 million award is presented annually to companies selling proprietary software products—including maintenance, modification and enhancements. Since DESIGN-EASE® was introduced in June of 1985, accumulated sales have exceeded \$1.25 million. We're quite proud of that.

Although many awards programs in the industry exist, the ICP Million Dollar Awards is the only one that is based on the true test of market acceptance. (*"Did anyone buy it?"*) Other awards are given based on an editor's judgment or the opinion of a "panel of experts." On behalf of OUR "panel of experts"—you—Stat-Ease is honored to share the award with our users.

Users who this year upgraded from DOS version 2 to DESIGN-EASE® version 3 (Windows and Macintosh) earned more than merely a piece of the award. Here's what else they earned:

- Extended designs to 128 runs -- double the capacity of the DOS version.
- "What if" analysis in side-by-side Windows.
- Post-ANOVA testing to indicate pairwise testing. (Example: test raw materials from four suppliers. Very handy!)
- Least significant difference "bars" on interaction plots show which results are statistically different -- you can make quick, informed decisions.
- Manipulate data in your GUI spreadsheet. Then paste the results as responses. (Examples: calculate mean, standard deviation, signal-to-noise.)

To upgrade from DESIGN-EASE® versions 1 or 2 (DOS) to Windows or Mac for just \$195, call or fax us. We can help you break through. We're at 800-325-9807.

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Mixture Design — Simple as Pound Cake

DESIGN-EXPERT® software makes mixture design simple. To show this, my 11-year-old daughter Emily and I ran an experiment with homemade pound cake. Pound cake makes an ideal product for experimentation because of its simple recipe: one-fourth each of flour, butter, eggs, and sugar.

To begin the quest for perfect homemade pound cake, we arbitrarily varied each of the four basic ingredients in a range from 3 to 5 ounces, with the total weight set at 16 ounces (one pound). Cake flour, recommended by experts, costs about four times more than the all-purpose variety. We included both, subject to the multicomponent constraint (total flour kept within 3-5 ounces), hoping to formulate a tasty yet less expensive recipe.

We used DESIGN-EXPERT® software

to set up a mixture design specifically geared to reveal interactions between ingredients. We could only fit half the cakes in the oven, so we split the design into two blocks. Within each block, the run order was randomized to prevent any bias from lurking factors such as aged ingredients, increasing ambient temperature, settling time, and the like.

A frozen pound cake made commercially by Sara Lee Corporation provided a measurement standard for the responses: color, density, and taste. Statistically significant linear fits were found in every response. Trace plots, such as the one shown below, displayed the effects of each component on the response.

Regarding taste, the preferable ingredient proved to be sugar (Note: sweet tooth at work here). Butter might also be preferred,

but more tests are needed to prove this conclusively. High levels of flour met with the tasters' disapproval. Eggs also may be negatively correlated with taste, but this was not conclusive.

Concerning type of flour, we detected no difference in any of the responses. Therefore we chose the cheaper all-purpose flour. *The use of multicomponent constraints in this manner offers tremendous opportunities for cost reductions.*

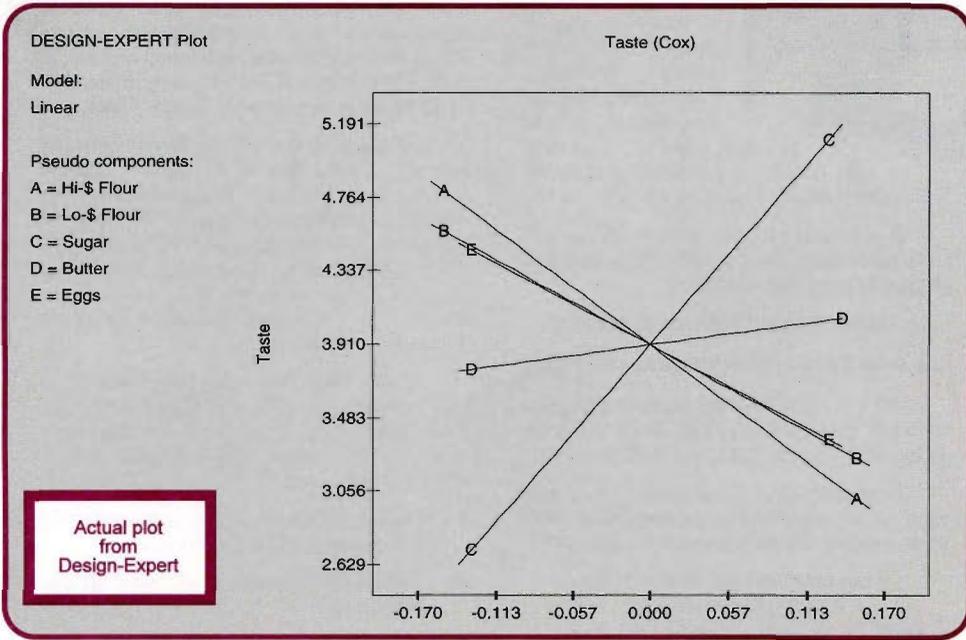
With the aid of DESIGN-EXPERT®, we then performed a desirability analysis to establish the optimal recipe. We assigned the greatest weight to taste, followed by density, and then color. The optimal recipe matched color, but density and taste fell short of the ideal set by Sara Lee.

We did make major improvements and gained profound insights on making pound cake. Formulators who still work on a one-factor-at-a-time approach would do well to study the techniques of mixture design so they can make similar breakthroughs. And if you're trying to create the ideal pound cake, make certain no dieters are nearby.

Mark J. Anderson

(A detailed report on this experiment, including the optimal recipe, is available just by calling us. Attend Stat-Ease's *Mixture Design for Optimal Formulation* workshop to gain an in-depth understanding of statistical design and analysis tools for mixtures.)

"Very well presented with excellent course notes. The software is great."
 — Phil Wright
 October '94 Workshop
 Brake Lining Development
 Abex Friction Products



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"One of the best DOE classes I have attended in the 12 years I've been working with DOEs."

— Bill Hayes
 September '94
 R&D Manager for Friction Materials
 Rockwell International