



# Stat-Teaser

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

June 22-25: Detroit, MI

August 3-6: Minneapolis, MN

September 14-17: 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

June 1-3: Minneapolis, MN

October 5-7: 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

July 13-15: Minneapolis, MN

October 19-21: Minneapolis, MN

Standard factorial designs don't work well for formulations. Learn all the skills you need for mixture designs in this course.

### • Advanced DOE and Robust Design

December 6-8: Anaheim, CA

Practice advanced analysis techniques and learn how to create products and processes that are robust to varying conditions.

### • Real Life DOE \*New Class!\*

September 28-30: Minneapolis, MN

No textbook data - analyze real data sets and learn how to deal with common pitfalls and analysis problems! Working knowledge of factorial designs required.

Attendance limited to 24. Reserve your place by calling Sherry, ext. 18, at (800) 801-7191

## Get Supercharged at the First Ever Stat-Ease DOE Conference!

Join Stat-Ease at its first ever DOE (Design of Experiments) Conference in Minneapolis, Minnesota this July 29-30! In this two-day conference you'll learn experimental design techniques and hear actual case studies. Attend sessions given by experts in the field. In addition, get free advice from Stat-Ease consultants and programmers. You'll also have plenty of time for networking and sharing DOE ideas with others. Come prepared to learn how to improve your organization's products and processes!

### Sessions - Tentative

(See descriptions on page 3.)

- Identify Significant Factors with Multilevel Factorial Designs
- How to Take Full Advantage of Powerful Design Evaluation Tools
- Leading Edge Response Surface Designs for Process Optimization
- Combining Mixture Designs with Process Variables to Discover Breakthrough Interactions
- Analyzing Real-life Data - Tricks of the Trade
- Robust Design via Propagation of Error (POE) - Climb to the High Plateaus
- DOE in Industry - Actual Case Studies

Keynote Dinner  
Presentation by  
Dr. Douglas Montgomery  
Thursday, July 29  
6-8 pm

### Our Keynote Speaker...

Dr. Douglas C. Montgomery is Professor of Industrial and Management Systems Engineering at Arizona State University. He holds BSIE, MS and Ph.D. degrees from Virginia Polytechnic Institute.

Dr. Montgomery is an author of 12 books, including *Response Surface Methodology*, 1995 and *Design and Analysis of Experiments*, 4th edition 1997 (pictured below).

We welcome Dr. Montgomery to Minneapolis!



Student Package of Design-Expert® Software & Dr. Montgomery's Book Available from J. Wiley & Sons. (Manual sold separately.)

# Mixture Design Shines for Working Gold

I recently ‘discovered’ a wonderful example of mixture design at an exhibition called “Ancient Gold: Jewelry from the Dallas Museum of Art.” The exhibit included spectacularly intricate earrings, necklaces and rings. It explained how goldsmiths as far back as the 7th century B.C. crafted this magnificent jewelry. They found it very difficult to attach the parts without melting the basic piece. Fortunately the melt-point of gold can be depressed by adding copper, a far cheaper metal that looks very similar. Therefore, a mixture of these metals can be used to attach parts of pure gold, without causing unwanted meltdown.



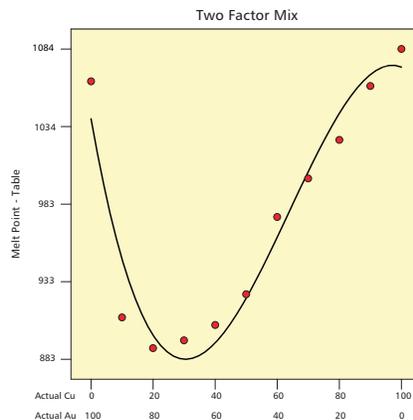
**Ancient gold jewelry**

Being a chemical engineer, I found this phenomena very intriguing. I just happened to have an old copy (46th edition, 1965) of the “Handbook of Chemistry and Physics” published by the Chemical Rubber Company. There I found a table of melting points (MP) of mixtures of metals. Table 1 shows the data for a mixture of gold (Au) and copper (Cu). Notice that the minimum melt point occurs at some combination of copper and gold. This example illustrates a couple of key aspects of mixture design: the components *interact*, and they do so in a way that is *synergistic* (at least for purposes of goldsmithing).

I thought it would be interesting to see a graph of this data, so I entered it in our Design-Expert® software. Figure 1

## Mark’s Experiment

by Mark J. Anderson



**Figure 1: Graph of Tabulated Melt Points of Gold/Copper Mixture**

shows the results from a cubic model, the highest order available in the current version. It fits fairly well, with a slight offset on the absolute minimum.

To simplify matters further, just for the purposes of illustration, let’s assume the original experimenter (back in ancient times) could not weigh the ingredients or measure the temperature very accurately. Perhaps they may have carved out a graph that looked like Figure 2. The software generated this graph from the following equation:

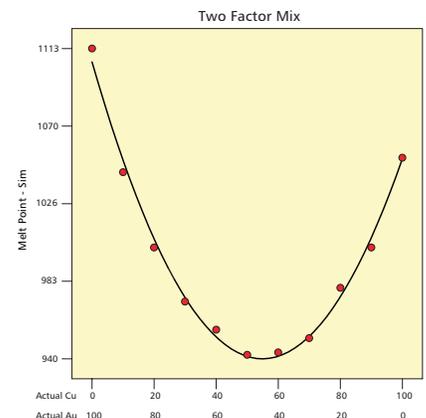
$$\text{Melt Point} = 1051 * \text{Au} + 1105 * \text{Cu} - 550 * \text{Au} * \text{Cu}$$

when the components are entered on a scale of 0 to 1. This form of polynomial, originally developed by Henri Scheffé, is easy to interpret. The linear coefficients, 1051 for gold and 1105 for copper, are the predicted responses (melt point) for the pure components. The 2nd order coefficient (-550) represents the interaction effect. It has the greatest impact at the 50/50 blend point. (To check this, try multiplying the respective component levels at any

other combination.) The deflection from linear blending can be determined by multiplying the components (0.5 x 0.5 = 0.25, or ¼th) by the coefficient. So in this hypothetical experiment, the melt point is depressed by 550/4, or 137.5 degrees C.

Anyone who does formulation, not just metallurgists, can benefit from use of mixture design tools such as those available in Design-Expert. Our software offers a variety of designs for up to 24 components. You can impose constraints on individual components or linear combinations, thus tailoring the experiment to a feasible region. Perhaps you will discover hidden gold by uncovering previously unknown interactions like that between gold and copper. I hope so!

The following quote by the author of “The Lord of the Rings” provides a fitting conclusion to these musings on



**Figure 2: Hypothetical Graph from Ancient Experiment**

ancient gold. To me it describes the process of discovery via well-planned empirical experimentation.

**“All that is gold does not glitter, not all those that wander are lost.” (J.R.R. Tolkien)**

- Mark J. Anderson  
(Mark@Statease.com)

(Want to learn more? Attend our Mixture Design for Optimal Formulations workshop. See page 1.)

Cu %	0	10	20	30	40	50	60	70	80	90	100
MP (deg C)	1063	910	890	895	905	925	975	1000	1025	1060	1084

**Table 1: Melting Points (MP) of Copper (Cu) and Gold Mixture**

# Session Descriptions for Stat-Ease DOE Conference

Survey suggestions were compiled to help us determine the content of our sessions. Thank you for your input! We will tentatively have sessions on the following topics:

## Identify Significant Factors with Multilevel Factorial Designs

Explore the use of full and fractional factorials, Taguchi designs, and general (multilevel) factorial designs. Learn how to graphically explore the alias structure.

## How to Take Full Advantage of Powerful Design Evaluation Tools

Learn how to evaluate a design BEFORE running it to determine if it will meet your needs. Utilize Design-Expert version 6's new power calculation.

## Leading Edge Response Surface Designs for Process Optimization

Understand the differences between various RSM designs, see how to add categorical factors, and explore optimization features.

## Combining Mixture Designs with Process Variables to Discover Breakthrough Interactions

Design-Expert version 6 offers experimenters a new design category - Crossed designs. Learn how to analyze these unique and effective designs.

## Analyzing Real-life Data - Tricks of the Trade

How do you analyze a design with missing data or botched factor levels? Can you analyze happenstance data, or data collected from the production floor? See sample analyses from real-world experiments.

## Robust design via propagation of error (POE) - Climb to the High Plateaus

Learn how to make a product or process robust to normal process variation by minimizing the amount of noise transmitted to your responses.

## DOE in Industry - Actual Case Studies

Hear how other companies have addressed problems using DOE techniques. Come away with new ideas of how you could use DOE at your company!

Stat-Ease will roll out **Version 6.0** of Design-Expert® software at the DOE Conference in July, although it may still be in the final stages of beta testing. All attendees will receive a 30-day time-limited copy of the new software that they can install immediately if they bring a laptop computer, or bring home to try out. *Attendees can also purchase upgrades to the new version at a discount during the conference.*

Thank you to everyone who responded to the survey in our last newsletter. The winner of the drawing for a Design-Expert version 6 software package is **Irfan Bhatti** from Fasco DC Motors in Michigan. Irfan is a product design engineer. Here is his reaction to our phone call: *"Beautiful! I'm excited to work with it. Thank you very much!"* Irfan will receive his copy when the software is released this summer.

# Stat-Ease DOE Conference Schedule

Wednesday, July 28	Thursday, July 29	Friday, July 30
4-7 pm Optional Registration	7:00 - 8:00 Registration and Continental Breakfast	7:00 - 8:00 Continental Breakfast
 <p><b>Conference Location:</b></p> <p><b>Holiday Inn Metrodome, Minneapolis, MN</b></p> <p>A block of rooms have been reserved at the discounted Stat-Ease rate of \$94 per night (plus tax). To reserve a room, call the hotel toll-free at 800-448-3663 or direct at 612-333-4646. Be sure to mention the Stat-Ease conference and ask for this rate. You must make your reservation by July 7 in order to get this special rate.</p> <p><b>Please Note:</b> Parking is not included in the conference fees. Parking is available in the attached municipal lot.</p>	<p>8:00 - 9:30 <b>Multilevel Factorials</b></p> <p>9:30 - 10:00 Break</p> <p>10:00 - 11:30 <b>Design Evaluation</b></p> <p>11:30 - 1:00 Lunch</p> <p>1:00 - 2:30 <b>Response Surface Designs</b></p> <p>2:30 - 3:00 Break</p> <p>3:00 - 4:30 <b>Mixture/Process Designs</b></p> <p>4:30 - 6:00 Break</p> <p>6:00 - 8:00 <b>Dinner with Keynote Presentation by Dr. Douglas Montgomery</b></p>	<p>8:00 - 9:30 <b>Tricks of the Trade</b></p> <p>9:30 - 10:00 Break</p> <p>10:00 - 11:30 <b>Robust Design via POE</b></p> <p>11:30 - 1:00 Lunch</p> <p>1:00 - 2:30 <b>Case Studies</b></p> <p>2:30 - 3:00 Questions, help, etc..</p>
		<p><b>Enjoy the summer weekend in Minnesota!</b></p> 

# Stat-Ease DOE Conference Registration Form

Please print or type:

Name \_\_\_\_\_ Title \_\_\_\_\_

Company \_\_\_\_\_

Mailing Address \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_

Telephone \_\_\_\_\_ E-mail \_\_\_\_\_

## Workshop Registration Fee:

Early Bird Registration (by June 30) **\$295**, Regular Registration (July 1-28) **\$345**  
 (Registration Fee includes 2-day conference, 2 continental breakfasts, 2 lunches,  
 dinner Thursday evening, and a 30-day time-limited copy of Design-Expert 6.0.)

## Keynote Dinner and Presentation:

Please confirm that you will be attending the dinner Thursday evening by checking this box. Thank you!

## Payment Information:

Check enclosed, payable to: Stat-Ease, Inc.

Purchase order # \_\_\_\_\_

Credit card information: \_\_\_\_\_ MasterCard \_\_\_\_\_ Visa \_\_\_\_\_ AmEx \_\_\_\_\_ Optima

Card Number \_\_\_\_\_ Exp. Date \_\_\_\_\_

Signature \_\_\_\_\_

## 4 easy ways to register

### By Phone

612-378-9449  
 or 800-801-7191

### By Mail

Complete and mail form to:  
 Stat-Ease, Inc.  
 2021 E. Hennepin Ave., #191  
 Minneapolis, MN 55413

### By Fax

612-378-2152

### By E-Mail

sherry@statease.com or  
 info@statease.com

Please include:  
 Name, mailing address &  
 billing information

Stat-Ease, Inc., Hennepin Square  
 Suite 191, 2021 E. Hennepin Ave.  
 Minneapolis, MN 55413-2723  
 Address Service Requested



Presorted  
 First-Class Mail  
 U.S. POSTAGE PAID  
 Minneapolis, MN  
 Permit No. 28684