stat teaser

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*Includes a $95 student materials charge which is subject to state and local taxes.

Attendance is limited to 20. Contact Sherry at **612.378.9449 x2038** or **sherry@statease.com**.

Stat-Ease statistics made easy™

The Ten Most Common Designed Experiment Mistakes

(This is a contributed article from Jeff Hybarger, a DOE practitioner with many years of engineering experience in manufacturing.)

I first learned about designed experiments from a trade publication in 1986. I really liked the fact that using these techniques I had the potential to solve production problems from the quality department. So, I hopped on a jet and went to a four-day seminar and thought that I was trained. Nothing could have been further from the truth. I was only trained on how to analyze perfect data from perfect experiments.

My first experiment was a very expensive failure. I spent one day to run samples, two weeks to measure, and two weeks for manual analysis. I definitely bit off more than I could chew. I hadn't been able to justify any software when I started, but the two weeks of analysis made it pretty easy.

The important thing was that I analyzed my failure. I learned from it and from similar failures as I went on. Often I received data from others to review and analyze, but usually the problems happened before the experiment started. **Planning is everything with a designed experiment.** If the planning is done properly, you will learn something. Let's take a look at ten tips for avoiding the most common designed experiment mistakes.

1. Get good software and learn to use it properly. I've tried about half a dozen different programs of all price ranges. Some will actually help you pick the wrong factors and some do not have residual analysis included. The easiest and most thorough software is developed and sold by Stat-Ease, Inc., out of Minneapolis, Minnesota.

2. Make sure that the equipment the experiment is going to run on is calibrated and all preventive maintenance is up-to-date. It's frustrating to optimize a process

—Continued on page 2.

—*Continued from page 1.*

only to lose it after calibration. You need to start from scratch and can't make assumptions from the first experiment.

3. Do not run too narrow of a range from low to high for your factors. If you do, it will appear as if key factors do not affect the process. In reality, they do not affect the process in the range you selected.

4. Do not run too wide of a range from low to high for your factors. If you run too wide a range, you may find that some combinations of factors do not yield usable results. Examples would be short shots and flashed tooling in injection molding, or a lack of bond between components in ultrasonic welding. You need results for each experimental run. Halfway through the experiment is not the time to discover this problem. You will need to start over. Before the experiment review the matrix and find the two worst cases by using subject matter knowledge. Run these samples first. If there are problems, tighten up the ranges of the factors. In injection molding I like to run ranges just inside of shorting or flashing the parts.

5. The sample size for each run and the number of runs needs to be large enough to detect the size of part changes you think are significant. If you do not use large enough samples, you will not detect changes that really occurred. There are formulas that assist in determining the optimum number of samples.

6. Factors that are not included in the experiment's matrix can't be touched during the experiment. Changing anything that is not in the matrix adds factors that are not accounted for. You may think you have good results until you complete a verification run and the part dimensions or attributes are not what you expected. **Stay on the production floor to keep a close eye on the machine settings.**

7. Experimental design run orders are not the easiest order to run the experiment in. It would be easier for the people running the experiment to change the order. Doing so causes loss of randomization of the runs and can lead to a failed experiment. Often the parts are numbered incorrectly and the experiment is a failure. Again, keep on the floor and keep an eye on things.

8. I've experienced two kinds of measurement error in experiments that can lead to poor results. The first is gage error. Gage error studies need to be complete before running the experiment. Error should be under 20% to give good results. The second is having more than one person measure a dimension or rate attributes. You may save time having two inspectors each measure half of the runs, but in reality you have added another factor. One inspector should measure all runs of a dimension. Of course, different inspectors can measure different dimensions.

9. Data entry is always an issue. I always have the inspectors enter the data in a spreadsheet. Standard deviations from all runs can be compared. If any standard deviation looks significantly higher, check for obvious data entry and measurement error. If the parts were numbered by run and part, the individual part can be re-measured and entered into the spreadsheet.

10. After analysis, verification run(s) need to be completed. Do not ever base tool work off of predicted software values. Run the optimized process and worst case runs if applicable, measure the parts and then make tooling changes.

If these tips are followed, a good 90% of designed experiment failures can be avoided. The important thing is to learn from the successes and failures of each experiment.

--By Jeff Hybarger
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Where can you find us in 2007?

February 12–13 — Biomedical Focus 2007, Brooklyn Center, MN

April 30–May 2 — ASQ World Conference on Quality & Improvement, Orlando, FL

June 4–6 — Annual 2007 Quality & Productivity Research Conference, Santa Fe, New Mexico

July 29–August 2 — Joint Statistical Meetings 2007, Salt Lake City, UT

October 11–12 — 51st Fall Technical Conference, Jacksonville, FL

October 17–18 — MD&M Minneapolis 2007, Minneapolis, MN

Stat-Ease Around the World in 2006

Stat-Ease, Inc. is located in the Midwest, USA; however, we do business in many countries around the world. This year, we have held workshops, talks, and meetings in Ireland, Great Britain, Belgium, Germany, Malaysia, Singapore, and Canada. Stat-Ease's two software packages, Design-Ease® and Design-Expert®, are sold all over the world, with international sales accounting for a third of our business.

In April, we had our first European DOE User Meeting in the charming and historic town of Leuven, Belgium. The meeting was held in the Grand Beguinage (founded in the 13th Century, it is now a UNESCO Heritage site). Organized by our reseller, CQ Consultancy, the meeting was a great success. Attendees came from all over Europe. One and a half days were filled with design of experiments (DOE) presentations, including keynote addresses by Gary Oehlert of the University of Minnesota and Peter Goos of the University of Antwerp. The food was incredible and there were plenty of networking opportunities. The meeting was both educational and fun for all involved. Look for the next one in Germany in 2008. *(See Figure 1, from left to right: Kristine Ooms, CQ Consultancy; Heidi Hansel, Stat-Ease; Bertram Schafer, Statcon; Bas van den Bogaert, CQ Consultancy; Peter Goos, University of Antwerp; Ivan Langhans, CQ Consultancy; Pat Whitcomb, Stat-Ease, and his wife Patty; and Alan Collins, QD Consulting.)*

Figure 1: First European DOE User Meeting Leuven, Belgium, April 2006

Figure 2: Stat-Ease's First Asian Reseller's Meeting Singapore, November 2006

Figure 3: Pat Whitcomb & Friend President & Founder of Stat-Ease Singapore, November 2006

In November, Stat-Ease held our first Asian Reseller's Meeting in Singapore. This was a great opportunity for us to meet face-to-face with our resellers in Asia and to go over the new features of the software with them. It was also a chance for networking and exploring beautiful Singapore. Representatives came from Singapore, Malaysia, Thailand, Taiwan, South Korea, and India. *(See Figure 2, from left to right: Shamsul Azran, Active Eight Networks; YongBin Lim, DOE Expert; Dr. Lim, Teow Ek, IQCS Certification & IQC Quality Services; Narongsak Nanthagasigorn, 21 Engineering and Service Co., Ltd.; Vivian Lin, Softhome International; Madhu Madhavan, Cubic Computing; Heidi Hansel, Stat-Ease; Paul Mullenix, SystatS Consulting Sdn. Bhd.; and Pat Whitcomb, Stat-Ease.)*

If you are interested in having us come to your area for a workshop or presentation, please contact us with the details at 1.612.378.9449 or info@statease.com. We will consider all requests and send quotations where appropriate. For purchases outside of the USA, please contact one of our international resellers for assistance. You will find a list (sorted by region) at: *http://www.statease.com/intldist.html*.

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