Feature: Data Acquisition

The ten most common designed experiment errors

By Jeff Hybarger

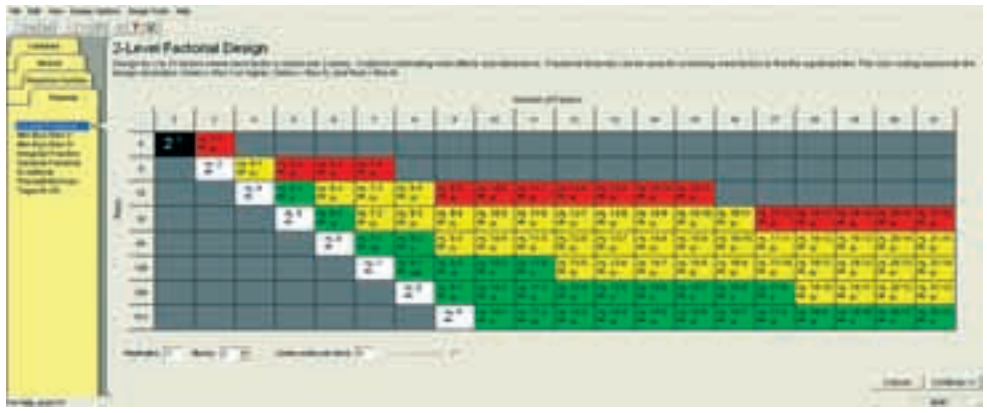
When I first learned about designed experiments in 1986, I really liked the fact that using these techniques I had the potential to solve production problems from the quality department.

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.

The important thing was that I analyzed my failure and found that 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.
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 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. 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. 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. 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.
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.



Design for 2 to 21 factors where each factor is varied over 2 levels. Good software and methods yield good results.

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