DOE Makes Research Pay Off

Design of experiments (DOE) systems are known for sorting through large numbers of variables, but they also can help build up baseline data.

While most development engineers now work on product designs for a particular need, some still work at a more fundamental level of trying out new concepts and hoping they lead to new products. At The Lee Company, a manufacturer of miniature automotive, aerospace, and medical components in Westbrook, Conn., our researchers often find themselves working in this latter fundamental mode.

To be successful at this in today's highly competitive environment, however, they find that they must quickly screen opportunities, identify key parameters, and build a knowledge base for potential new products. A tool they've found that helps them accomplish all of these goals is to use design of experiments procedures for their fundamental product development.

For DOE to succeed, our researchers require a straightforward software product that everyone involved can use. They also need software that provides useful results, not pages of statistical jargon, and something that is cost effective.

A key project our researchers worked on with DOE tools was the development of a new line of pressure adapters for the automotive industry. This design involves installing a tapered plug into a hole to seal against pressure. The project is complicated by a large number of possible housing materials, tapers, lubricants, installation loads, and thermal environments.

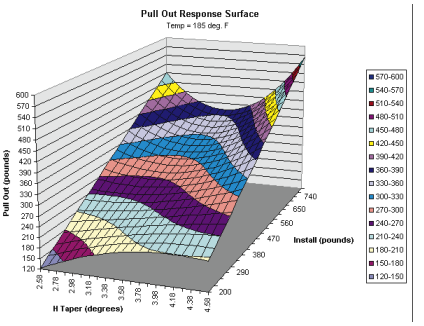
To further complicate matters, we wanted to develop a family of parts rather than individual components, and the behavior of the smallest parts can often be quite different from that of larger ones. To determine if the design concept represented a viable product, we needed to quickly find the dominant factors affecting performance and establish some baseline operating parameters.

The DOE system we chose was the CARD (computer-aided research and development) software program from S-Matrix, Eureka, Calif. CARD departs from generalized statistics software by providing a logical sequence of steps with clear prompts and guidelines. To select the right design, the software prompts you with simple question- and-answer options.

The value of using DOE techniques for our pressure-adaptor problem surfaced right away, as the design steps required us to focus on identifying specific goals and looking for measurable results.

Analysis of DOE data is always a significant concern. Many programs provide no guidance, and provide a lot of statistical output which then requires substantial effort by the researchers to translate into relevant answers.

CARD's analysis is a logical sequence of guided steps that are geared towards useful answers. The program output includes a PlainTalk Report, which assists the user in reviewing the output data and suggests alternative refinements to the analysis. The final results are visualized in graphical line, 2-D, and 3-D formats.



3-D response surface of the installation forces for a pressure adaptor is created with design of experiments software. (photo: The Lee Co.)

Once our pressure-adaptor analysis was complete, the real engineering of the problem emerged: "Did the answer make sense?" We had expected a relatively linear response across the variable ranges (flat response surface), but the analysis revealed a complex interaction.

To determine if this unexpected result was real, we reexamined both the data and the parts from the experiment. Examination revealed that galling of the parts was produced when a high installation load was coupled with an out-of-specification taper. This failure condition caused damage to both the plug and the housing.

Galling had produced the complex interaction we didn't expect, but the DOE program clearly revealed the effects of the galling condition in a 3-D graph.

Using DOE taught us an important lesson: preconceived notions about what the answers will be can complicate your analysis. By investigating the DOE answer, our simple problem revealed an intricate effect we had not anticipated. DOE enabled us to quickly and efficiently test a concept, prove its viability, and generate enough information to apply for a patent.

The DOE results also helped us generate baseline operating parameters that we can use in field trials and in preparing specifications for customer applications.

—Robert Kolp, Jr., VP/R&D at The Lee Co., Westbrook, Conn.

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