Design Of Experiments In Industrial Testing and How It Relates To Your Business

Movement in Testing

Historically, it has been relatively easy to meet customer system requirements using basic testing techniques. Today, however, customers require faster changes in technology and requirements are getting more difficult to meet. Competitive cost pressures have made the achievement of goals an even tougher task. In some cases, customers have requested and in a few cases mandated tools for companies to "be more efficient and organized in testing". These facts create the need for organized and effective testing methods to be incorporated in all phases of the development process.

A technique is available called Design Of Experiments (DOE) which assists in accomplishing these goals. It uses a statistically based methodology to efficiently plan and execute tests to achieve the desired performance levels. DOE has historically been used in process industries as well as in manufacturing environments. A strong movement has recently begun applying DOE in the area of research and development.

How DOE Works

Design Of Experiments uses work group experience to generate test responses and key variables as is current practice. By knowing the number of variables and a test budget, an efficient and effective testing matrix can be determined. Testing the variable combinations defined in the matrix allows the tester to determine many pieces of information. For example, a DOE test can identify key variables and key interactions between variables, magnitude of effect of key variables, values for optimum performance and tolerance limits or operating ranges for acceptable operation. In addition to these capabilities which are obviously part of design, it can also help in improving product reliability, developing manufacturing processes, improving process capability (decreasing variability), assisting in manufacturing problem solving (SPC) and understanding field failures. It is important to note that DOE not only can improve products and processes but can also lead to optimization and tolerance design.

The DOE process is best performed in a team environment and may include input from engineering, customers, vendors, operators/ technicians and management. With the up-front agreement by all team members on variables, test response(s), desired output and project constraints, the DOE process has high acceptance and a high success rate.

The engineer or scientist is very involved in the DOE process. If the technical expert is taken out of the loop, and the statistician or DOE expert directs the testing, failure of the DOE process is likely to occur. The technical expert can contribute experience, subject matter knowledge and intuition to guide testing and ensure test results are interpreted

properly. Use of a technical expert and an experienced DOE tester is important for success in DOE testing.

Why use DOE at Your Company?

Many areas exist to use DOE tools. It can be used in trade studies, simulations, development testing, manufacturing and analyzing field failures. We can use the tools ourselves as well as assist vendors in using it to optimize and understand components for which they are responsible. This is an opportunity for your company to be a leader in the movement of using DOE in the research and development area.

DOE has proven to be an excellent tool to reduce test time and provides the ability to reach higher levels of system performance by accounting for interactions and quadratic effects. Compared to traditional test methods, DOE can reach similar objectives yet reduce costs by a minimum factor of 2.

DOE can also be used in the area of computer modeling and simulations, which are areas that many companies have increasingly used. This area of testing could include utilizing Finite Element Analysis, empirical codes, financial models and many others.

Training

Perry's Solutions, LLC offers training in DOE methods to meet the need created by this movement in testing. The class trains personnel in how to perform DOE in the production environment as well as research and development. The class has been enhanced over typical DOE training to include DOE process steps that are non-obvious in the research and development area. The class covers the statistical tools, the process of applying DOE to manufacturing or development areas, and assists the students in beginning to use the tools in their own work areas. The class includes practical application examples and has a project from each student's own work environment integrated into the class.

Projects done as a part of the class are encouraged to be small and low risk (technically as well as schedule). The selected project can act as a tool to learn about DOE applications within the class participant's work area. It is also discussed when to use and when not to use DOE as a tool. It is best used in areas that need to be improved, optimized or understood. It is important to note that DOE can only assist in getting the most performance that a concept is capable of. If the concept is not capable of achieving the goal, DOE can not "make the concept work".

The class discusses the classical western methods of DOE. Scope of training can include the basic tools or can encompass the advanced tools as well. The class can also include techniques and philosophies from Taguchi and Shainin. It is also possible to extend the problem solving toolset to include related areas such as SPC, QFD and Gage R&R. The class takes an overview approach to statistics. Manual mathematical calculations are

minimized since software is available. The choice of software depends on the company requirements.

Advantages and disadvantages of each tool are stated. Assumptions made with each tool are identified. Potential testing pitfalls are listed and methods to avoid them are discussed. Solutions for recovery from a pitfall are provided in case of occurrence during testing.

Summary

Recognizing a movement in testing toward the use of DOE in research and development, it is rational for any company to create a DOE competency within the engineering ranks. The course relates the DOE tool to the application for all companies needs and teaches how to use the tool intellectually compared to a blind, cookbook approach. Skill in DOE methods will support your companies business and technology needs and is a critical competency for your future.

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