

# Design of Experiments

GoSkills online course syllabus

Tuesday, April 30, 2024

**Skill level**

Intermediate

**Lessons**

26

**Accredited by**

CPD

**Pre-requisites**

None

**Video duration**

2h 25m

**Estimated study time**

13h for all materials

**Instructor**

Ray Sheen

## Experimental Design Approaches

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### Experiments and Design

The design process typically relies on experiments to create and analyze data that is used when making design decisions. This data is invaluable to the design team as they strive to create a superior design. There are several approaches to the experimental process that design teams use.

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### Trial and Error

The simplest experimental design approach is trial and error. If subject matters experts are generating the trial design, this can be successful. However, if the trial fails, this approach can lead to delays and overruns.

3

### One Factor At A Time

The OFAAT method is often considered the best scientific method for creating a plan of experiments. It is very controlled, and the design performance often grows in capability over time. But it is also the most timing consuming and expensive approach when conducting a set of experiments.

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### Full Factorial Design of Experiments

A full factorial DOE conducts a set of experiments with carefully controlled configurations of the independent or control factors in the design. The results are statistically analyzed to create a design space equation that can be used to optimize the design. It is faster and cheaper than OFAAT, but longer and more costly than a lucky guess with Trial and Error.

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### Fractional Factorial Design of Experiments

A fractional factorial DOE conducts only a fraction of the experiments done with the full factorial DOE. It then statistically analyzes the results to fine tune the design and normally does a second optimizing study. Even though there are typically several sets of experiments, the total is still less than the number conducted with a full factorial study and much less than OFAAT.

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### Theory of Design of Experiments

This lesson provides a high level description of the DOE process that applies to any type of DOE. It also answers the questions of when to do a DOE and why to do a DOE.

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### DOE Studies

This lesson explains the preparation needed to initiate a DOE study of any type. It includes a discussion on setting the DOE objective and has a checklist of questions that will need to be answered either before the study starts or early in the study design.

## Full Factorial Design of Experiments

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## 8 Full Factorial DOE Methodology

This lesson describes the eight steps to be followed when conducting a full factorial DOE.

## 9 Factor Selection

This lesson explains the different types of factors that are involved in the DOE study design including control factors and response factors. The characteristics that should be used when selecting each type of factor are discussed.

## 10 Full Factorial DOE Study Design

This lesson explains how to design the study so that the statistical analysis can be performed. The preparation of the test sample configurations is explained. The use of design features of replication, center points and blocking are also addressed.

## 11 Conducting the Study

This lesson addresses how to execute and control each of the experimental runs in the study. It also explains the importance of the measurement system that is used.

## 12 DOE Functional Equation

The statistical analysis of the full factorial DOE results in the determination of the coefficients for a design space equation that relates all the control factors to the response factors. This equation includes interaction effects between control factors. This equation can then be used by designers to solve for the best overall system performance.

## 13 DOE in Minitab

Minitab is the statistical analysis software application that is most often used with Lean Six Sigma projects. Minitab has a Wizard that guides you through the setup and design of a Design of Experiments study. This lesson demonstrates how to use that Wizard.

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# Fractional Factorial Design of Experiments

## 14 Fractional Factorial Pros and Cons

This lesson compares the difference between the full factorial approach and fractional factorial approaches. It explains the pros and cons of using a fractional factorial methodology.

## 15 Fractional Factorial DOE Methodology

This lesson describes the nine steps to be followed when using one of the fractional factorial DOE methods. The emphasis is on how the steps differ from the full factorial DOE methodology.

## 16 Confounding Effects

This lesson explains the importance of designing a fractional factorial DOE study using a set of experiments that is balanced and orthogonal. Otherwise the runs can become confounded and that will invalidate the statistical analysis of the results.

## 17 Factor Selection

This lesson builds on the previous factor selection lesson. However, now it addresses how the factor selection process changes as a fractional factorial DOE progresses through two or three levels of studies.

## 18 Plackett-Burman DOE

The Plackett-Burman DOE is a special case fractional factorial DOE. It is used as a screening study when there are a large number of control factors. This lesson explains when to use Plackett-Burman DOE and how to design this type of study.

## 19 Taguchi DOE

The Taguchi DOE is a special case fractional factorial DOE. It is used primarily for analyzing manufacturing processes. The Taguchi DOE separates the control factors into two categories and analyzes them with different DOE approaches. This lesson explains the characteristics of this type of study.

## Applying DOE Results

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### 20 DOE Analysis in Minitab

This lesson reviews the different types of graphical and tabular results for a DOE study that are generated by Minitab. Each of these types of results provides a different perspective on the analysis of the design that is being studied.

### 21 DOE Factorial Plots

One of the most common techniques for analyzing the results of a DOE study in Minitab is to review the factor plots. These will provide insight into the optimal settings for control factors. The interactive plots will also highlight the settings associated with local maximum or minimum performance levels.

### 22 DOE in Design Creation

The DOE results can be used by design teams to make wise design decisions. This lesson will address how to use the DOE results in predicting system performance, designing system controls and establishing tolerances on system control and response factors.

### 23 Path of Steepest Ascent/Descent

Some DOE analyses will indicate that the optimal performance of the system would occur when control factors are set beyond the bounds of the study. When this occurs, it is best to shift the study to the likely region of optimal performance and then determine the best control factor settings. Following the path of steepest ascent or descent will ensure that the new analysis is conducted in a region with maximum or minimum performance.

### 24 DOE in Design Optimization

The DOE results can be used by design teams to improve and optimize an existing design based upon new needs or uses. The structure of the DOE study, particularly the fractional factorial DOE methodologies, allows the design team to easily establish optimal performance in a variety of settings.

### 25 DOE in Problem Solving

The DOE results can be used by problem solving teams, such as Lean Six Sigma project teams, to identify which factors provide the major contribution to the problem or problem performance. It can also be used to explain the expected benefit from implementing different types of solutions.

### 26 DOE Keys to Success

This final lesson reviews the key principles that must be followed when conducting a DOE study. It highlights the benefit of each and the dangers if the principle is not properly applied.