Design of Experiments

By: Mustafa Shraim, *SupplierSixSigma.com*

The process of what is referred to as “design of experiments” involves planning, execution, collecting data, analyzing it and drawing conclusions. Designed experiments are simply planned tests performed by manipulating some factors (input) and observing the response (output). One of these tests would be fixing the input variables at certain settings, run the process, then observe an established characteristic.

Off-line quality methods (like DOE) are usually utilized during the development stage. This enables engineers to resolve problems that may have the potential of occurring at a later stage (i.e. during production). As a result, reducing downtime, scrap, rework and other problems are well worth the initial investment.

The Objectives of DOE are to (1) determine what factors significantly affect a certain dependent variable (response) and/or (2) design quality into the product prior to production by selecting the appropriate settings that affect a response.

Example

Consider a simple experiment where the objective is to determine the effects of two factors A and B (input) on the response (output). If a factorial design at two levels is considered, then each factor is investigated at two levels (low “-” , high “+”). The number of combinations for this factorial experiment is the product of the levels of these factors. In this case, there are four (4) combinations (2 levels x 2 levels) which are displayed in the table below. To run combination 1, we set both factors at their low levels and observe the response, which is 6 in this case.

Combination	A	B	Response
1	-	-	6
2	+	-	9
3	-	+	5
4	+	+	10

Below, theses effects and the only interaction (AxB) are illustrated graphically. Notice that factor B is represented by a horizontal line indicating zero effect. The interpretation of the interaction effect depends on whether the two lines are parallel or not. If they are, it means that there is no interaction effect. In this case, the two lines are not parallel. In fact, they cross each other within the region of experimentation. This indicates that the change in the response when factor A is changed from one level to the other depends on the level at which factor B is set.

The above example is the simplest factorial design possible. As we increase the number of factors, calculations become more tedious. Therefore, software should be used for efficiency and accuracy. Also, analysis of variance (ANOVA) can be used to show the significance of effects.

In summary, DOE methods are useful in investigating processes so that variability can be minimized. Team effort should be encouraged when planning the experiment for the importance of including practical experience in this process. Also, the design stage is the most important stage of this process. The team must consider many issues including blocking noise factors, replication and randomization before a design is selected.