

Improving Processes using Multivariable Testing (MVT) and Design of Experiments (DOE) Matrices *

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A Forbes article, " The new mantra: MVT" [1], describes the benefits of a technique called multivariable testing (MVT). The approach is more typically described as Design of Experiments (DOE). The name, MVT or DOE, does not matter. No matter what you call it, the approach is very powerful and can help organizations improve their "bottom line" and/or be the difference between survival or not. The technique can also be very powerful when making a product Designed for Six Sigma (DFSS).

Applications of approach described in the article are:

- reducing the rejection rate of a touch-sensitive computer screen from 25% to less than 1% within months.
- maintaining paper quality at a mill while switching to a cheaper grade of wood. reducing the risks of misusing a drug in a hospital by incorporating a standardized instruction sheet with patient-pharmacist discussion.
- reducing the defect rate of the carbon-impregnated urethane foam used in bombs from 85% to zero.
- improving the sales of shoes by using an inexpensive arrangement of shoes by color in a show chase, rather than an expensive flashy alternative.
- reducing errors on service orders, while at the same time
- improving response time on service calls.
- improving bearing durability by a factor of five.

These referenced examples represent only a small portion of possible money saving opportunities for organizations. These techniques are truly very powerful. However, implementation issues can arise. Organizations can have problems:

1. determining how to apply the techniques to "their situation."
2. selecting the important variables and levels of variables to use in an experiment.
3. determining what test matrices to incorporate.
4. analyzing data and presenting results so that the best corrective action is taken.

Organizations wanting to use MVT (DOE) can save a lot of time and resources by addressing these issues up-front in conjunction with other Six Sigma tools.

To illustrate the power of the concept, consider that a brainstorming session was conducted and there were 7 factors that were thought could affect a response. Factors for a computer performance test might include load on the system, network type, and number of stations. Factors for a reduction of high school absenteeism study might include age of student, economical background of student, and whether the student would be called if they were absent. Factors for the development of pharmaceutical products might include quantifying an ingredient, age of patient, and sex of patient. Factors for the improvement of product reliability might include various design options and supplier considerations as a function of user configurations.

The seven factors are then described as A, B, C, D, E, F, or G, where each factor has two-level possibilities described by a + or - sign. For example Network type might be designated as an "A" with level possibilities of type 1, designated as a "+", and type 2, designated as a "-". An 8-trial design of the 7-factors considerations determined from a table M with reference 2 is

| Trial # | A | B | C | D | E | F | G |
|---------|---|---|---|---|---|---|---|
| 1 | + | - | - | + | - | + | + |
| 2 | + | + | - | - | + | - | + |
| 3 | + | + | + | - | - | + | - |
| 4 | - | + | + | + | - | - | + |
| 5 | + | - | + | + | + | - | - |
| 6 | - | + | - | + | + | + | - |
| 7 | - | - | + | - | + | + | + |
| 8 | - | - | - | - | - | - | - |

A response is then obtained for each trial. The "best estimate" effect for each factor is determined by subtracting the average "-" response for a factor from the average "+" response. Significance tests using effects plots, t-tests, and/or analysis of variance (ANOVA) determine if each factor effect significantly affects the response. The significant effects can be used in a model that predicts a response for other factor level settings and/or directing process improvement activity.

An extension of traditional MVT and DOE techniques is described in reference 3. In this reference a methodology is described that can efficiently detect combinational problems, which could affect the field failure rates of products.

Additional information and a roadmap for integrating measurements with process improvement activities can be found within *Implementing Six Sigma: Smarter Solutions using Statistical Methods*, Forrest W. Breyfogle III, John Wiley and Sons, New York, NY, 1999. The wise integration of MVT (DOE) and other Six Sigma tools is described within our training. Focus during the training is given to building effective implementation procedures that have bottom line results for the application situations described by attendees.

References

1. "The new mantra: MVT," Rita Koselka, Forbes, March 11, 1996, pp. 114-118.
2. *Implementing Six Sigma: Smarter Solutions using Statistical Methods*, Forrest W. Breyfogle III, John Wiley and Sons, New York, NY, 1999.
3. *Designed for Six Sigma (DFSS): Improving and Quantifying Hardware Test and Software Test Coverage*, Forrest W. Breyfogle III,

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