The Six Sigma Method and Design of Experiments

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Six Sigma is becoming a proven approach for businesses and organizations to improve their performance. The spectrum of companies actively engaging in Six Sigma today is wide from industrials like Celanese, Caterpillar, GE, Honeywell, and 3M to service/retail organizations like Starwood Hotels, Sears, and Home Depot. Six Sigma has even started in the financial industry with Bank of America and JPMorgan Chase initiating major deployments in the past two years. Probably the most exciting area is in the public and healthcare sectors with success stories emerging from city government and John Hopkins Medical.

So what is all this excitement about? Haven't these quality tools been around for years? Is it just the fact that people have strange names like Champion, Green Belt, Black Belt and for the chosen few, Master Black Belt? Okay, if it is not the names then what? Six Sigma's success revolves around the fundamental elements needed for any successful organization. Six Sigma starts with a vision of delivering products and services to customers with no defects from the eyes of the customers. For companies it is vital to deliver these products and services at a profit. Once the organization has created their own vision of Six Sigma, the business leaders need to define their organization's objectives in numerical terms. These "high-level metrics," often called big Y's in Six Sigma, are the foundation for identifying project y's that Six Sigma Belts will execute projects on. With big Y's in hand, business leaders called Six Sigma "Champions" breakdown these organizational level Y's into smaller y's a project leader called a Green Belt or Black Belt can work from.

So what's next, do business leaders take a hands-off management by objectives (MBO) approach of, "I don't care how you do it as long as you get results!"? For Six Sigma organizations the answer is a loud "NO." Champions do care how projects are executed and have appointed highly trained Master Black Belts to assist and mentor project leaders in applying the Six Sigma method to manage their projects. I believe this is the key to Six Sigma's success. In a past life I participated in a high-level meeting with executives from the world leader in the production of a product we all know. The purpose of the meeting and visit was to evaluate a critical new product design. All of the high-tech executives were dressed in dark Italian business suits complemented with gold and diamonds. I listened closely to each question these executives asked. I never once heard "how much?", "when?" or even "why?" – every question was "by what method?." Methodology is what Six Sigma is about.

Six Sigma Methods

There have evolved two key methods for carrying out Six Sigma projects. The first method is the most well-defined and works best if you have a problem with an unknown solution in existing products, processes or services. This method is called DMAIC or Define, Measure, Analyze, Improve and Control. The newest method, which is in the developing stages, is called Design for Six Sigma or DFSS. The goal of DFSS is to develop a new product,

process or service that is defect-free in the eyes of the customer. A number of consulting companies have invented roadmaps for DFSS like IDOV (Identify, Design, Optimize and Validate) and DMADV (Design, Measure, Analyze, Design and Verify).

Six Sigma and Design of Experiments

Once an organization has decided on the method and the project y's, Belts are marched off to training "waves" bringing management-approved projects to class. DMAIC Green Belt training is normally two one-week sessions separated by one month. Black Belt training waves are extended by two additional months with two more weeks of training. The emphasis during the extended two weeks of Black Belt training is often on learning more details about advanced tools such as Design of Experiments (DOE).

So where does Design of Experiments fit into Six Sigma? Six Sigma is about understanding and controlling the variation of key process variables known as inputs or x's in order to obtain improved results on project outputs or y's. In Design of Experiment terms these inputs or x's are often referred to as factors and the outputs are referred to as responses. In nearly all Six Sigma projects the relationship of the project y's takes on the form of **$y=f(x_1,x_2,\ldots x_n)$.** Wait a minute, isn't this what Design of Experiments is all about? Of course, for almost 100 years Design of Experiments has been proven to be one of the best known methods for validating and discovering relationships between responses and factors. In Six Sigma terms it is discovering the relationship between outputs called y's and inputs called x's. Today's Six Sigma Belts are primarily taught to focus their use of Design of Experiments in the Improve phase of DMA**I**C and the Optimize phase of ID**O**V. For DMAIC Six Sigma training the most common experimental designs taught are factorial and fractional factorial designs. Some curriculums introduce response surface designs and optimization designs at a high level. DFSS includes the experimental designs taught in all levels of DMAIC training and often expands to include the concept of robust designs. As an alternative to the classical approach, there are also a number of consulting companies teaching Taguchi designs as the preferred method for robust design.

Final Remarks

Six Sigma looks as though it is here to stay and even in today's slow economy one of the few areas where there still are a number of new positions. The Six Sigma process is a great step toward creating learning organizations with its well-defined roadmaps and management structure. As with most new methodologies Six Sigma will mature and grow as it expands into new areas such as DFSS. As Six Sigma professionals learn more about the power of properly planned experiments, Design of Experiments will be integrated into most phases of the Six Sigma roadmap and not just considered an advanced tool for the improvement and optimization phases. Experienced practitioners of statistical methods like Design of Experiments should learn the language of Six Sigma and help integrate new methods into the Six Sigma process to improve its effectiveness.