Design for six sigma: a breakthrough business improvement strategy for achieving competitive advantage

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Abstract

The six sigma methodology aims to reduce the number of mistakes/defects in a manufacturing process and hence the manufacturing costs. Six sigma is the ultimate measure of quality. As firms improve their processes, and move towards the elusive six sigma, they often need to re-design the products, process and services to "design-out" defects and design-in quality. Describes the underlying statistical concepts behind the six sigma methodology and outlines the process of moving towards the realisation of six sigma quality.

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The six sigma methodology was developed and pioneered at Motorola in the 1980s with the aim of reducing "quality costs" (i.e. the costs involved in making mistakes, in not doing things "right first time", etc.). Six sigma is a business performance improvement strategy that aims to reduce the number of mistakes/defects – to as low as 3.4 occasions per million opportunities. Sigma is a measure of "variation about the average" in a process (which could be in manufacturing or service industry). According to Conlin (1998), most companies produce a defect rate of between 35,000 and 50,000 per million opportunities (where a defect can be anything from a faulty part to an incorrect customer bill). This defect rate equates to a sigma quality level of 3 to 3.5 sigma.

Organisations that have adopted the principles and concepts of the six sigma methodology become aware that, once they have achieved five sigma quality levels (i.e. 233 defects per million opportunities), the only way to progress further (towards the elusive six sigma) is to redesign their products, processes and services. This has led to the development of what today is termed "Design for six sigma" (DFSS). DFSS is a powerful approach to designing products, processes and services in a cost-effective and simple manner to meet the needs and expectations of the customer while driving down quality costs. It involves the utilization of powerful and useful statistical tools to predict and improve quality before building prototypes. It is not a replacement for such techniques/approaches as new product introduction process (NPIP); rather it is a methodology to make the introduction of new products, processes and services more efficient, reliable and capable of meeting high customer expectations and requirements. DFSS has the potential to simplify design configuration, eliminate non-value added steps or processes in the design of a product or service, and hence reduce material costs, labour costs and overhead costs. The DFSS approach seeks inventive ways of satisfying and exceeding customer requirements and expectations. It seeks to optimize the function of the product/service design and then verify that the product/service meets those requirements specified by customers.

Work Study
Volume 51 · Number 1 · 2002 · 6-8

Why DFSS?

The following benefits can be gained from the application of DFSS principles to a new product/service introduction process:

- Reduced time to market for new or revised products.
- Reduced life cycle costs associated with products.
- Increased understanding of customers' expectations and their priorities related to product/service attributes.
- Reduced number of design changes or iterations and hence reduced number of prototypes made during the design stage.
- Enhanced quality and reliability of products/services.
- Enhanced ability to manage risk in design processes of products/services.
- Reduced warranty costs.

A methodology for DFSS

Figure 1 illustrates a simple methodology for DFSS.

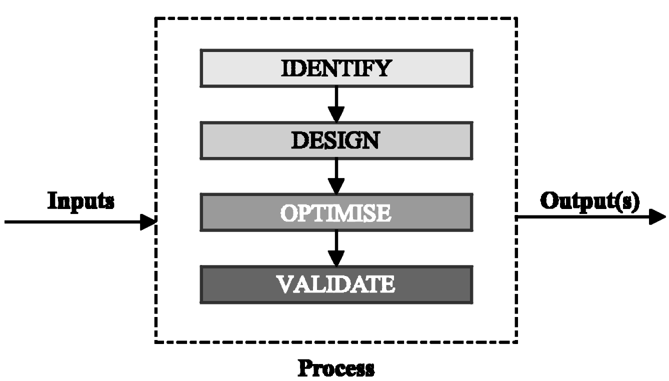
In the DFSS methodology, the inputs can be customer needs and wants, business needs, raw materials, and so on. The outputs are quality products, processes or services. The process of activity within the methodology has four stages: identify, design, optimise, and validate.

Stage 1: identify

This stage essentially ensures that the organisation understands the criteria for success. It achieves this by:

- identification of customers and their requirements;
- clear definition of the design requirements for the product;
- identification of customer critical-to-quality characteristics (CTQs) using quality function deployment (QFD);
- planning of functional and engineering requirements;
- determination of the relationship between customer requirements and technical requirements; and
- determination of the target for each CTQ.

Figure 1 DFSS system methodology



Stage 2: design

Once the organisation understands the parameters of design, these must be translated into the actual, effective design. This stage involves:

- analysis of the design requirements and key design parameters and their relationship with CTQs;
- identification of design alternatives;
- utilisation of concurrent engineering practice;
- study of the relation of design parameters to CTQs at sub-levels in complex processes or systems; and
- identification of the risks involved and typical failures, using, for example, design failure mode and effect analysis (DFMEA).

Stage 3: optimise

The third stage involves the further consideration of design to ensure effective "makeability" – so that the organisation is confident that the product can be manufactured within the identified design parameters, and within the agreed budget. This stage involves:

- identification of sources of variability (manufacturing, environmental, etc.);
- minimizing product performance sensitivity to all sources of variation using robust design;
- application of tolerance design for critical design parameters obtained from robust design;
- optimising the design for manufacturability (DfM);
- optimising the design for product reliability; and
- determination of design capability and comparison with design specifications.

Work Study
Volume 51 · Number 1 · 2002 · 6-8

Stage 4: validate

The final stage checks that the process is complete, valid and will meet requirements in practice! It involves:

- verification of the design to ensure that it meets the set requirements;
- assessment of performance, reliability, capability, etc.;
- development of process control plan for the mean and variance of CTQs in production; and
- development of a DFSS scoring card.

If this stage suggests that the design of the product does not (or may not) meet the required capability, then it is necessary to retract back through steps 1, 2 and/or 3.

DFSS is the most effective means of realizing the full benefits of six sigma capability. It ensures that the concepts and principles of six sigma are applied at the production design and development stages for enhanced customer satisfaction, improved long-term profitability, increased product reliability, improved profit margin, etc. This has been a simple introduction to the underlying approach. In practice of course, it is a more complex procedure which, like many others, depends crucially on the selection of team members and on ensuring that they have a supportive environment in which to work. However, successfully applied, DFSS does prove to be a means of harnessing the best design practices to achieve competitive advantage and business excellence.

Reference

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Further reading

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