Quality Function Deployment Essay, Research Paper

PREFACE

Product development knits a new technology or novel idea together with specific customer requirements to fill a corporate strategic need. The customer requirements are deployed through the hierarchy of the product and through time as the technology being embodied in the product is refined.

The deployment of customer requirements into a product involves numerous decisions at all product hierarchical levels. Some useful concepts in understanding the complexity of decisions in product development are the following: Quality Function Deployment (QFD), teamwork, and designation of static/ dynamic status of parts of the product early in the development process.

QFD is one of the many tools existing for Concurrent Engineering. It is a tool to translate the wishes of the customer into technical demands for the product. Demands for the design, funtional demands and process demands originate in these technical demands. With these demands it is possible to fit the wishes of the customer to the product. As a consequence of this it is possible to manufacture a product that fulfils all the needs of a client. Furthermore QFD makes a comparison between the already existing product and the products of the more important competitors.

The Definition of Quality Function Deployment

Quality Function Deployment (QFD) is a way of making the ‘voice of the customer’ heard throughout an organization. It is a systematic process for capturing customer requirements and translating these into requirements that must be met throughout the ’supply chain’. The result is a new set of target values for designers, production people, and even suppliers to aim at in order to produce the output desired by customers.

QFD is particularly valuable when design trade-offs are necessary to achieve the best overall solution, e.g. because some requirements conflict with others. QFD also enables a great deal of information to be summarized in the form of one or more charts. These charts capture customer and product data gleaned from many sources, as well as the design parameters chosen for the new product. In this way they provide a solid foundation for further improvement in subsequent design cycles. QFD is sometimes referred to by other ‘nicknames’ – the voice of the customer (from its use as a way of communicating customer needs), or the House of Quality (from the characteristic house shape of a QFD chart).

QFD as discussed here contains far more. King (1989) and Clausing and Pugh (1991) provide more extensive and complete views. Dean (1992) views QFD as a system engineering process which transforms the desires of the customer/user into the language required, at all project levels, to implement a product. It also provides the glue necessary, at all project levels, to tie it all together and to manage it. Finally, it is an excellent method for assuring that the customer obtains high value from your product, actually the intended purpose of QFD. Mizuno and Akao (1994) indicates that QFD is far more than has previously been disclosed. It is clearly the mechanism for deploying quality, reliability, cost, and technology throughout the product, the project to bring forth the product, and the enterprise as a whole.

According to Akao (1990), QFD “is a method for developing a design quality aimed at satisfying the consumer and then translating the consumer’s demand into design targets and major quality assurance points to be used throughout the production phase. … [QFD] is a way to assure the design quality while the product is still in the design stage.” As a very important side benefit, Akao (1990) points out that, when appropriately applied, QFD has demonstrated the reduction of development time by one-half to one-third.

Sullivan (1986) says that “The main objective of any manufacturing company is to bring new (and carryover) products to market sooner than the competition with lower cost and improved quality. The mechanism to do this is called quality function deployment …. [QFD is] an overall concept that provides a means of translating customer requirements into the appropriate technical requirements for each stage of product development and production (i.e., marketing strategies, planning, product design and engineering, prototype evaluation, production process development, production, sales). … In QFD, all operations are driven by the ‘voice of the customer’; QFD therefore represents a change from manufacturing-process quality control to product-development quality control.”

QFD is a structured process, a visual language, and a set of interlinked engineering and management charts which uses the seven management (new) tools. It establishes customer value using the voice of the customer and transforms that value to design, production, and manufacturing process characteristics. The result is a systems engineering process which prioritizes and links the product development process so that it assures product quality as defined by the customer/user. Additional power derives from use within a concurrent engineering environment. QFD, as applied under the kaizen philosophy and within total quality control, is by far the most highly developed form of integrated product and process development in existence.

The Comprehensive QFD

According to Akao (1990) the definition of QFD reflects two purposes:

? Quality deployment: focus on the product, deployment of customer needs and requirements together with other important areas of of the product, e.g. technology, cost, reliability etc.

? Quality function deployment in the narrow sense: focus on the processes, deployment of quality activities in the functional organization.

Together these two purposes create ‘Quality function deployment in the broad sense’ or Comprehensive Quality Function Deployment.

To rephrase this in a single sentence, Comprehensive QFD is the simultaneous deployment of quality, technology, cost, and reliability throughout the product, throughout the project to bring forth the product, and throughout the enterprise as a whole.

Comprehensive QFD include the simultaneous deployment of:

Quality

Technology

Cost

Reliability

The quality deployment component of comprehensive QFD is shown below. Note that the roof and side roof on the charts correspond to a deployment, in the sense of the systematic diagram, rather than to the correlation matrix used in the USA for the house of quality.

The quality chart is the key to quality deployment. But we must remember that it is only one chart of many in the Bob King matrix of matrices (King, 1989), which provided the West with it’s first glimpse of a recent version by Prof Ohfuji (Ofuji, 1995) shown at the next page.

The Seven Management Tools

According to Mizuno (1988), the seven new tools are the product of the Japanese Society for Quality Control Technique Development. After a worldwide search, in 1976 they proposed the following new tools for quality control:

Relations Diagram

Affinity Diagram (KJ method)

Systematic Diagram (Tree Diagram)

Matrix Diagram

Matrix Data Analysis

Process Decision Program Chart (PDPC)

Arrow Diagram

They were chosen to meet the following criteria:

? The ability to complete tasks

? The ability to eliminate failure

? The ability to assist in the exchange of information

? The ability to disseminate information to concerned parties

? The ability to use “unfiltered expression”

Nayatani, Eiga, Futami and Miyagawa (1994) note that the “Committee for Developing New QC Tools was dissolved in 1978 and reconstituted as The Seven New QC Tools Research Group for the long-term study of the new tools. … The First Seven New QC Tools Symposium was held in 1979.” Figure 3 on page 5 uses a relations diagram to examine the problem solving process with and without the seven new tools. If you want to understand the power of these tools, you must study it.

A personal observation is that a concept can only be expressed if the language is rich enough to permit the concept to be expressed. A corollary is that many concepts cannot be expressed because the language is not rich enough. The seven new tools compose a rich visual language which allows the user to easily explore and decompose complexity that cannot be dealt with otherwise.

Relationships Diagram

According to Mizuno(1988), the relations diagram method

is a technique developed to clarify intertwined causal relationships in a complex situation in order to find an appropriate solution.

It is typically represented graphically as squared ellipses (concepts) connected by directed lines (arrowheads show direction). The directed lines represent causal relations between the concepts.

He further notes that relations diagrams can be used to

? Determine and develop quality assurance policies

? Establish promotional plans for TQC introduction

? Design steps to counter market complaints

? Improve quality in the manufacturing process (especially in planning to eliminate latent defects)

? Promote quality control in purchased or ordered items

? Provide measures against troubles related to payment and process control

? Effectively promote small group activities

? Reform administrative and business departments

Affinity Diagram (KJ method)

Mizuno(1988), says that the affinity diagram method (KJ method)

clarifies important but unresolved problems by collecting verbal data from disordered and confused situations and analyzing that data by mutual affinity.

It is typically represented graphically as nested squared ellipses (concepts) which have smaller and smaller subgroupings of concepts.

He further notes that the

KJ method can be used to

? Establish a QC policy for a new company or a new factory and to implement that plan

? Establish a QC policy concerning new projects, new products, or new technology and to implement that plan

? Conduct quality assurance market surveys when entering a new untested policy

? Find a starting point for TQC promotion by creating a consensus among people with varying opinions regarding the problems that arise within each department

? Invigorate project teams within various groups

Systematic Diagram

According to Mizuno(1988), the systematic diagram method

searches for the most appropriate and effective means of accomplishing given objectives. … Systematic diagrams can be divided into two types: The constituent-component-analysis diagram breaks down the main subject into its basic elements and depicts their relationships to the objectives and means of obtaining those objectives. The plan-development diagram systematically shows the means and procedures necessary to successfully implement a given plan.

It is typically represented graphically either a horizontal or vertical tree structure connecting the elements.

He further notes that

the systematic diagram method can be used to

? Deploy a design-quality plan in the development of a new product

? Depict the relationship between a QC production process chart and the development of certified levels of quality designed to improve the accuracy of quality assurance activities

? Create a cause-effect diagram

? Develop ideas in order to solve problems dealing with quality, cost, and delivery that arise in new businesses

? Develop objectives, policies, and implementation steps

? Pursue the specification of increased efficiency in parts and control functions

Nayatani, Eiga, Futami, and Miyagawa (1994) note that

Tree diagrams, also know as systematic diagrams or dendograms, are an application of a method originally developed for function analysis in value engineering. … The main advantages of tree diagrams are as follows:

? They allow a system of strategies for solving a problem or means of achieving an objective to be developed systematically and logically, making it less likely that any essential items will be omitted.

? They facilitate agreement among group members.

? Because they identify and clearly display the strategies for solving a problem, they are extremely convincing.

They further note that

… strategies may be developed to as many as five successive levels, thus systematically generating many different approaches to solving the problem.

Ofuji (1995) demonstrates that the word “deployment” in “quality function deployment” (QFD) is the implementation of the systematic diagram. The two types of deployments are the “ladder of abstraction,” which is the constituent-component-analysis diagram, and the “purpose and means deployment,” which is the plan-development diagram. There are many instances of each type of deployment throughout the many charts in “comprehensive QFD. In Japan, the depiction of a roof, or a sidewise roof, on a QFD quality chart represents a deployment, rather than the correlation matrix used in the House of Quality in the USA.

Matrix Diagram

According to Mizuno(1988), the matrix diagram method

clarifies problematic spots through multidimensional thinking. … The matrix diagram method identifies corresponding elements involved in a problem situation or event. These elements are arranged in rows and columns on a chart that shows the presense or absence of relationships among collected pairs of elements. … Effective problem solving is facilitated at the intersection points, also refered to as the idea conception points. … Matrix diagram are classified on the basis of their pattern into five groups: (1) the L-type matrix, (2) the T-type matrix, (3) the Y-type matrix, (4) the X-type matrix, and (5) the C-type matrix.

He further notes that

Matrix diagrams can be used to

? Establish idea conception points for the development and improvement of system products

? Achieve quality deployment in product materials

? Establish and strengthen the quality assurance system by linking certified levels of quality with various control functions

? Reinforce and improve the efficiency of the quality evaluation system

? Pursue the causes of nonconformities in the manufacturing process

? Establish strategies about the mix of products to send to market by evaluating the relationships between the products and market situations

Matrix Data Analysis

According to Mizuno(1988), the

matrix analysis method qualtifies and arranges matrix diagram data so that the information is easy to visualize and comprehend. The relationships between the elements shown in a matrix diagram are quantified by obtaining numerical data for intersection cells. Of the seven new QC tools, this is the only numerical analysis method. The results of this technique, however, are presented in diagram form. … One major technique that this method also utilizes is known as principal-components analysis.

He further notes that the

matrix data-analysis method can be used to

? Analyze production processes where factors are complexly intertwined

? Analyze causes of nonconformities that involve a large volume of data

? Grasp the desired quality level indicated by the results of a market survey

? Classify sensory characteristics systematecally

? Accomplish complex quality evaluations

? Analyze curvilinear data

Process Decision Program Chart

According to Mizuno (1988), the PDPC method

helps determine which processes to use to obtain desired results by evaluating the progress of events and the variety of conceivable outcomes. Implementation plans do not always progress as anticipated. When problems, technical or otherwise, arise, solutions are frequently not apparent. The PDPC method, in response to these kinds of problems, anticipates possible outcomes and prepares countermeasures that will lead to the best possible solutions.

He further notes that

the PDPC method can be used to

? Establish an implementation plan for management by objectives

? Establish an implementation plan for technology-development themes

? Establish a policy of forecasting and responding in advance to major events predicted in the system

? Implement countermeasures to minimize nonconformities in the manufacturing process

? Set up and select adjustment measures for negotiating process

The PDPC diagram is a simple graphical tool which can be used to mitigate risk in virtually any undertaking.

Arrow Diagram

According to Mizuno(1988), the arrow diagram method

establishes the most suitable daily plan and monitors its progress efficiently. … The arrow diagram method utilized by PERT or CPM, is a network of lines that connect all the elements related to plan execution ….

It is typically represented graphically by either a horizontal or vertical tree structure connecting the elements.

He further notes that

The arrow diagram method can be used to

? Implement plans for new product development and its follow-up

? Develop product-improvement plans and follow-up activities

? Establish daily plans for experimental trials and follow-up activities

? Establish daily plans for increases in production and their follow-up activities

? Synchronize the preceding plans for QC activities

? Develop plans for a facility move and for monitoring follow-up

? Implement a periodic facility maintenance plan and its follow-up

? Analyze a manufacturing process and draw up plans for improved efficiency

? Plan and follow up QC inspections and diagnostic tests

? Plan and follow-up QC conferences and QC circle conferences.

The Voice of the Customers

Scherkenback (1986) notes that

We literally cannot be competitive in international markets unless we can operationally define our customer’s needs. In order to meet those needs and expectations at a price they are willing to pay, we must first know them.

The purpose of the voice of the customer within quality function deployment (QFD) is to know the customer’s expectations, voiced desires, and as yet unperceived turnons.

The purpose of QFD is to deploy the quality necessary to satisfy and even delight the customer. Thus, obtaining the voice of the customer is the focal point of the QFD process. If an inaccurate representation of customer desires is obtained, the QFD process will fine tune the system to bring forth the wrong product. What a waste! Thus, obtaining the voice of the customer accurately is critical for the proper application of QFD. Guess work will not do! You must ask the customer! To be accurate, scientific process is necessary!

Gustafsson (1993) provides the relationships between QFD and conjoint analysis. Conjoint analysis is one of the seven product planning tools which Japanese Society for Quality Control Product Planning Research Group recommends be used to determine the voice of the customer through a scientific process.

Barnard and Wallace (1994) integrate concepts from QFD and policy deployment into a process to deploy upper management strategy so that customer desires are met or exceeded. They also introduce the concept of choice modeling which appears to be a powerful means of determining the choice of the customer. Ultimately, it is the choice of the customer which determines whether or not the potential customers of the target market will actually buy the product or service.

Benefits of QFD

The main ‘process’ benefits of using QFD are:

? improved communication and sharing of information within a cross-functional team charged with developing a new product. This team will typically include people from a variety of functional groups, such as marketing, sales, service, distribution, product engineering, process engineering, procurement, and production

? the identification of ‘holes’ in the current knowledge of the design team

? the capture and display of a wide variety of important design information in one place in a compact form

? support for understanding, consensus, and decision making, especially when complex relationships and trade-offs are involved

? the creation of an informational base which is valuable for repeated cycles of product improvement

The main ‘bottom line’ benefits of using QFD are:

? greater likelihood of product success in the marketplace, due to the precise targeting of key customer requirements

? reduced overall design cycle time, mainly due to a reduction in time-consuming design changes. This is a powerful benefit: customer requirements are less likely to have changed since the beginning of the design project; and more frequent design cycles mean that products can be improved more rapidly than the competition

? reduced overall cost due to reducing design changes, which are not only time consuming but very costly, especially those which occur at a late stage.

? reduced product cost by eliminating redundant features and over-design.

The History of Quality Function Deployment

The creation of QFD is generally attributed to Mitsubishi’s Kobe shipyard in Japan. The original approach, conceived in the late 1960’s, was adopted and developed by other Japanese companies, notably Toyota and its suppliers. In 1986 a study by the Japanese Union of Scientists and Engineers (JUSE) revealed that 54% of 148 member companies surveyed were using QFD. The sectors with the highest penetration of QFD were transportation (86%), construction (82%), electronics (63%), and precision machinery (66%). Many of the service companies surveyed (32%) were also using QFD. Specific design applications in Japan range from home appliances and clothing to retail outlets and apartment layouts.

In the USA the first serious exponents of QFD were the ‘big three’ automotive manufacturers in the 1980’s, and a few leading companies in other sectors such as electronics. However, the uptake of QFD in the Western world appears to have been fairly slow. There has been no survey comparable to the JUSE study regarding the spread of QFD in North America, and there are relatively few sources of literature and case studies, compared with other methodologies such as Benchmarking.

There is also some reluctance among users of QFD to publish and share information – much more so than with other quality-related methodologies. This may be because the data captured and the decisions made using QFD usually relate to future product plans, and are therefore sensitive, proprietary, and valuable to competitors.

CONCLUSION

Quality Function Deployment is a system engineering process which transforms the needs and requests of the customer/user into the specification required, at all project levels, to implement a high quality product. It also provides the necessary tie ups between all project levels, to tie it all together and to manage it. It is an excellent method for assuring that the customer obtains high value from your product, actually the intended purpose of QFD.

Quality, technology, Cost, and Reliability are the crucial elements of a good Quality Function Deployment.

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