Quality Function Deployment

Introduction

Quality Function Deployment (QFD) is the systematic translation of the "voice of the customer" to actions of the supplier required to meet the customers' desires, based on a matrix comparing what the customer wants to how the supplier plans to provide it. This basic matrix can be expanded to provide additional insight to the supplier, and cascaded to identify process parameters that must be controlled to meet the customer requirements. There are many varieties of QFD, and many variations of the charts used. Following is an illustration of the basic theory, and some references for further study.

The Basic Matrix

QFD must start with an understanding of the customers' needs and wants. These *whats* become rows in a matrix, against columns representing the suppliers processes (*hows*) designed to provide products (or services) meeting the customers' desires. For example, Figure 1 is a hypothetical matrix for producing these Selected Topics in Assurance Related Technologies (START) sheets. The *hows* can also be a set of parameters for a product (e.g. sail area, weight, shape may be some of the *hows* selected to meet the *whats* desired by the owner of a racing sailboat) Relating the *whats* to the *hows* are an arbitrary set of symbols. In Figure 1 the filled in circle represents a strong relationship, the circle a weaker relationship and the x an adverse relationship. (Other sets of symbols can be used).

Several observations may be made from Figure 1:

- First, the *whats* are rather vague. Some are subjective, such as "good references" and cannot be quantified. Those than can be quantified, however, should be. In Figure 1, "Understandable" could be defined, if desired, by a clarity indexes available in the literature, "brief" can be defined by a page limit, and "cycle time" by a specified time period. These, in turn, can be used to guide the editor, define the standard format, and establish time limits for peer review.

- The symbols provide an indication of importance. Without further analysis it would appear that research, which impacts more *whats* than any other *how*, is the most important factor.

	Standard Format	Knowledgeable Author	Research	Edited for Clarity	Peer Review	Bibliography
Understandable		○	○	●	●	
Of Current Interest						
Brief	●					X
Good References		○	●			●
Reasonably Thorough		●	●		●	
Low Cycle Time	○		X		X	

Figure 1: QFD Matrix

- None of the *hows* address the need for the START sheets to be of current interest. The supplier must find a way to address this need, perhaps by establishing a means for customer feedback (which becomes a new *how*).

Expanding the Matrix

The observations listed illustrate the usefulness of the basic matrix. Indeed, the better understanding of the customers' wants that it may provide may alone be invaluable. However, there are several ways in which the matrix can be expanded to make it potentially more useful. Some of these are illustrated by Figure 2.

Features of Figure 2 are:

- The relative importance of each *what* is quantified in a new column labeled "priority". This can be done by simply listing them in order of customer priority. It may be more helpful to assign each item a relative weight, based on a customer survey, which is done in Figure 2.

- The relative importance of each *how* is established by weighting each symbol and summing down the columns. For example, a filled circle is worth 3 points, an open circle worth one point, and an x
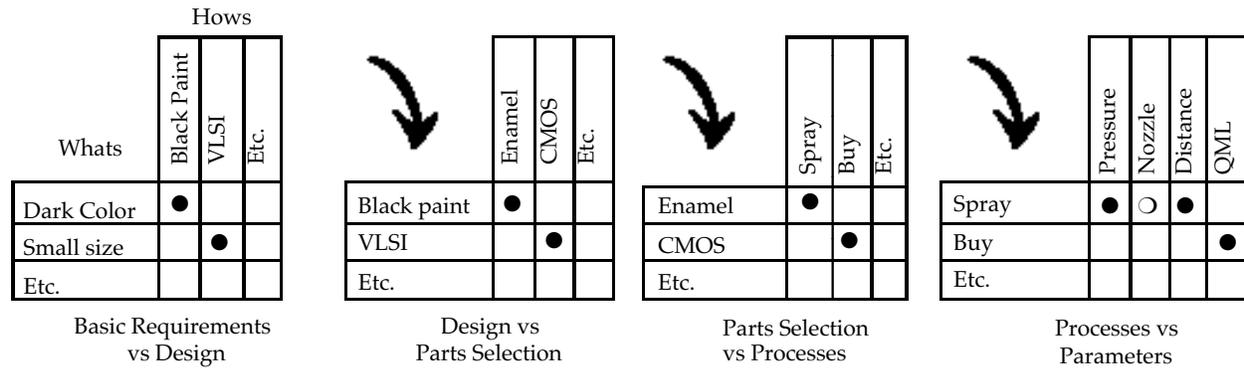
worth 2 points. Using these weights, research would be worth 9 points, and the standard format worth 4. In case of conflict, the research would be given priority. This procedure is further developed in Figure 2 by multiplying each symbol weight by the weight assigned to the *whats* in the row the symbol appears, thus accounting for the importance of the need which is affected. Using the priority weights, research in Figure 2 has an importance rating of 20.

- Customer perceptions of the degree to which the supplier and the supplier's competitors are meeting each need are shown on the right, revealing sales points (where the supplier has an advantage over his competitors) and areas needing improvement.

- Quantitative goals for each *how,* measured achievements by the supplier and his competition, estimates of difficulty, and other data of interest can be added below the basic matrix. These are more pertinent when the *hows* are parameters, rather than processes.

- A correlation matrix showing *how* vs. *how* impacts is added above the basic matrix. This shows which supplier processes or product parameters reinforce others and which conflict, requiring trade-off. In Figure 2, the matrix recognizes that a standard format may preclude some ways of improving clarity.

A matrix such as Figure 2 is often called a "house of quality" from its shape.

Figure 2: Expanded QFD Matrix

Cascading Matrixes

Though most QFD analyses use only the top level house of quality, it is possible to cascade matrixes to provide a trail from the customer requirements to the process parameters that need to be controlled to meet the needs. This is illustrated in Figure 3.

In Figure 3, the first matrix matched the customer's requirements as *whats* against the design features (the *hows*) intended to meet the needs. These *hows* become

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Figure 3

Hows →

Basic Requirements vs Design

Whats	Black Paint	VLSI	Etc.
Dark Color	●		
Small size		●	
Etc.			

Design vs Parts Selection

	Enamel	CMOS	Etc.
Black paint	●		
VLSI		●	
Etc.			

Parts Selection vs Processes

	Spray	Buy	Etc.
Enamel	●		
CMOS		●	
Etc.			

Processes vs Parameters

	Pressure	Nozzle	Distance	QML
Spray	●	○	●	
Buy				●
Etc.				

Figure 3: Cascading QFD Matrixes

the *whats* of the next matrix, which charts design features against *hows* which are the parts selected to implement them. The parts selected then become the *whats* of the third matrix, plotted against the *hows* of the processes used to create the parts. Finally, the processes become the *whats* of the last matrix, where the *hows* are the process parameters which must be controlled. Thus, the cascaded matrixes translate the customers requirements to a set of process parameters to be controlled. One such translation in Figure 3 relates the customers requirement for a dark color to the pressure of a spray paint nozzle.

The trail from requirement to process parameter need not be the same as the one in Figure 3, so long as the requirements are decomposed in a logical fashion from the top level *whats* to the detailed process *hows*.

Summary:

Whether a cascaded set of houses of quality or a simple top level *what* vs. *how* matrix is used, a quality function deployment is a labor-intensive process. Essentially, it invests time in planning to reap a profit in a shorter overall development cycle, based on an insight into the customers' wants. The same insight should also minimize the need for redesign.

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On the Web:
Information on QFD conferences and a bibliography of sources are maintained by the QFD Institute at URL: http://www.nauticom.net/www/qfdi.

Software:
Various quality consultants offer software packages to aid in the construction of QFD matrixes.

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