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The Role of QFD in Capturing the Voice of Customers

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**THE ROLE OF QFD IN CAPTURING THE
VOICE OF CUSTOMERS**

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ABSTRACT

This paper discusses a powerful tool that has been proven to be very effective in translating the Voice of The Customer . QFD is an extremely powerful catalyst for driving in quality at all stages of the business life cycle. After briefly describing what QFD is, the paper discusses in detail the various aspects and tools associated with Quality Function Deployment. The paper discusses in detail the process involved in applying QFD and concludes with a section on the importance of integrating quality throughout the value chain by starting with the Voice of Customer (VOC) and working with quality until the positive impact on customer satisfaction is achieved.

Key Words: Quality Function Deployment, Voice of Customer, Benchmarking, Quality, Measurement, Customer-Supplier Relationships

1. DEPLOYING THE VOICE OF THE CUSTOMER THROUGH QFD

Karabatsos,(1988) quotes Larry Sullivan (chairman of the American Suppliers Institute) as stating in 1986 that QFD is the *'mechanism to deploy customer desires vertically and horizontally throughout the company'*. At a fundamental quality process level QFD can also be seen as a 'positive' quality improvement approach as opposed to a (traditional) 'negative' quality improvement approach to deliver customer satisfaction (Ford Motor Company 1983), see Fig. 1 (Ford Motor Company 1983)

For a more detailed baseline definition, Sullivan, (1986) proposes that there are six key terms associated with QFD, which are as follows;

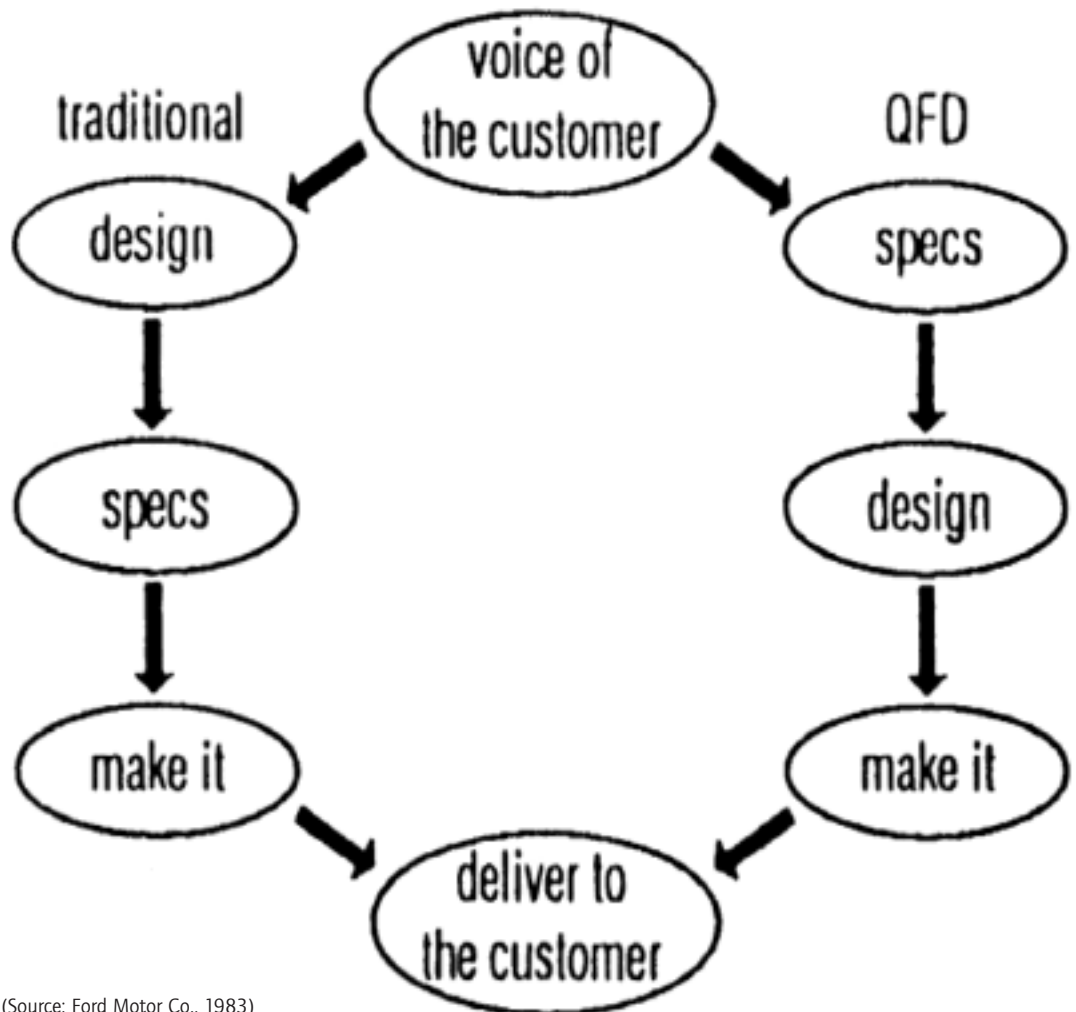
- i) *'Quality Function Deployment'* (an overall concept that translates customer requirements into appropriate technical requirements for each stage of product development and production).
- ii) *'Voice of the Customer'* (the customers' requirements as expressed in their own terms).

- iii) *'Counterpart Characteristics'* (the voice of the customer expressed in technical language).
- iv) *'Product Quality Deployment'* (the activity required to translate the voice of the customer into technical requirements).
- v) *'Deployment of the Quality Function'* (the activity required to assure that customer required quality is achieved).
- vi) *'Quality Tables'* (the series of matrices used to translate the voice of the customer into final product characteristics)

The six key terms of QFD described by Sullivan, (1986) can be further simplified as follows;

- i) a 'concept' for translating customer wants into the product,
- ii) a requirement to understand 'what' the customer 'wants'
- iii) the requirement to identify 'how' to technically deliver the what the customer wants,

FIGURE 1: TWO APPROACHES: NEGATIVE VS. POSITIVE QUALITY



(Source: Ford Motor Co., 1983)

- iv) the requirement for a 'team' to carry out the 'translation' of whats into hows,
- v) the requirement for a 'team' required to 'deliver' the hows into the product,
- vi) the requirement for 'charts' that facilitate the translation of whats and hows into the product. In even simpler terms, this can be distilled down to just one 'concept' of QFD with four key 'requirements' of; customer 'whats' (or wants), technical 'hows', 'team(s)' and 'matrices'. This can be taken a step further by proposing that the first requirement of 'customer whats' needs the second requirement of 'technical hows' to translate itself into the product, this second requirement in turn needs the third requirement of 'teams' to translate itself into the product, and finally this third requirement needs 'matrices' to translate its decisions into the product. This systematic trace from customer subjectiveness, to technical objectiveness, to team decision making with the aid of matrices into product characteristics is a fundamental basis for QFD.

2. THE QUALITY TOOL OF QFD

QFD is often referred to as a 'tool' in broad terms Reynolds, (1992), and in more specific terms; a 'competitive tool' Kathawala and Motwani, (1994), a 'communication tool' Fowler, (1991), a 'marketing tool' Potter, (1994), a 'design tool' Slinger, (1992), a 'planning tool' Sullivan, (1988), McElroy, (1989), and a 'quality tool' Ealey, (1987). This last reference of, 'quality tool', perhaps best summarises all the tool references, and needs a definition in itself to better understand the basic roots of QFD. Straker, (1995) describes quality tools as:

'structured activities that contribute towards increasing or maintaining business quality.'

By 'structured activities', Straker, (1995) means repeatable and using a defined set of rules, by 'contribute', he means add value, by 'increasing or maintaining' it is meant for use in all areas of quality improvement, and for 'business quality' it means that the company benefits from the quality tool use. In simple terms Straker, (1995) suggests that quality tools are both serious and valuable ways of doing business. Straker, (1995) also proposes that tools can be used at either the organisational level or (structuring the way people work together), or at an individual level (helping people and groups solve problems and tasks in their everyday business). Straker, (1995) finally

suggests three areas where tools can be used, which are;

- i) *'collecting various levels of numeric and non-numeric information.'*
- ii) *'structuring the information in order to understand aspects of process and problems.'*
- iii) *'using the information to identify and select information and plan for specific actions.'*

The definition of quality tools and the three areas of use as described above by Straker, (1995) helps outline the fundamental basis of any quality tool including QFD as defined already by Sullivan, (1988), Barlow, (1995) and Clausing, (1994). However, according to Straker, (1995) who lists some 33 individual tools in a relationship diagram with their information uses, it is apparent that not all tools are suitable for all three areas of use, or are of equal use. Asaka and Ozeki, (1988) list some 15 individual quality tool types, while Nickols, (1996) lists just three suites of tool types. It is clear then that the interpretation of what constitutes a tool, a tool type, or a suite of tools is largely dependent on the perspective the various authors and the application of the tool(s) in question. Nickols, (1996) considers the question of tools in terms of its 'problem solving' capability, and proposes his three tool types in terms of;

'Repair Tools' for technical trouble shooting

'Improvement Tools' such as Kaizen, continuous improvement, TQM and re-engineering

'Engineering Tools' for design or solution engineering from scratch.

3. THE MATRIX DIAGRAM OF QFD

Asaka and Ozeki, (1988) describe matrix diagrams as a method to 'show the relationships between results and causes, or between objectives and methods, when each of these consists of two or more elements or factors'. Asaka and Ozeki, (1988) continue by stating that 'various symbols are used to indicate the presence and degree of strength of a relationship between two sets of essential items'. Asaka and Ozeki, (1988) propose some four key benefits of using matrix diagrams with symbols as follows;

- i) The use of symbols makes it visually clear whether or not a problem is localised (symbols appear isolated) or more broad ranging (symbols in rows or columns).
- ii) It possible to show the problem as a whole, and view all the various relationships between the various at once

- iii) By testing and evaluating each relationship intersection of the essential factors it becomes easier to discuss the problem at finer levels of detail.
- iv) A matrix makes it possible to look at specific combinations, determine essential factors and develop an effective strategy for solving the problem.

Asaka and Ozeki refer to four different types of matrix as follows;

- i) 'L-type', a two dimensional pairing of rows and columns.
- ii) 'T-type', a three dimensional matrix comprising of two 'L-type' matrices.
- iii) 'Y-type', a combination of 3 'L-type' matrices.
- iv) 'X-type', a combination of 4 'L-type' matrices.

4. SOME BASIC MECHANICS OF THE QFD PROCESS
The House of Quality Mechanics Within QFD

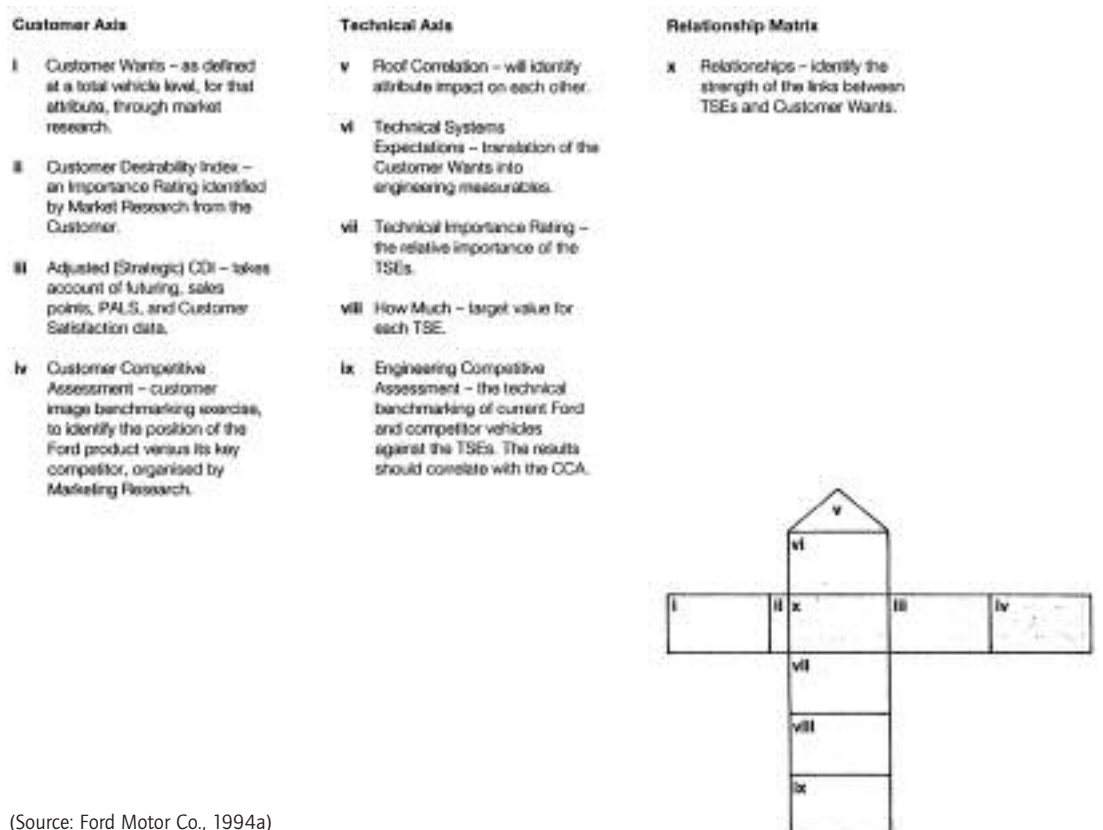
To begin explaining the mechanics, Kim and Ooi, (1991) argue that 'QFD is a set of planning and scheduling routines that has proven effective in producing high quality as well as low cost products' (Kim and Ooi, 1991). Burton, 1995 on the other hand, proposes that the QFD chart, often referred to as a 'house of quality' due to its so called construction of 'rooms' and a 'roof' is essentially a chart comprising nothing more

complicated than a series of 'lists' and 'relationship matrices' (Clausing, 1994) agrees with the term rooms, but adds they can also be referred to as 'cells' and adds that the QFD matrix diagram comprises of 8 such rooms (or cells) which in turn contains 20 steps in completing the 'Basic QFD' matrix. The American Suppliers Institute (ASI), (1992) also refer to 10 'analytical steps' for studying the completed house of quality at the product planning level.

The eight rooms Clausing, (1994) describe are effectively the same basic rooms Ford Motor Company use for instance in their House of Quality charts at a planning level, but Ford, (1994) go further by adding a ninth 'Quality Plan' room', (excluding the Relationship Matrix) which is a key strategic aspect of the QFD process within the Company. For an example of the 9 rooms and Relationships matrix format used in a Ford 'CFE-QFD' Phase 1 HOQ see Fig. 2 (Ford, 1994).

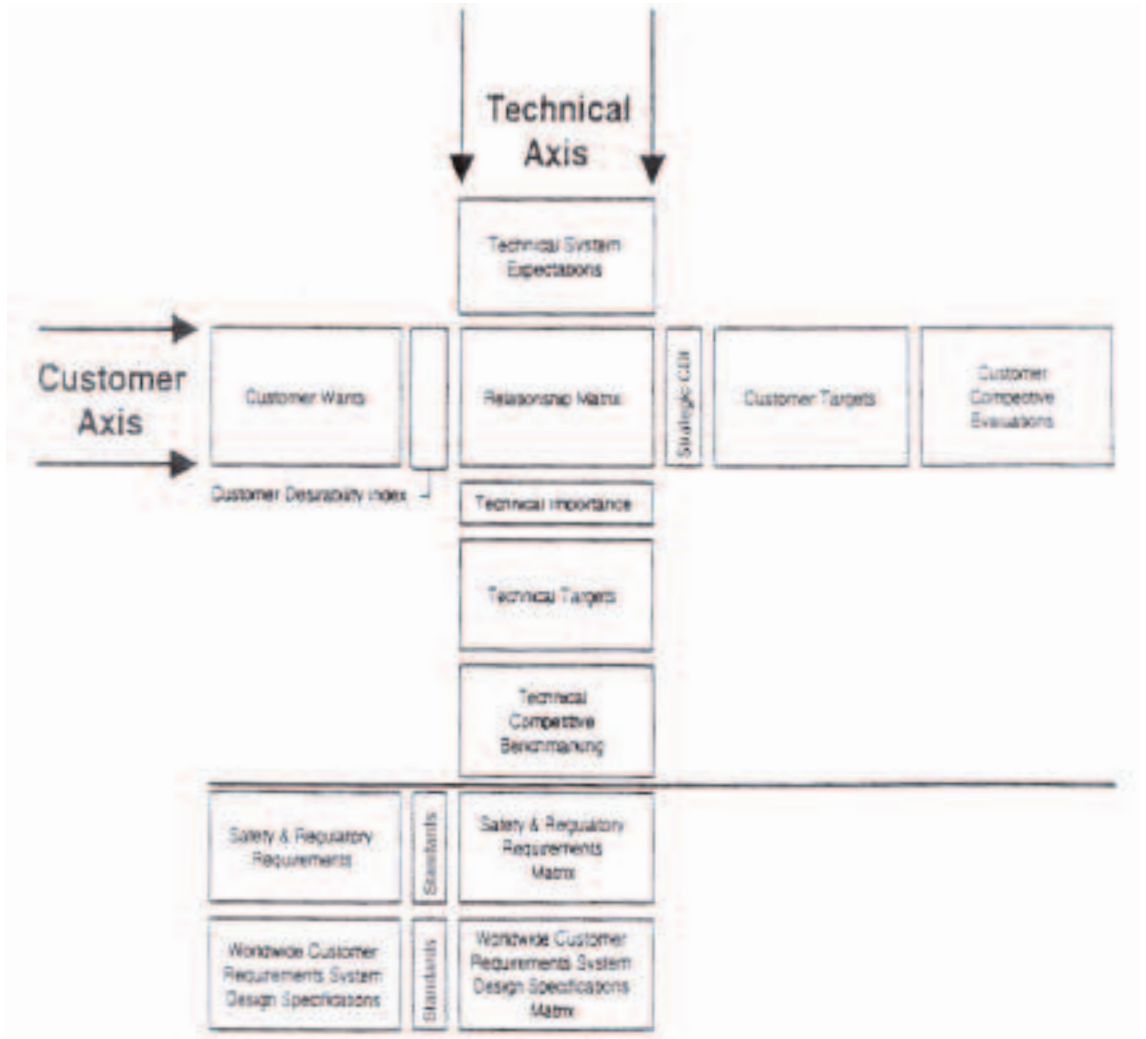
Fig. 3 (Ford, 1994) shows the subtle difference that a Ford 'Quick-QFD' Phase 1 Matrix exhibits, also with 9 rooms and a Relationships matrix, plus a further 4 rooms and 2 Relationships matrices to include safety and regulatory requirements as well as the Ford Worldwide Customer Requirements and Systems Design Specifications.

FIGURE 2: FORD CFE-QFD '9 ROOMS QFD'



(Source: Ford Motor Co., 1994a)

FIGURE : 3 FORD QUICK-QFD NINE ROOMS QFD PHASE 1 MATRIX



(Source: Ford Motor Co., 1994b)

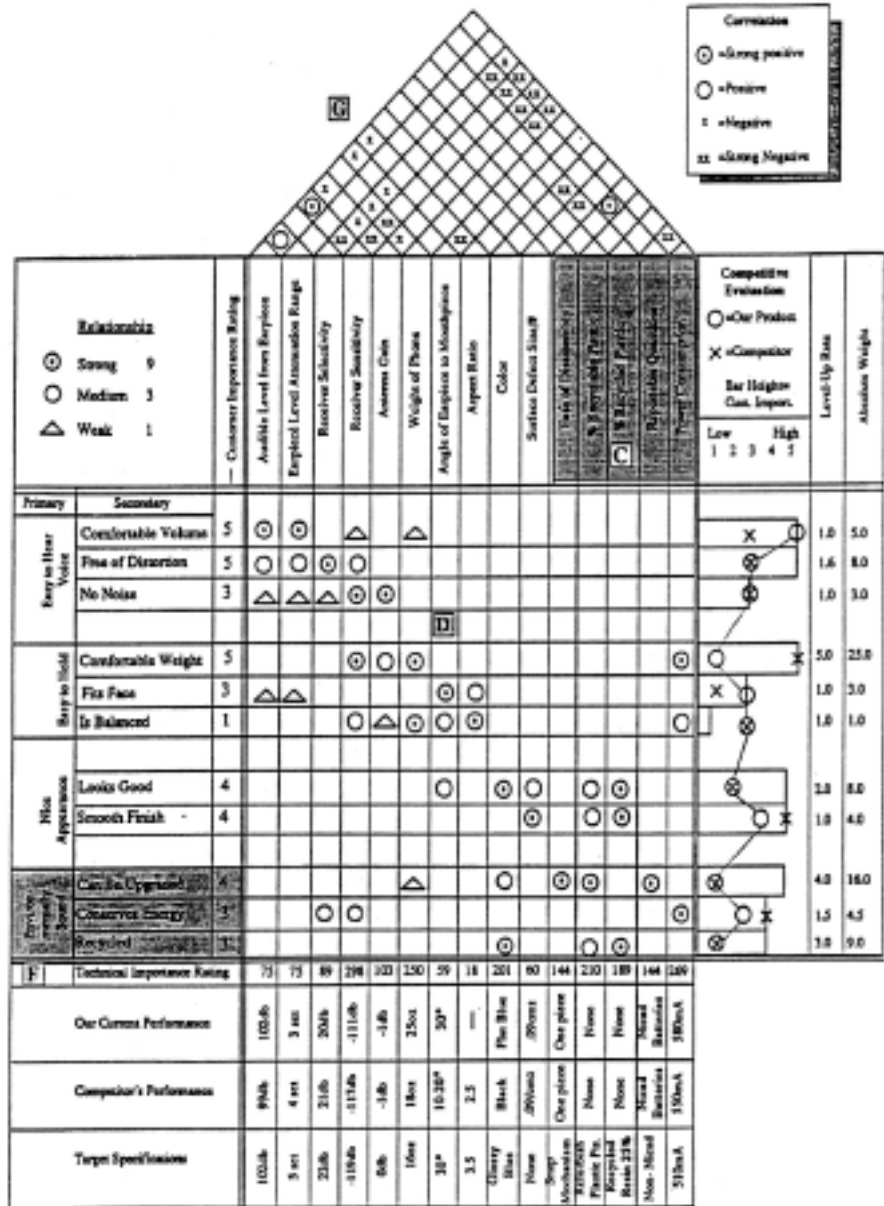
Burton, (1995) adds to his description of the House of Quality chart comprised of lists and relationships matrices by stating that they are aligned along two axes, where the x-axis is called the customer axis, and the y-axis is called the technical axis. This twin axis description is supported by Asaka and Ozeki, (1988), who suggests QFD is generally charted using a 'two dimensional diagram', with customer quality requirements on the vertical axis and the quality requirements needed to satisfy the customer requirements on the horizontal axis. Akao, (1988) on the other hand refers to these symbols within the quality charts used for QFD as indicators of correlation between the customers 'demanded qualities' and the technical 'quality elements'. Akao, (1988) also refers to the traditionally used symbols depicting; strong, medium and weak as the; double circle, circle and triangle respectively.

For an example of a typical Phase 1 House of Quality Chart see Fig 4., (Hochman and O'Connell 1993), which charts the customer requirements and key measureables for a portable phone.

4. THE CASCADING PHASE TO PHASE MECHANICS OF QFD

Sullivan, (1986) defines four levels of QFD matrices that reflect different stages of application in the product development cycle. The first of these is the 'Planning Matrix' that culminates with selected control characteristics (based on customer importance, selling points and competitive evaluations). The second is the 'Component Deployment Matrix' which culminates in defining the finished component characteristics (based on the planning matrix targets). The third stage is the 'Process Plan Chart', which culminates in the production process monitoring plan required by the operators. Finally the fourth stage is the 'Control Plan' which culminates in defining quality controls that would typically include control points, control methods, sampling size frequency and checking methods. In each case Sullivan (1986) outlines that the previous charts' key outputs feed into the next chart as key inputs, and represent the transition from the development phase to the execution of the production phase within the product development cycle.

FIGURE 4 : EXAMPLE QFD PHASE 1 HOUSE OF QUALITY



Integrating customer environmental concerns into the design of a portable phone.

(Source: Hochman & O'Connell, 1993)

The four Phase QFD process can be seen in a cyclical way (see Fig. 5 [Ford, 1983]). And as a 'Process Clock' as used by Ford Motor Company (Fig 6 [Ford, 1994]).

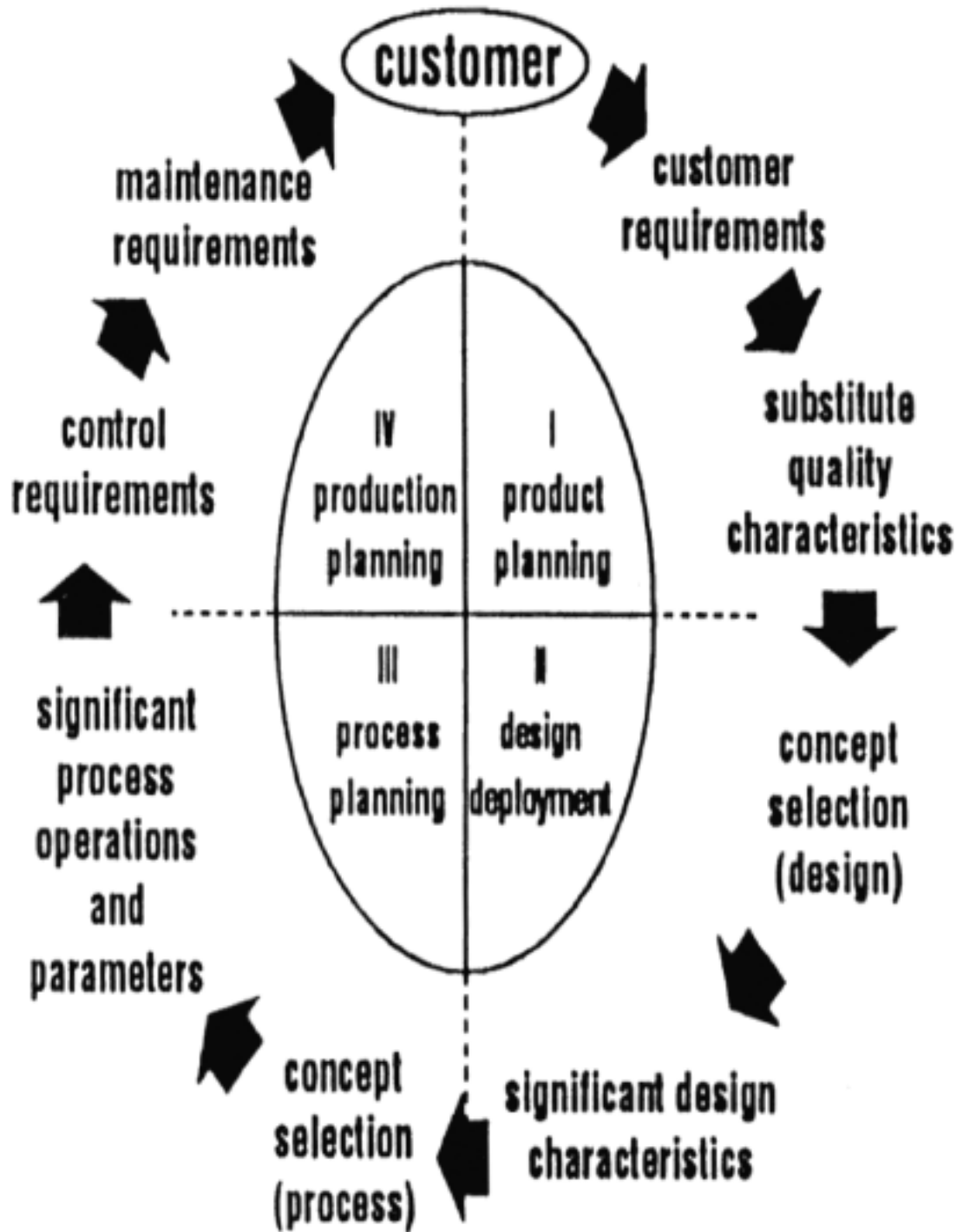
The cascading phase to phase QFD can be seen through Fig. 7 (Hauser, and Klausning, 1988) for a typical 4 Phase QFD process and Fig. 8 (Ford, 1994) for the Ford 5 Phase QFD process using a 'Rear View Mirror.

5. THE MECHANICS OF THE BENCHMARKING PROCESS WITHIN PRIORITISATION

Benchmarking within the Phase 1 HOQ comes in two forms, the first is the Customer Competitive Assessment (or Evaluation), (CCA or CCE) [Ford, 1994 Version 3.0, Ford 1994 Version One]. As the

title suggests this is the qualitative benchmarking that the customer participates in within the horizontal customer axis (Ford 1994 Version One). Customers evaluate the products by comparing the relative 'perceived' performance according to the key customer requirements (using customer language) as identified by prior market research with the support of the QFD team. This exercise will involve the company product (or service) amongst its key competitive products (or services). The second benchmarking activity is the quantitative Engineering Competitive Assessment (or Evaluation) (ECA or ECE) (Ford 1994 Version 3.0). This technical benchmarking exercise will compare the same products (or services) through conducting tests that are 'global and measurable' (Ford, 1983, 1994 Version 3.0), (Ford 1994

FIGURE 5 EXAMPLE CYCLICAL QFD PROCESS: PHASES FOR PRODUCT DEVELOPMENT



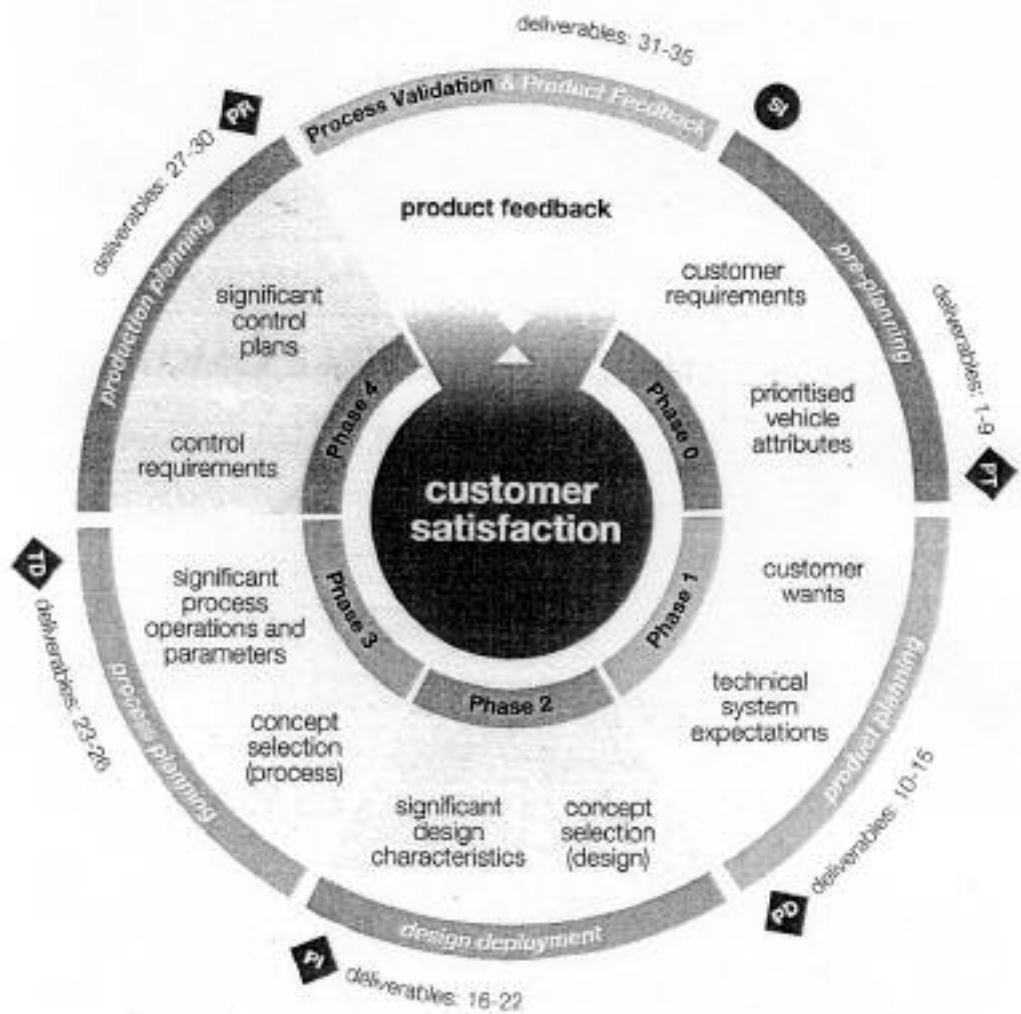
(Source: Ford Motor Co., 1983)

Version One) and have been correlated objectively or subjectively to best represent the technical function of the subjective customer wants. These tests have been typically referred to as Substitute Quality Characteristics (Akao, 1988), or Design Requirements (Ford, 1987), (Ford, 1989), Technical System Expectations (Ford, 1994 Version 3.0), (Ford 1994 Version One), or Hows, (ASI Quality Systems, 1996). These are the technical Company Measures (Verduyn and Wu, 1995). These make up the key element to the technical axis (Ford, 1994 Version 3.0). The benefit of conducting both

benchmarking exercises within the same HOQ matrix is that it is then possible to compare subjective customer ratings to objective engineering ratings. The first benefit is to show the company where improvements are required the most, and where there is already high satisfaction relative to competition. The second key benefit is that it is possible to compare discrepancies between customer perception and technical reality.

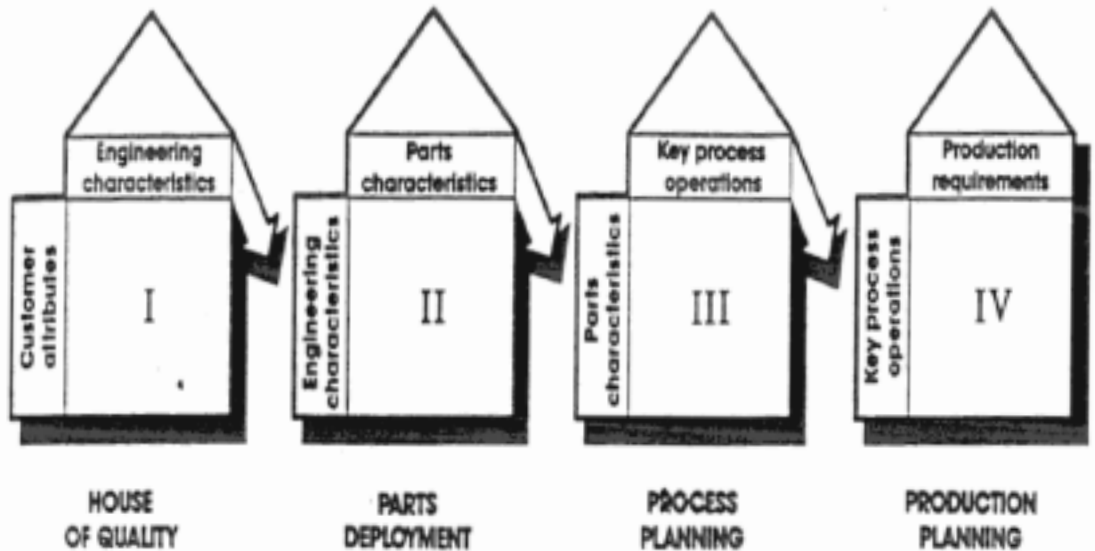
Competitive benchmarking to set goals is a powerful tool and is supported by Vaziri, (1992)

FIGURE 6 FORD CFE-QFD PROCESS CLOCK



(Source: Ford Motor Co., 1994a)

FIGURE.7 LINKED QFD HOUSES CONVEY THE CUSTOMER'S VOICE TO MANUFACTURING



(Source: Hauser & Clausing, 1988)

who adds that it assists companies to anticipate customer needs. This ability to anticipate customer wants is a critical measure of success within any QFD exercise, and in the absence of any other

form of futuring provides the engineer a key tool in setting so called 'stretch' targets (Ginn, 1996). Vaziri, (1992) adds that it is important to obtain this benchmarking data in a timely fashion to be

effective. Vaziri, (1992) also argues that QFD derived customer requirements are a precursor to benchmarking, but not a pre-requisite, although he does reinforce the argument that the combination of QFD and benchmarking culminates in feeding information to quality improvement teams. Ohinata, (1994) supports the idea that benchmarking was originally a Japanese invention (rather than an American invention, typically attributed to Xerox) used by small companies who used this tool for modelling best practice from other larger Japanese and American companies. Ohinata, (1994) cites some five areas for benchmarking of; product, function, process, management and strategy. Ohinata, (1994) adds to this the five steps for successful benchmarking as; clarifying goals, organising a team, selecting target organisations (products or services), collecting and analysing information and devising an action plan. These five areas and steps are arguably a mirror image of the basic key areas and steps required to set up and run a QFD exercise. It is therefore perhaps no coincidence that the synergy of the QFD process with benchmarking is complete when it is recognised that the two key axis of QFD include a benchmarking exercise to support the target setting and prioritisation of both axis. Finally when considering benchmarking, as with all tools, De Toro, (1995) warns of 10 pitfalls that confront the benchmarking team which De Toro, (1995) refers to as 'miscues'.

6. THE MECHANICS OF THE QUALITY STRATEGY PLAN WITHIN PRIORITISATION

The quality strategy or plan (Ford, 1987), (Ford, 1989), (Ford, 1992), (Ford, 1983 Level 1), (Ford, 1983 Level 2), (Ford 1994 Version 3.0), (Ford, 1994 Version One) is the area or room within the QFD HOQ where consideration of the customer importance rating (CIR) or customer delight index (CDI) (Bergeon, 1996) for the key customer wants is effectively weighted using a combination of techniques. First it is important to emphasise the subtle difference between CIR and CDI. Typically CIR's were individually rated by the customer during drive surveys. The CDI method based on Thurstone is only one of many methods that can be used to compare customer wants. Effectively this is a form of prioritisation before the QFD HOQ is constructed in an effort to keep the total matrix size containable.

7. THE MECHANICS OF TECHNICAL IMPORTANCE RATINGS WITHIN PRIORITISATION

Although the software algorithms and strategies for determining weightings of customer wants CIR's and CDI's often a closely guarded secret

with most companies, the basic QFD HOQ maths for determining the final technical axis TIR's remains universal. Each TIR is the sum of the 'final' weighted CIR multiplied with each respective relationship value (typically 9, 3 or 1) across the horizontal axis, and then the summed down the vertical axis. Typically the CIR's are also normalised between 1 to 5, although the Strategic CDI (which is the weighted CDI as a result of the Quality Strategy maths and algorithms to produce a futuring effect) may vary, and even include decimal points (Ford, 1994 Version 3.0), (Bergeon, 1996). The maths is invariably an automatic feature of any QFD software.

8. THE MECHANICS OF THE ROOF CORRELATION MATRIX WITHIN PRIORITISATION

This last section of the mechanics of QFD is perhaps the least utilised part. The completion of the Phase 1 'roof' correlation has either been a simple tick box item of the QFD process, or completed with just the strong negative trade offs with little follow up to deploy recommendations to avoid conflicting technical system expectations (TSE's). The full function of the roof correlation is to assign weak and strong positive and negative relationship symbols between the technical measurables of the QFD HOQ. As a result it has become the practice to just assign strong negatives that highlight the critical conflicts between optimised technical measureables.

9. EXTERNAL & INTERNAL CUSTOMER TO SUPPLIER 'VOICE-QUALITY-SATISFACTION' CHAINS

This section will now discuss the various arguments and proposals that link together the end user customers voice to the internal customer-supplier chains that act on the customer input and feedback to improve product quality and ultimately deliver higher end user satisfaction. This concept is covered both directly and indirectly by many authors, but this review will consider the implications for QFD and its role within a Company Wide Quality Control process to support customer-supplier chains. Within the context of QFD, Ansari and Modarress, (1994) state that it is the role of the QFD team to determine strategies that consider all opportunities presented by both internal groups and external suppliers. The scenario by Ansari and Modarres (1994) suggests that QFD teams make ideal coordinators of the external-internal customer-supplier chain, because the four phase QFD process spans the product development cycle. This scenario is supported by Gopalakrishnan, McIntyre and Sprague, (1992)

who propose that, while the QFD tool defines customer-supplier relationships, it also improves internal processes.

To look generically how the custom-supplier chain links to key goals of product quality, product timeliness, and customer satisfaction Chaston, (1993) proposes the three overlapping areas of 'mutual overlap (Chaston, 1993) states requires more than these three areas just working together, these areas must build a degree of mutual trust through a common set of goals to assure mutual satisfaction. Chaston, (1993) concludes this scenario of developing inter-organisational partnerships to deal with future management is becoming increasingly common in high technology industries, such as computing, precision engineering, communications and health care.

Clark and Fujimoto, (1991) state that the global economy is now characterised by intense international competition, with a fragmented market of discerning customers who demand quality and satisfaction. This assertion is corroborated by Bemowski, (1996) who quotes Wolfgang R. Schmidt (CEO of Rubbermaid Inc) as stating that customers are now demanding more for less. Bemowisiki, (1996) continues Schmidt's assertion who continues to state that customer want more quality, more service, more choice and most important, more innovation. For all these extra demands, Schmidt concludes, the customer will continuously want to spend less time, less risk and less money obtaining what they want (Bemowiski, 1996). Brecka, (1994) corroborates the previous statements by stating that the importance of product quality and customer satisfaction has reached such a critical level it the future success for all companies rests on these two criteria. Brecka, (1994) concludes his argument by quoting Claes Fornell (the developer of the American Customer Satisfaction Index) who states that when a buyer recognizes quality it is reflected in customer satisfaction. Customer satisfaction in turn leads to increased revenue. Fornell continues to state that customers are an economic asset and although they are not on the balance sheet they should be (Brecka, 1994). Stewart, (1995) supports this by stating that if a company cannot demonstrate the link between increased customer satisfaction and improved financial results, the company is not measuring customer satisfaction correctly. Stewart, (1995) adds that to retain customer loyalty to the product, companies must learn what are the specific factors that make the most difference to

the retention rate, be it faster delivery, electronic billing and payment or better trained personnel, or whatever. Fierman, (1995) adds further support to Stewart's, (1995) argument by stating that companies should try harder to thrill its customer with new technology and innovations. This directly supports the Kano, (1994) argument for excitement quality, or attractive quality. Denton, (1990) reinforces all these statements by proposing that leadership in the global marketplace belongs to those who meet or exceed customer requirements. Clark and Fugimoto, (1991), corroborate these statements by confirming that increasing customer demands have become the focal driver of recent and current market forces for all products and services, and the automotive industry alike. The changes in business drivers since the 1970's have changed subtly from low investment, capacity utilisation and crisis management to the current state of customer satisfaction, time to market and brand loyalty. Next will be a discussion that pulls all these lessons learnt above into the context of QFD, and its role and impact in delivering the critical traceability of the customers voice through the product development process. Ultimately, if successful, product design and function quality will be sufficiently improved in the key areas most important to customers' 'perception' of that product (or service). With this, will come a customer feedback of higher satisfaction that prompts greater brand loyalty and increased return of investment through more sales and profit. Although QFD is only one of many quality tools available, it does have the unique characteristic that it starts with the end user and finishes with the end user providing its is deployed, as is designed, throughout the complete product development cycle.

If the foundation of the QFD house of quality (HOQ) is based on the premise that products are designed to reflect customers desires (Hauser and Klausing, 1988), then outcome of the QFD process delivers a product that provides a sustained or increased level of customer satisfaction (Hochman and O'Connell, 1993). Increased customer satisfaction as a key outcome of QFD as supported by many authors including Hochman and O'Connell, (1993) assumes the successful deployment of QFD driven targets. It is this successful delivery process of customer requirements through the customer-supplier chain that is critical (Ford, 1994 Version One). Although the assumption that QFD is deployed effectively, it has already been recognised in the East versus West scenario that QFD needs to be linked into a

TQM process such as Company Wide Quality Control. The assumption that the successful delivery of customer satisfaction into a product or service can only be achieved through the use of a company wide Total Quality Management (TQM) system is discussed at length and detail by Hellard, (1993). Hellard (1993) details some 8 principles of TQM, but places customer satisfaction as number 1. This connection between customer satisfaction, TQM and QFD will be discussed in more detail later in section (Zairi, 1993), (Morrell, 1988). When discussing customer satisfaction it is important to recognise the importance of the segmentation of customer wants which needs careful handling within the QFD process. This market segmentation will now be reviewed.

Two warnings are stated by Graessei and Zeidler, (1993) in discussion market segmentation using QFD derived customer requirements. First, Graessei and Zeidler, 1993) emphasize the importance to first segment the customers according to their specialised market requirements, as this will increase the chance of improving customer satisfaction. No one size fits all, states Graessei and Zeidler, (1993), who adds a second warning that it is important to recognise that the customer may not have 'voiced' all their requirements.

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