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QFD: A Tool for Managing Customer Satisfaction

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Abstract

For the success of any organization, it is very important to understand the concept of internal and external customer. The desired results cannot be achieved unless internal and external customers are satisfied. Worldwide organizations are using QFD for assuring that the 'voice of the customers' is not lost in the noise of product development. In this paper a brief description of QFD has been given. QFD planning matrices have been customized for designing a course. Organizations are used as external customers to identify their requirements.

INTRODUCTION

The concept of using QFD was Mitsubishi and Toyota n 70's. This was them followed by American companies like ford, GM in 1980's. Afterwards, many other companies like AT&T, Bulllabs, and Digital equipments, Hewlett-Packard, P&G, Xerox and Jaguar followed the path of QFD.

The concept of QFD can easily be explained with the help of example. Making design decisions, *concurrently* rather than *sequentially*, requires superior coordination among the parties involved. Keeping this in new, consider the design of a new car. Even for the best Japanese manufacturers, the design of an automobile can take several years and involve hundreds of design engineers. The coordination of the design decisions activity involving many individuals can be difficult. For example: Imagine that two engineers are working on two different components of a car sunroof simultaneously but separately. The 'insulation and sealing' engineer develops a new seal that will keep out rain, even during a blinding rainstorm. The 'handles, knobs and levers' engineer is working on a simpler lever that will make the roof easier the open. The new laver is tested and works well with the old seal. Neither engineer is aware of the activities of the other. As it turns

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out, the combination of heavier roof (due to the increased insulation) and lighter lever means that the driver can no longer open the sunroof with one hand, thereby, violating a quality characteristic expected by the consumer. It is hoped that the problem will be detected in prototype testing before the car is put into production. At that point, one or both components will need to be redesigned. Otherwise, cars already produced will need to be reworked and cars already sold, will have to be recalled. None of these alternatives is pleasant, they all involve considerable costs.

This likely would not have happened if the engineers had worked in teams and shared information. But there is no guarantee that all decisions would be coordinated. A formal method is needed for making sure that everyone working on a design project knows the design objectives and is aware of the inter-relationships of the various parts of the design. Similar communications are needed between the customer and marketing, between marketing and engineers, between engineers and productions, and between production and the worker. In broader terms, then, a structured process is needed that will translate the ‘voice of the customer’ to technical requirements at every stage of design and manufacture. Such a process is called Quality Function Deployment (QFD).

QFD, in the QFD’s first application is traced back to Mitsubishi’s Kobe Shipyard in 1972 of process the lifecycle of a product from its conception through design, manufacture, distribution and use are brought together, until the product has, in the customer’s opinion, served its expected life. The management of QFD ensures that vital customer satisfaction and excitement attributes are recognized and developed so that the company can achieve a competitive edge. It is equally, if not more, important that this is achieved profitably. These are providing increased security of the business for its employees. Quality Function Deployment may be defined as a system for translating consumer requirements into appropriate company requirements at every stage, from research through product design and development, to manufacture, distribution, installation and marketing, sales and service.

QFD is best visualized as a technique which identifies the true voice of the customer and ensures that this is the common, continuous thread of information going through all stages of the product

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lifecycle, from design concept, component design, process and manufacture through to the eventual user.

The House of Quality

A series of matrix diagrams or quality tables are used to represent QFD. The first matrix, dubbed the 'house of quality', converts customer requirements into product design characteristics. The house of quality has six sections: a customer requirements section, a competitive assessment section, a design characteristics section, a relationship matrix, a trade-off matrix and a technical assessment/target values section.

(i) **Customer requirements:** The entire QFD process is chosen by the Customer requirements. Customer requirements provide a list of the attributes of the product that are important to the customer. These attributes can get quite lengthy. So, they are grouped into bundles (e.g. and electric iron that irons well, easy and safe to use) by consensus of the design team or by more formal nonparametric statistics techniques. The 'smokestack' of the house shows the importance the customer attaches to each attribute on a scale of 1 to 10. Increasing number denotes increase in importance.

(ii) **Competitive assessment:** A perceptual map is on the right side of the house in which customer's rate the performance of our product, X, against competing products, A and B, for each customer requirement. With the increase of numbers, the performance is considered better and better. This information is used to determine which customer-needs will yield a competitive advantage and should be pursued. In case, our iron, already, excels in the customer-requirements of "presses quickly", "removes wrinkles", and "doesn't break when dropped", so, we do not need to improve those factors. However, if we are rated poorly on "doesn't stick", "heats quickly", "fast cool down" and "light-weight", we may have to improve upon these characteristics. Also, we could gain some competitive advantage with an iron that "doesn't scorch cloth" and "doesn't

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burn when touched", if products A, B and have similar ratings and there is room for improvement. (2)

(iii) **Design characteristics:** Product design characteristics, expressed in engineering terms, are located on the top floor of the house ("energy needed to press", "weight of iron", and so on). These characteristics are bundled just like the customer attributes except that the terminology reflects more of an engineering orientation ("force", dimension, and material", and so on). (3)

The objective-measures towards the bottom of the house provide the technical data as regards customer perceptions. For example, customers may rate our iron poorly on "fast cool-down". Fast cool-down may be measured by the time required to go say. From 400^o to 100^o. Just suppose, our iron takes 8 minutes to cool down, while A and B take just 6 and 4 minutes, respectively. The customer is correct, if our iron does take longer to cool down than our competitors.

(iv) **Relationship matrix:** The relationship matrix, located in the middle of the house, (4), correlates customer requirements with product characteristics. A strong positive relationship may exist between the customer requirement "doesn't break when dropped" and the product characteristic, "thickness of soleplate", but a strong negative relationship may exist between the requirement "fast cool-down" and the characteristic, "thickness of soleplate". This information is useful in coordinating design changes in response to one customer requirement that may conflict with others.

(v) **Trade-off matrix:** The trade-off matrix looks at the impact of changing product characteristics. For example, if the thickness of the soleplate is increased, the time required to heat up and cool-down the iron will also increase, but the iron will press better ("energy needed to press" goes down and "weight of iron" increases). All these characteristics will need to be optimized as design changes are made in soleplate thickness. This is not an easy task, but, at least, we are aware of the potential problems. (5)

(vi) **Technical rankings and design targets:** The bottom portion of the house contains various factors important to management in determining design changes including cost.

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The output of the house is in terms of measurable values of the product characteristics that are to be achieved in the new design of the electric iron. These values are determined by considering the information contained in the 'house of quality' and may not be calculated, directly, from the information. (6)

The outline of 'house of quality' is given in Fig.1.

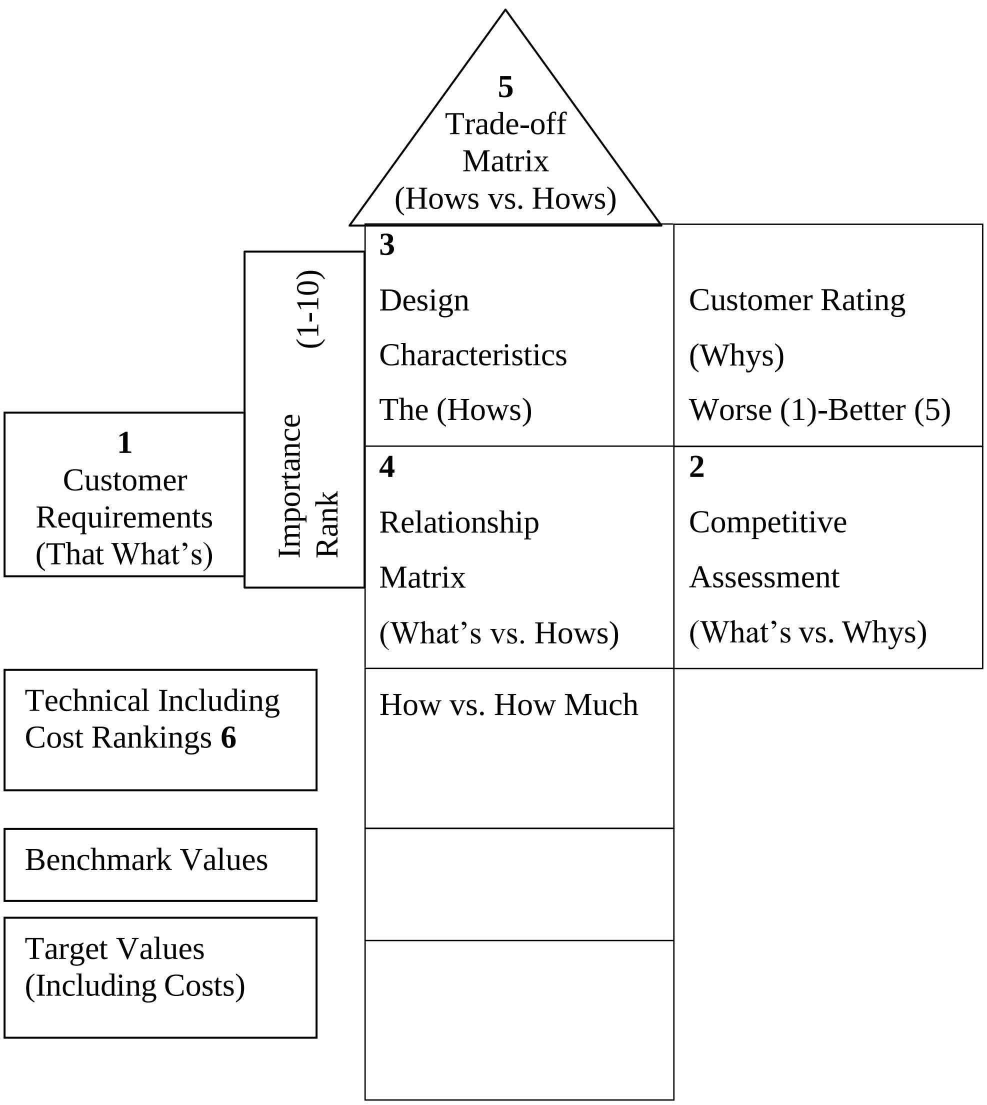

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Fig. 1: the house of quality in QFD

The target-values are compared with the current objective measures for iron X. The last row indicates with arrows the design characteristics that are targeted for change. The 'house of quality' is the most popular QFD matrix. However, to understand the full power of QFD, we need to consider three other houses that can be linked to the house of quality. In our example, suppose, we decide to meet the customer requirement of, "heats quickly", by reducing the thickness of the soleplate, the second house, parts deployment, examines which component-parts are affected by reducing the thickness of the soleplate. Obviously, the soleplate itself is affected but so is the fasteners used to attach the soleplate to the iron as well as the depth of the holes and connectors that provide steam. These new part-characteristics, then, become inputs to the third house of process planning. To change the thickness of the soleplate, the dies used by the metal-stamping machine to produce the plates will have to change and the stamping machine will require adjustments. Given these changes, a fourth house, operating requirements, prescribes how, the fixtures and gauges for the stamping machine will be set, what additional training the operator of the machine needs and how process control and preventive maintenance procedures need to adjust. Nothing is left to chance-all aspects are covered from customer to design manufacturing.

CONSTRUCTING A QFD

Constructing the House of Quality

Using the electric iron, as an example, the procedure used for the construction of the house of quality chart is as follows. Similar example is provided by Burn, 1990. This is outlined through different items of Fig

(i) Establish full identification of customer wants. List all the wants, taking care to include basic wants which are often taken for granted. Ensure that customer dislikes are identified as well as those items which, if included in the product, would cause excitement and pleasure. Summaries these customers want into a small number of major (primary) wants, supported by several secondary and, if necessary, tertiary

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wants. By using carefully chosen words, the full pattern of customer wants is obtained in subjective terms. (Item 1)

- Aesthetic looks
- Not to heavy
- Will not scorch fabric
- Easy to operate
- Heats evenly
- Does not break when dropped
- Does not stick
- Fast to heat and cool
- Not expensive
- Does not give shock

Primary	Secondary	Tertiary
Appearance	Colour	Body
		Ends
		Control
	Size and weight	Handle and knob
		Soleplate and body
	Shape	Proportions
Operates Easily	Operational Controls	Heating
		Auto shut-off/on

Fig. Item 1 – Customer Wants (What's)

(ii) The customer's wants are ranked in importance by the customer, on say, a scale 1-5 here. As discussed earlier, larger number means greater importance. (Item 2)

Tertiary	Importance
Body	5
Ends	5
Controls	4
Handle and knob	2
Soleplate	3
Size and Proportions	5
Heating	5
Auto shut-off/on	2

Fig. Item 2- Importance Ranking

(iii) Translate these wants into corresponding 'how's' or design characteristics. Express them in terms, which can be quantified or qualified and arrange them in primary, secondary and tertiary order. (Item 3)

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1	Paint and panel	Material
2	Smoothness of plate	
3	Coating on soleplate	
4	Plastic knob, handle-properties	
5	Soleplate metal/alloy-thickness	
6	Weight of iron	Mechanical
7	Force required to press	
8	Fasteners required	
9	Insulation required	Electrical and automatic nature
10	Thermostat-temperature control	
11	Time required to reach X°C	
12	Time required to cool down	

Fig. Item 3-Design Characteristics (How's)

(iv) Establish whether a relationship exists between every want and every how. If a relationship exists, categories it as strong, medium or weak. (Item 4)

Sequence →		1	2	3	4	5	6	7	8	9	10	11	12	13
Body	5	●	●		●	●							▲	
Ends	5	●	●		●	●								
Controls	4	●	●	●	O									
Handle and knob	2													
Soleplate	3													
Proportions	5													

→ Customer Importance Rating Scale 1-5

Relationship: ● – Strong; O – Medium; ▲ – Weak

Fig. Item 4 – Relationship Matrix

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(v) The measurement units are chosen for each ‘how’ enable target-values to be established.(Item5)

1. ‘X’ years (Paint and panel durability)
2. Coefficient of friction
3. mm – coating thickness
4. Material properties, e.g. thermal stability/sticking point C^{o}
5. mm – metal/alloy thickness
6. Kgs (weight of iron)
7. Newtons (Force requirement)
8. mm (Size and diameter of fasteners)
9. Dietectric constant (insulating strength)
10. ^{o}C change/unit-time (temperature control)
11. Minutes (time to heat-up); conductivity and wattage of element
13. Minutes (time to cool-down)

Fig. Item 5 – How much

(vi) The target-figure can be increased or decreased as improvement is made; using the direction of the arrow to indicate that improvement is by raising or lowering the target-value. This is important, particularly when considering the inter-relation between the hows. (Item 6)

↑	↓	↓	↑	↓	↓	↓	↓	↓	↑	↓	↓

Fig. Item 6 – Improvement (Increase/Decrease) In Target Values

(vii) This is part of the chart is known as the correlation matrix. These relationships are again categorized but this time as, either positive or negative, and to note if there is a strong relationship. (Item 7)

						#	●				
										×	
					●				O		
	↓	↓	↑	↓	↓	↓	↓	↓	↑	↓	↓

● Strong Positive
O Positive
Strong Negative
× Negative

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Fig. Item 7 – Correlation Matrix

(viii) The customer-wants of the design are compared with those of the competitors and the findings are ranked. This will establish whether the design is better or worse, with a ranking of features. Preparation of this information will be assisted if specific customer complaints or warranty-claims are known. The dotted line traces out the position of own-product in relation to the competitor's-product and indicates where there is a competitive advantage or disadvantage. (Item 8)

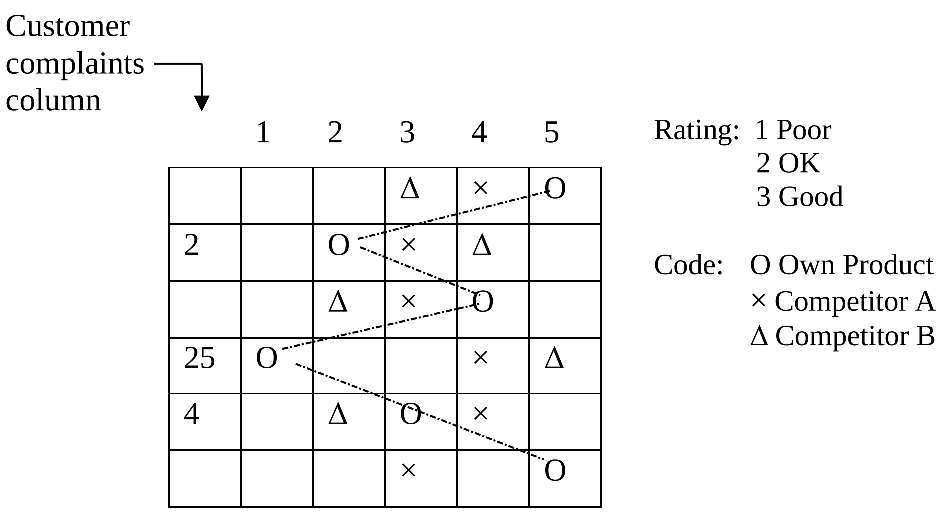

Fig. Item 8 – Competitive Assessment of Wants

(ix) Compare each 'how' against a technical competitive benchmark. In the example shown, there is a correlation between these two competitive ratings. What is seen as better in the customer want-rating should correlate with technically better. If this is not so, then, it is necessary to check both assessments. The ranking of technical difficulty 1-5 is an assessment of the relative technical difficulty of improving the target-value. (Item 9)

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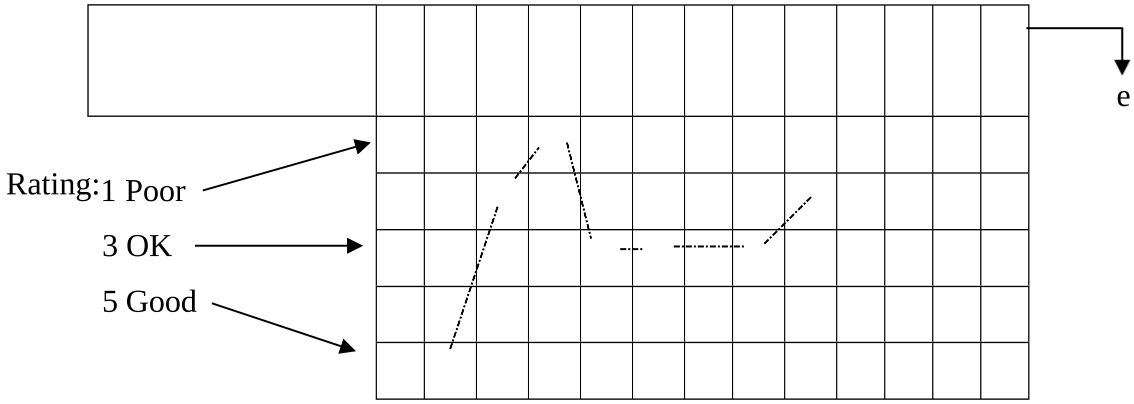

Code: O Own Product; × Competitor A; ∆ Competitor B

Fig. Item 9 – Competitive Technical Assessment

(x) Regulatory or company-control items are included at the bottom of the chart. (Item 10)

Regulatory and Control	IS 366	●	●
	IS 302-2-3 (safety)	●	●
	Cost	O	O
	Design for assembly	▲	▲

Relationship: ● Strong; O Medium; ▲ Weak

Fig. Item 10 – Regulatory Item

(xi) By assigning figures to the 'what/how' relationship in item 4, an overall assessment can be made of the relative importance of each customer-want. Ranking these assessments will indicate, which items are of most importance in the opinion of the customer and, which must, consequently, by given careful attention by consideration at the next stage.

The calculation is as follows. For each column, multiply the customer-rating for each want, where there is a relationship-entry, by the figure assigned for the entry, using the code strong 9, medium 3, and weak, 1. The total for each column gives the absolute value; the relative value is the ranking of absolute values. Hypothetical figures are tabulated in figure. (Item 11)

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Absolute	25	50	40	90	160			40	50
Relative	6	5	5	4	1			5	5

Fig. Item 11 – Importance

This marks the completion of stage 1 of QFD covering product planning. The three remaining phases are part-deployment, process-planning and production-planning and methods. Similar charts are constructed for each of these phases as shown in Fig.

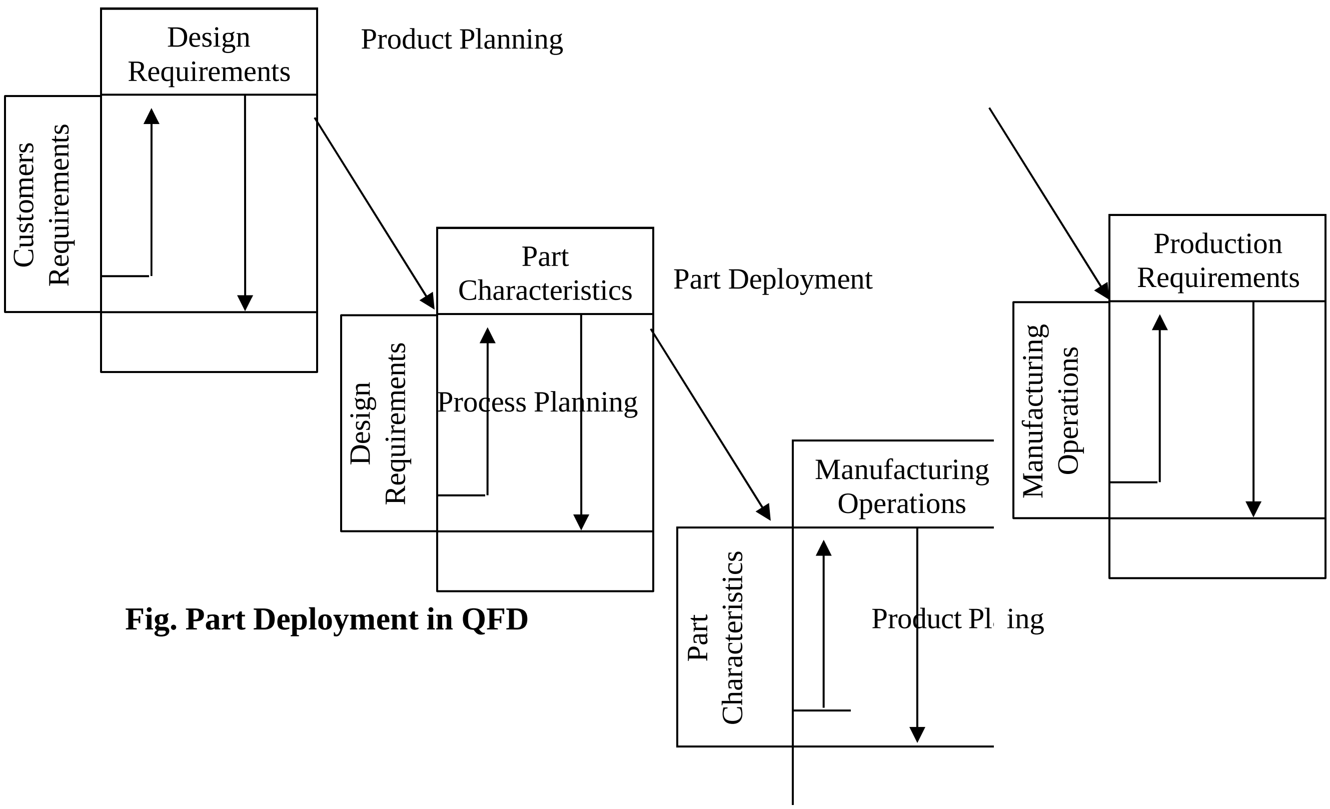

Fig. Part Deployment in QFD

Conclusion

In comparison to traditional design approaches, QFD forces management to spend more time defining the new product changes and examining the ramification of those changes. More time spent in the early stage of design means less time is required later to revise the design and make it work. This reallocation of time shortens the design-process considerably. Some experts suggest

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that QFD can produce better product designs in half-the time as conventional design processes. In summary, QFD is a communication and planning tool that:

(i) Promotes better understanding of customer demands;
(ii) Promotes better understanding of design interactions;
(iii) Involves manufacturing in the design process;
(iv) Breaks down barriers between functions and departments;
(v) Focuses the design effort;
(vi) Fosters teamwork;
(vii) Improves documentation of the design and development process for product improvement through technical benchmarking;
(viii) Increase customer satisfaction;
(ix) Reduces the number of engineering changes;
(x) Brings new design to the market faster; and
(xi) Reduces the overall costs of design and manufacture.

For the success of any organization it is very important to understand the concept of internal and external customer. The desired results can not be achieved unless internal and external customers are satisfied. Worldwide, organizations are using QFD tool for assuring that the ‘voice of customer’ is not lost in the noise of product development. In many organizations, environment is not conducive to make full use of the potential of employees. There is lack of transparency in award and recognition of the employees. Lack of using customer listening techniques like QFD is a weak area and thus customer and market focus lacks depth. Consequently, roles for all levels of management and technical staff in quality improvement based on customer perception are not developed. Need based training should be organized in QFD in Indian industry. Most company executives are still not aware about QFD and its implication on production, material and processes.

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