Product Development Techniques Implementation for Bottle Holder

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Abstract: During journey or travelling by any vehicle it is needed to carry water bottle. In such vehicle it is expected to have some arrangement for bottle holding. In some of vehicles are having certain arrangement to hold bottle but that arrangement have expressed some deficiencies like able to hold only fix size of bottle and broken after short use. Hence it is needed design robust and user friendly arrangement named as the Bottle Holder. Product designing techniques are implemented to attain robust design. Need identification can be done by Kano Model, QFD (Quality Function Deployment) approach will convert voice of customer into design parameters as well it gives competitive assessment so that drawback of existing models can be understood and rectified to have robust design. DFMA (Design for Manufacture and Assembly) can be useful to simplify manufacturing and assembly while design stage. After successful experimentation it is expected that customers will be satisfied.

Key words: DFMA, Engineering Analysis, Kano Model, Pugh Concept, QFD.

INTRODUCTION

The need of implementation of Product designing technique is to achieve the improved product having capability to satisfy customer expectations as well as improve performance over its life. Hence it is needed to identify different customer expectations, their needs, and priorities of their needs. The QFD is used to transform qualitative user demands into quantitative parameters, to deploy the functions forming quality, and to deploy methods for achieving the design quality into subsystems and component parts. The Kano Model is a useful tool in understanding customer needs . The Kano model categorizes customer needs into three groups that are basic, performance, and excitement. This model must be applied to a specific market segment. Basic needs are those that get a company in the market; they are not spoken unless violated. Performance needs are known as those that keep a company in the market. They are spoken by the customer and considered when purchasing decisions are made. Performance needs make the customer happy or unhappy, and the customer's happiness is proportional to how well the performance needs are met. The last category of needs per the Kano model are those that afford the greatest opportunity in terms of becoming a market leader or innovator. These needs are known as excitement needs. Like basic needs, excitement needs are unspoken. However, unlike basic needs, which are expected and known, excitement needs are beyond customer expectations. DFM is that by considering the limitations related to the manufacturing at the early stage of the design; the design engineer can make selection among the deferent materials, different technologies, estimate the manufacturing time the product cost quantitatively and rapidly among the different schemes. They compare all kinds of the design plans and technology plans, and then the design team will make revises as soon as possible at the early stage of the design period according these feedback information and determine the most satisfied design and technology plan.

PRODUCT DEVELOPMENT TECHNIQUES

Kano Model

The Kano model is a theory of product development and customer satisfaction developed in the 1980s by Professor Noriaki Kano, which classifies customer preferences into five categories.

Must-be Quality

One of the main points of assessment in the Kano model is the threshold attributes. These are basically the features that the product must have in order to meet customer demands. If this attribute is overlooked, the product is simply incomplete. If a new product is not examined using the threshold aspects, it may not be possible to enter the market. This is the first and most important characteristic of the Kano model. The product is being manufactured for some type of consumer base, and therefore this must be a crucial part of product innovation. Threshold attributes are simple components to a product. However, if they are not available, the product will soon leave the market due to dissatisfaction. The attribute is either there or not. An example of a threshold attribute would be a steering wheel in a car. The car is no good if it is not able to be steered.

The threshold attributes are most often seen as a price of entry. Many products have threshold attributes that are overlooked. Since this component of the product is a necessary guideline, many consumers do not judge how advanced a particular feature is. Therefore, many times companies will want to improve the other attributes because consumers remain neutral to changes in the threshold section.

One-dimensional Quality

A performance attribute is defined as a skill, knowledge, ability, or behavioural characteristic that is associated with job performance. Performance attributes are metrics on which a company bases its business aspirations. They have an explicit purpose. Companies prioritize their investments, decisions, and efforts and explain their strategies using performance attributes. These strategies can sometimes be recognized through the company’s slogans. Performance attributes are those for which more is better, and a better performance attribute will improve customer satisfaction. Conversely, a weak performance attribute reduces customer satisfaction. When customers discuss their needs, these needs will fall into the performance attributes category. Then these attributes will form the weighted needs against the product concepts that are being evaluated. The price a customer is willing to pay for a product is closely tied to performance attributes. So the higher the performance attribute, the higher the customers will be willing to pay for the product.

Performance attributes also often require a trade-off analysis against cost. As customers start to rate attributes as more and more important, the company has to ask itself, "how much extra they would be willing to pay for this attribute?" And "will the increase in the price for the product for this attribute deter customers from purchasing it." Prioritization matrices can be useful in determining which attributes would provide the greatest returns on customer satisfaction.

Attractive Quality

Not only does the Kano Model feature performance attributes, but additionally incorporates an "excitement" attribute as well. Excitement attributes are for the most part unforeseen by the client but may yield paramount satisfaction. Having excitement attributes can only help you, in some scenarios it is ok to not have them included.

The beauty behind an excitement attribute is to spur a potential consumers' imagination, these attributes are used to help the customer discover needs that they've never thought about before. The key behind the Kano Model is for the engineer to discover this "unknown need" and enlighten the consumer, to sort of engage that "awe effect." Having concurrent excitement attributes within a product can provide a significant competitive advantage over a rival. In a diverse product assortment, the excitement attributes act as the WOW factors and trigger impulsive wants and needs in the mind of the customer.

The more the customer thinks about these amazing new ideas, the more they want it. Out of all the attributes introduced in the Kano Model, the excitement ones are the most powerful and have the potential to lead to the highest gross profit margins. Innovation is undisputedly the catalyst in delivering these attributes to customers; you need to be able to distinguish what is an excitement today, because tomorrow it becomes a known feature and the day after it is used throughout the whole world. Attributes' place on the model changes over time an attribute will drift over time from Exciting to performance and then to essential. The drift is driven by customer expectations and by the level of performance from competing products.

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Uses

The Kano model offers some insight into the product attributes which are perceived to be important to customers. The purpose of the tool is to support product specification and discussion through better development of team understanding. Kano's model focuses on differentiating product features, as opposed to focusing initially on customer needs. Kano also produced a methodology for mapping consumer responses to questionnaires onto his model.

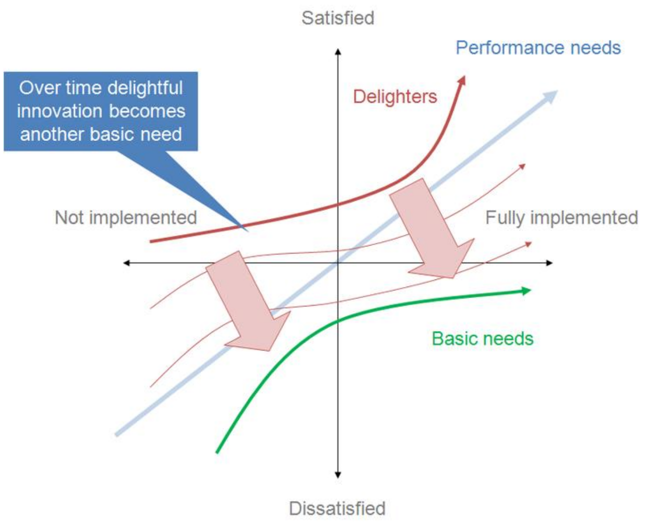

Fig 1: Kano Model

QFD Methodology

QFD utilizes a series of matrices, referred to as the House of Quality (HOQ), to translate the voice of the customer through product design and manufacture. There are four phases of the process: Phase 1-Product Planning, Phase 2-Design Deployment, Phase 3-Process Planning and Phase 4-Production Control. The HOQ provides a direct link from phase to phase. The four key elements of each HOQ are what (customer needs), how (company measures), relationship (between what and how), and how much (target value). The company measures (how) of one phase become needs (what) of the next phase. Target values (how much) are carded over from phase to phase to ensure the objective values are not lost. The cascade process continues until each objective is refined to an actionable level. In order to keep the process manageable to the next phase is necessary. In addition to the four key elements mentioned above, extensions of basic QFD are used as required for specific projects. The correlation matrix is the roof of the house and establishes the relationship between the hows. This allows for conflict identification early in the process. Conflicts can be used to generate excitement qualities since competitors may also have the conflict. A tape example is the need for high adhesion to backing and low high speed unwind. Competitive assessment, which depicts each item (either the customer needs or company measures) in terms of the current product and the competition, is another extension of the HOQ. For the customer needs (what), the customer's perception of the current product versus the competition is determined and a Customer Competitive. Assessment added to the house. For the company measures (how), an analysis of competitive products takes place and a Technical Competitive Assessment added to the house. The technical assessment can be useful in establishing values for the target values. Another useful extension of basic QFD is the addition of importance ratings for the customer needs. The ratings must truly represent customer beliefs rather than internal company beliefs; therefore, they are based on a customer assessment or prioritization. The importance ratings for the customer needs are then correlated to importance ratings for the company measures. Additional extensions include service complaints, organizational difficulty, service repairs, service cost, and regulatory and company requirements. See Figure 2 for HOQ with extensions.

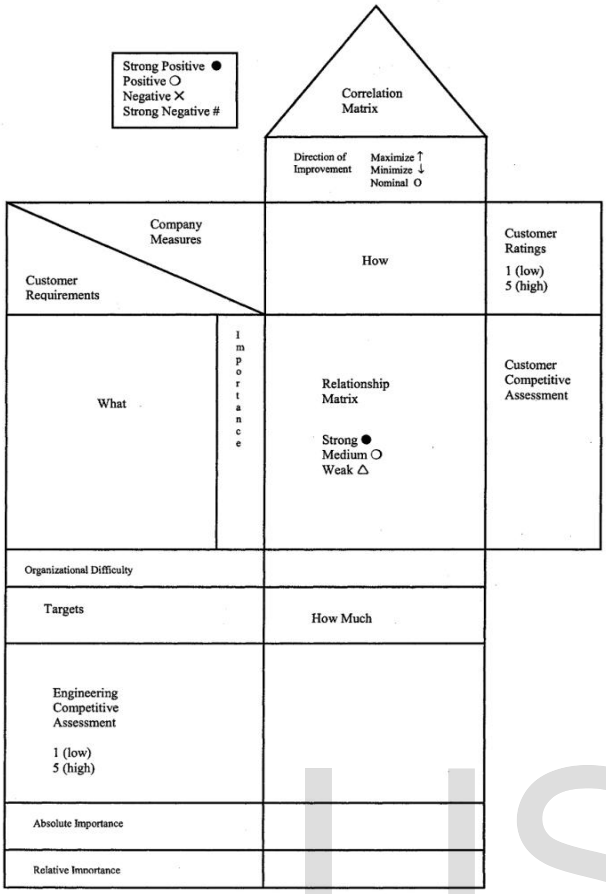

Fig 2: QFD Methodology

THE PUGH MATRIX

The Pugh Matrix (PM) is a type of Matrix Diagram that allows for the comparison of a number of design candidates leading ultimately to which best meets a set of criteria. It also permits a degree of qualitative optimization of the alternative concepts through the generation of hybrid candidates. The Pugh Matrix is easy to use and relies upon a series of pairwise comparisons between design candidates against a number of criteria or requirements. One of its key advantages over other decision- making tools such as the Decision Matrix is its ability to handle a large number of decision criteria.

Why do it?

Many decisions often concern a number of interwoven factors or criteria for which humans struggle to handle the complexity resulting in inconsistent and irrational decisions. The Pugh Matrix provides a simple approach to taking these multiple factors into account when reaching a decision. By exploiting peoples innate ability to make a pair wise comparison allows for subjective opinions about one alternative versus another to be made more objective. The Pugh Matrix also allows for simple sensitivity analysis to be performed, thereby providing some information as to the robustness of a particular decision.

Where and when to use it?

Fundamentally a Pugh Matrix can be used whenever there is the need to decide amongst a number of alternatives. Although specifically developed by Stuart Pugh to help in selecting between a number of design alternatives, the tools has in recent years be used a general purpose decision making aid because of its ease of use.

Who does it?

An individual or team can use a Pugh Matrix. It is important to emphasize, however, that the quality of the outcome is dependent upon the experience of team or individual.

How to do it?

The basic concept of a Pugh Matrix is both simple and elegant. Figure 3 shows a completed Pugh Matrix that has been used to evaluate and select from a number of design alternativesThe process for constructing a Pugh Matrix comprises five steps. This assumes that alternative candidate design options (or decision options) have been determined.

Step 1: identify and clearly define the criteria for selection. Typically when using a Pugh Matrix to select between a number of candidate design options the design requirements can be used either in part or in whole. Ideally the design requirements should reflect both the user-customer as well as other key stakeholders including internal stakeholders. The robustness and validity of the outcome is fundamentally dependent on an appropriate set of criteria/requirements. Rushing this step usually results in a nonrobust outcome that is challenged and overturned.

Table 1: Attributes of Cleveland dataset

	Alternative 1	**Alternative 2**	**...**	**Alternative *M***
Criterion 1	x_{11}	x_{12}	...	x_{1M}
Criterion 2	x_{21}	x_{22}	...	x_{2M}
...	...	...	X_{ij} = Good	...
Criterion *N*	x_{N1}	x_{N2}	...	x_{NM}
Sum				
Rank				
Status		No		No

Step 2: Use one candidate design option as the baseline and core all criteria/requirements as „S" (some people prefer to use an O) for this baseline. If appropriate, a good choice is to, use the previous design for the baseline because it exists and therefore its performance should be reasonably well known.

Step 3: Compare each candidate design option against the baseline design, criteria by criteria (or requirement by requirement) and decide a "pair-wise score with:
S = same
+ = better
- = worse
It is also possible to add extra levels of discrimination by using:
++ = much better
-- = much worse
Some people use a 1 to 5 scale where the baseline/same is a 3 with 1 and 2 being much worse and worse respectively, and 4 and 5 being better and much better respectively

Step 4: For each candidate design option the total score can be calculated by summing the number of +"s and –„s. The highest ranked score is the "winner" but use common sense do not just select "highest" ranked concept.

Step 5: Having scored each candidate design option consider hybrids by combining where possible the best from each alternative. This is form of qualitative optimization.

Step 6: Make the decision and record reasons behind decisions. Quite often with a Pugh Matrix there is no clear "winner" but there is often a clear "loser" in such cases perform a sanity check (does the decision make sense) and remove the losing option. At this point the criteria/requirements can be weighted to give better differentiation. Typically the weighting is on a 1 to 5 scale with 1 the lowes t and 5 the highest weighting. If there is still no clear winner, the matrix is basically saying that there is not enough information to discriminate between the options. In such cases it will be necessary to refine the criteria/requirements, use an alternative selection approach, perform more work to gain the information to be able to select between the options.

DESIGN FOR MANUFACTURING & ASSEMBLY

DFM is the practice of designing products keeping manufacturing in mind. "Design for manufacture" means the design for ease of manufacture for the collection of parts that will form the product after assembly. Similarly DFA is called Design for Assembly. DFA is the practice of designing product with assembly in mind. "Design for assembly" means the design of the product for ease of assembly. So design for Manufacture and assembly is the combination of DFM and DFA as shown in Fig. 3.

Steps for applying DFMA during product design

The following steps are followed when DFMA used in the design process.DFA analysis lading to simplification of the product structure. Early cost estimation of parts for both original design and modified design. Selecting best material

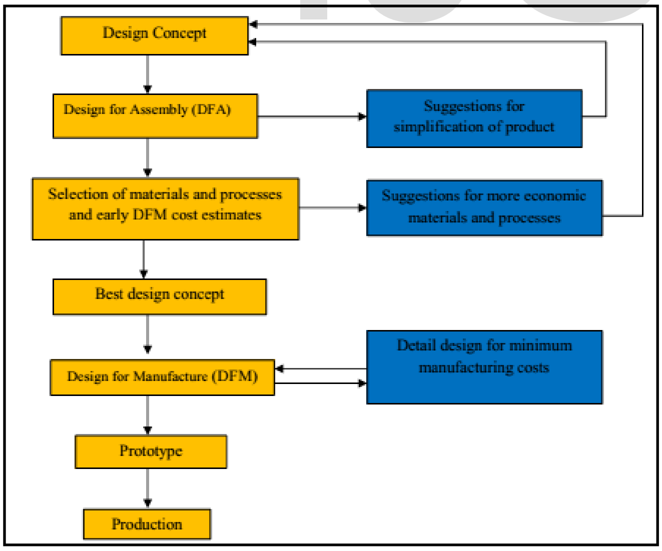

Fig 3: DFMA process

and process to be used. After final selection of material and process carry out a thorough analysis of DFM.

Today products are tending to becoming more complex and required in increasingly large number as well intended to satisfy a wide variation in user population along with required to compete aggressively with similar products that are required to consistently high quality through DFMA it is possible to produce competitively priced, high performance product at a minimal cost.

The advantages of applying DFMA during product design are as DFMA not only reduces the manufacturing cost of the product but it helps to reduce the time to market and quality of the product and provides a systematic procedure for analyzing a proposed design from the point of view of assembly and manufacture as well Any reduction in the number of parts reduces the cost as well as the inventory. DFMA tools encouraged the dialogue between the designer and manufacturing engineer during the early stages of design.

DFMA Guidelines

DFM guidelines are statements of good design practice that have been empirically derived from years of experience.

1. Minimize total number of parts:

Eliminating parts results in great savings. A part that is eliminated costs nothing to make, assemble, move, store, clean, inspect, rework, or service. A part is a good candidate for elimination if there is no need for relative motion, no need for subsequent adjustment between parts, and no need for materials to be different.

2. Standardize components:

Costs are minimized and quality is enhanced when standard commercially available components are used in design. The benefits also occur when a company standardizes on a minimum number of part designs (sizes, materials, processes) that are produced internally in its factories. The life and reliability of standard components may have already been established, so cost reduction comes through quantity discounts, elimination of design effort, avoidance of equipment and tooling costs, and better inventory control.

3. Use common parts across product lines:

It is good business sense to use parts in more than one product. Specify the same materials, parts, and subassemblies in each product as much as possible. This provides economies of scale that drive down unit cost and simplify operator training and process control. Product data management systems can be used to facilitate retrieval of similar designs

4. Standardize design features:

Standardizing on design features like drilled hole sizes, screw thread types, and bend radii minimizes the number of tools that must be maintained in the tool room. This reduces manufacturing overhead cost. An exception is high-volume production where special tooling may be more cost effective. Space holes in machined, cast, molded, or stamped parts, so they can be made in one operation without tooling weakness. There is a limit on how close holes can be spaced due to strength in the thin section between holes.

5. Aim to keep designs functional and simple:

Achieving functionality is paramount, but don't specify more performance than is needed. It is not good engineering to specify a heat-treated alloy steel when a plain carbon steel will achieve the performance with a little bit more careful analysis. When adding features to the design of a component, have a firm reason for the need. The product with the fewest parts, the least intricate shapes, the fewer precision adjustments, and the lowest number of manufacturing steps will be the least costly to manufacture. Also, the simplest design will usually be the most reliable and the easiest to maintain.

6. Design parts to be multifunctional:

A good way to minimize part count is to design such that parts can fulfil more than one function, leading to integral architecture.

7. Avoid excessively tight tolerances:

Tolerances must be set with great care. Specifying tolerances that are tighter than needed results in increased cost.These come about from the need for secondary finishing operations like grinding, honing, and lapping, from the cost of building extra precision into the tooling, from longer operating cycles because the operator is taking finer cuts, and from the need for more skilled workers.

8. Minimize the total number of parts:

A part that is not required by the design is a part that does not need to be assembled. Go through the list of parts in the assembly and identify those parts that are essential for the proper functioning of the product.

9. Mistake proof the design and assembly:

An important goal in design for assembly is to ensure that the assembly process is unambiguous so that the operators cannot make mistakes in assembling the components.

10. Avoid separate fasteners or minimize fastener costs:

Fasteners may amount to only 5 percent of the material cost of a product, but the labour they require for proper handling in assembly can reach 75 percent of the assembly costs. The use of screws in assembly is expensive. Snap fits should be used whenever possible.

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