Prioritised Engineering Design Requirements of Gas Turbine Engine by QFD

ABRAHAM MOODY K

Dept of Mechanical Engineering, AISECT University Bhopal, MP, INDIA

Abstract: *The success of product or service largely relies upon how they meet customer's needs and expectations. Thus, more effort is required in getting the information needed to determine what the customer truly needs. It is substantial as it integrates the voice of the customer t in design henceforth it is likely that the final product will be better designed to satisfy the client's needs. The case study executing QFD demonstrates product design and development technique that compares and the fit between customer t needs and product features .Using this technique permitted to keep a client focus, decrease in product cycle , increment in consumer satisfaction and cost reduction .*

1 INTRODUCTION:

To compete and exists in the global market, companies need to focus ate on the needs of the consumer and offer them quality products or services approach satisfying their greater expectations. Therefore, they require an management system that motivates the continuous development their operations and products. Firms must perceive the quest for alluring results through these endeavours as their critical management objective. To these reasons many companies changing their business operations from a product oriented approach to market oriented approach[1] QFD is method for structured planning as "an efficient and customer- focussed approach for distinguishing and planning customer 's requirements, making an interpretation of these requirements into product/benefit details, and following them all through the product realization process" [2].

QFD is a technique for structured product planning and enables a development team indicate clearly the customer's wants and needs, and after that to assess each proposed product or service capacity systematically in terms of meeting those needs [3]. The primary purpose behind this is the combination of individuals required to manufacture the resulting grids, will utilize 80 % of a company's representatives [4].

QFD utilizes a few standards from Concurrent Engineering in that cross-utilitarian groups are associated with all periods of product development. Each of the four stages in a QFD procedure utilizes a lattice to interpret client needs from starting arranging stages through generation control [5] an observational investigation directed by [6] inside the United Kingdom (UK), recognized numerous QFD usage issues among the organizations overviewed. The outcomes demonstrated that there was an issue in western organizations related with working groups, Issues in keeping up a promise to the technique and an inadmissible "organizational culture" were likewise featured.

Besides, it gives a more insight into the whole design and manufacturing operation (from concept to manufacturing) and it can significantly enhance the proficiency as generation issues are settled ahead of schedule in the plan stage .Quality Function Deployment (QFD) is an planning tool used to satisfy client desires. It is a trained way to deal with product plan, designing, and manufacturing and gives inside and out assessment of a product .QFD determines what level of performance to be delivered intelligently relating the necessities of the customer with a specific design , development , engineering , manufacturing and service capacities of an organization [7].It means that this tool is setup with considering within industrial realities and the customer s' needs and interest towards the product or service rendered, [8]. As indicated by an investigation by [9] the two most critical factors that decide the QFD's successful use in giving definite strategic product development benefits are the high commitment of all team members in every utilitarian territory.

The most-utilized QFD methodology beyond the HoQ is the conventional manufacturing based QFD, which is sent through a four-staged sequence [10].

The use of the same component in multiple products can be defined as component standardization [11].

2 QFD METHODOLOGIES:

QFD is a method for requirements engineering resulting from the quality development in the 1980's. QFD is characterized as "a methodical and customer-focus design approach for identifying and prioritizing customer needs, making an interpretation of these necessities into item/benefit determinations, and following them all through the item acknowledgment prepare" [2]. The QFD tool gives a graphical system to deciding client desires. The QFD as a rule will show to the included people how the requirements and desires of the customers are satisfied. These instruments additionally show how the clients' advantages are paralleled with the organizations' advantages. There are six fundamental components of QFD, which are.

1. Deciding the customer's requirements QFD (WHAT)
2. Meeting HOW the prerequisites can be accomplished QFD (HOW) of the clients are basic to conclusive item control.
3. Connection between the requirements and HOW they are to be met

4. Target values for the requirements
5. Connections between how the prerequisites are to be met
6. A quantification of the importance of the requirements

Case Study –Quality Design Performance of Gas Turbine Engine

[12] The objective of this investigation is to provide a framework for identifying Potential platform elements from among key system design variables. The proposed structure is approved with a contextual analysis of commercial gas turbine engines.

From the perspective of an air transportation vehicle, the gas turbine engine is a subsystem of an airplane system.

All airplane engines have the same basic functionality of producing thrust to propel an airplane into the air and over a design range with a specified payload. Some secondary engine functions that support airplane functions include providing cabin air, electrical power to airplane systems, and pressurization for airplane hydraulic systems through airplane/engine interfaces.

Customer Requirements

1) Rugged Design	CR1
2) Long life	CR2
3) Extended Overhauls	CR3
4) High Availability	CR4
5) Quality assurance	CR5
6) High Reliability	CR6
7) Low Maintainability	CR7

Engineering Design Requirements

Power Output	EDR1
Engine speed	EDR2
Max service life	EDR3
Low sfc Consumption	EDR4
Exhaust pollution	EDR5
Noise	EDR6
C C Efficiency	EDR7

S.No	Customer Requirements	Design Reqiuirements
1	Rugged Design	Power Output
2	Long life	Engine speed
3	Extended Overhauls	Max service life
4	High Availability	Low sfc Consumption
5	Quality assurance	Exhaust pollution
6	High Reliability	Noise
7	Low Maintainability	C C Efficiency

Fig 1: Customer Requirements and Engineering Design Requirements.

3 CONSUMER SATISFACTION RATINGS

Importance to Customer

[13] The QFD group—or, ideally, the concentration gathering—positions every client necessity by allocating it a rating. Numbers 1 through 10 are recorded in the significance to client column to demonstrate a rating of 1 for weak and 10 for strong. As such, the more critical the client need, the higher the rating.

Target value

The Target Value column is on an indistinguishable scale from the customer competitive evaluation (1 for most exceedingly bad, 5 for best can be utilized). This segment is the place the QFD group chooses whether they need to keep their item unaltered, enhance the item, or improve the item than the opposition.

Scale-up factor/development ratio

The scale-up factor is the proportion of the objective incentive to the product evaluating given in the customer focused appraisal. The higher the number, the more effort is required. Here, the essential thought is the level the product is at now and what the objective rating is and choosing whether the identification is within. In frequently there isn't a decision on account of difficulty in finishing the objective. Subsequently, The Sales Point tells the QFD group how well a customer requirement will offer. The aim here is to advance the best customer requirement and any outstanding client prerequisites that will help in the offer of the item.

Table 1: Customer Requirements, Target value and Absolute Weight.

S.NO	Customer Requirements	Importance Rating	Sales Point Rating	Target Value	Scale-up Factor	Absolute Weight
1	Rugged Design	5	2	5	1	10
2	Long life	5	2	5	1.66	16.6
3	Extended Overhauls	4	1.5	4	1.33	7.98
4	High Availability	4	1.5	4	2	12
5	Quality assurance	2	1	2	1.66	3.32
6	High Reliability	4	2	3	1.66	13.28
7	Low Maintainability	3	1.5	3	1.66	7.47

The Sales point

Sales Point is controlled by identifying the customer needs that will help the offer of the product. For example, an aerodynamic look could enable the offer of the product so the business point is given an estimation of 1.5. On the off chance that a client requirement won't help the offer of the product the business point is given an estimation of 1.

Absolute weight

Absolute weight = Importance to customer × Scale-up factor × Sales Point

House of Quality

Table 2: Interrelationship Matrix of CR and EDR of Gas Turbine Engine

Interrelationship Between Design Requirements (Correlation matrix) HOWs vs HOWs

Engineering Design Requirments (HOWs)

WHATs vs HOWs

Relation between Customer Requirements Design Requirements

+9 Strong
+3 Medium
+1 Weak

Customer Requirement (What)

Technical Parameters	Importance Rating	Pow er	Engine speed	Max service life	Low sfc Consumption	Exhaust pollution	Noise	C C efficiency	Own company	Competitos form 1	Competitors form 2	Importance to Customer	Sale Poit Rating	Scale-up Factor	Absolute Weight Percent	Rank
Rugged Design	5	9	9	9		3	9	9	5	3	4	5	2	1	10	4
Long life	5	3	3	9		9			5	4	3	5	1.5	1.66	16.6	1
Extended Overhauls	4	1		3	3	3	3	3	4	2	3	4	1.5	1.33	7.98	5
High Availability	4	9	3	9	9	9	3	9	3	3	4	4	1	2	12	3
Quality assurance	2			1	9		3	9	4	3	3	2	1	1	3.32	7
High Reliability	4		9	3		3	9	3	3	4	3	4	1	1.66	13.3	2
Low Maintainability	3	1	1	3	3	9	3	3	3	2	2	3	1.5	1.66	7.47	6
Technical Competitive Assesment — Our Product		5	4	3	4	3	4	5								
Technical Competitive Assesment — A's Product		3	3	3	4	3	2	2								
Technical Competitive Assesment — B's Product		3	3	2	3	2	2	3								
Degree Of Technical Difficulty		9	7	9	6	8	5	4								
Target Value		5	5	3	4	3	3	5								
Absolute weight percent		103	111	161	75	147	120	132								
Relative weight percent		264	301	439	184	421	302	293								
Rank		6	4	1	7	2	3	5								

Our Product | A's Product | B's Product | Customer Competitive Assesment

Prioritized Customer Requirements

4 ANALYSES:

As showed by Customer Satisfaction for quality product, investigation house of quality for has been shown in Table 1. The working of The HOQ covered the following stages. The significance of demands of customer has been assembled.

[14] & [15] the span of the centrality of has activity at Customer with His Requirements has been analyzed. Fulfilled ask for of client have been dispensed to relating parameters of product. Level of technical difficulty, the examination of estimation achieved by client is shown. Comparison between organization's item and focused item, in perspective of specialized parameters appeared in. Organized Customer Requirement (target value, scale-up factor, sales point, absolute weight and percent) are evaluated Table 2.

5 CONCLUSIONS :

The Absolute weight rating for each Design Requirement is dictated by taking the dot product of the column in the relationship matrix and column weight for importance to customer the greater value of Absolute weight rating for Design Requirement is Maximum Service life demonstrated that 161 in the Table 2.

The Relative weight for each Design Requirement is dictated by taking dot product of the column in the relationship matrix and Absolute weight, the greater value for Design requirement is Maximum Service life i.e. 439 in the table 2.

The Prioritised Customer Requirement is Long life

The Prioritised Engineering Design Requirement is Maximum Service life

Investigations uncovers that the House of Quality recognizes the basic Engineering Design Requirements that requires a change. The Top Ranking of the Customer Requirement is Long life, High Reliability, Rugged Design and Extended Over hauls.

And Top Ranking of Design Requirement Maximum is Service life, Exhaust pollution, Noise, Engine speed can be seen in Table 2.

REFERENCES:

[1] Lai, K. H, Market orientation in quality- oriented organizations and its impact on their performance. International Journal of Production Economics, 84 (1), 17-34, 2003.

[2] Davis, G., Zannier, C. and Geras, A. "QFD for Software Requirements Management", PowerPoint Presentation, www.adamgeras.com, last accessed: June 2006.

[3] Cohen, Lou. Quality Function Deployment. Addison Wesley. 1995.

[4] Amos, L, QFD in theory & practice, unpublished undergraduate research project. University of Birmingham, UK, 1997

[5] Akao, Y., ed. Quality Function Deployment, Productivity Press, Cambridge MA, Becker Associates Inc (Becker Associates Inc, 2002.

[6] Martins, A. and Aspinwall, E.M. Quality function deployment: an empirical study in the UK, Total Quality Management, Vol.12, No.5, pp. 575-588, 2001.

[7] Joseph P. Ficalora, Louis Cohen Quality Function Deployment and Six Sigma, A QFD Handbook, 2nd Edition, 2012 by Prentice Hall. ISBN-10: 0-13-336443-7.

[8] John Terninko, Step-By-Step QFD: Customer-Driven Product Design, CRC Press; 2nd Edition, 1997.

[9] Griffin, A. and Hauser, J. "The Marketing and R and D Interface", ISBM Working Series 14, P.4, 1994.

[10] Sullivan, Larry P., Quality Function Deployment – a system to assure that customer needs drive the product design and production process, Quality Progress. June, 1986, pp. 39- 50.

[11] Ulrich, Karl, the Role of Product Architecture in the Manufacturing Firm, Research Policy, 24, pp. 419-40, 1995.

[12] Habs M. Moy Commercial Gas Turbine Engine Platform Strategy and Design Massachusetts Institute of Technology February 2000.

[13] Dale H. Besterfield, Carol Besterfield-Michna, Glen H. Besterfield, Mary Besterfield- Sacre, Hermant Urdhwareshe, Rashmi Urdhwareshe "Total Quality Management", Perason edision ,Revised Edition 2011

[14] Abraham Moody K Abraham Moody K, R.R Lal and Vijay Pandey, Analysis of Customer Oriented Product Development with Quality Function Deployment, International Journal of Mechanical Engineering and Technology, 8(5), 2017, pp. 270-279.

[15] Abraham Moody K K Quantification of prioritized requirements of steel product with QFD Analysis International Journal of Mechanical and Production Engineering Research and Development (IJMPERD) Vol. 8, Issue 1, Feb 2018.337-444.