

A COMPARISON OF GRAPHICAL OUTPUT FOR PRODUCT PLANNING USING QFD SOFTWARE MODEL AS A TOOL

Thesis submitted in partial fulfillment of the requirements
for the award of the degree of

**MASTER OF ENGINEERING IN MECHANICAL ENGINEERING
(INDUSTRIAL ENGINEERING)**

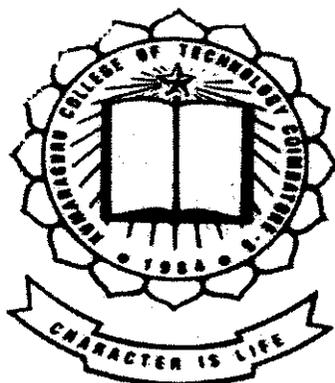
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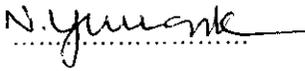
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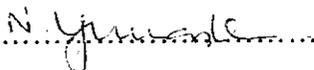
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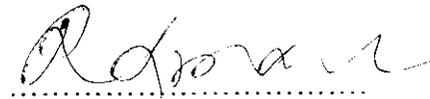
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CERTIFICATES

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This is to certify that this thesis work entitled "A COMPARISION OF GRAPHICAL OUTPUT FOR PRODUCT PLANNING USING QFD – SOFTWARE MODEL AS A TOOL" being submitted by T.PRABHURAM (Reg.No 0137H0012) for the award of DEGREE OF MASTER OF ENGINEERING IN MECHANICAL ENGINEERING (INDUSTRIAL ENGINEERING) is a bonafide work carried under my guidance. These results embodied in this thesis have not been submitted to any other University or Institute for the award of any degree or diploma.



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DEDICATED
TO MY
BELOVED PARENTS

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T.PRABHURAM.

SYNOPSIS

SYNOPSIS

Quality is a key to a nation's economy. The developments of Science and Technology have been Successful in providing customer with better and more consistent quality products. Now Quality control is an integrated approach to the quality function in an organization. The basic objective of quality function is to satisfy the customer wants and needs with optimum quality cost. This can be achieved by making continuous improvement of the product/service throughout.

There are various tools for continuous improvement of product/service. This project concentrates on one of the tools – Quality Function Deployment (QFD). The aim of this project is to make a software model with necessary graphical outputs for the QFD process and to check the validity of the developed software.

To check the validity of the software, case studies are made in both production and service industry. Case studies are made and its results are analysed based on the output of this software package.

This project deals with the introduction to QFD process, Structure of QFD, Software model for QFD and case studies with results and discussions.

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CHAPTER - 1

INTRODUCTION

1.INTRODUCTION

1.1 Introduction to Quality Planning

“ Building things right is only a part of the battle. Building the right thing is just as important and only the customer can tell that ”

For most part of Industrial era, manufacturer has believed quality to be controllable at the shop floor. The first generation of quality activities concentrated on inspection. The focus was the final product, with the objective of meeting product specifications. The motto was “ Control quality of the product”

The next generation of quality activities took a step backwards, recognizing the importance of the product process. Customers demanded better quality products at lower costs and companies realized that inspecting quality was no longer economical. Manufacturers began using statistical process control (SPC) to prevent defects. The objective was to meet specifications by controlling reducing or eliminating variations in the process. The motto in this second generation of Quality activities was “ Build Quality into the product”

Manufacturers has now entered a new era; a post – industrial one characterized by increasing complexity, uncertainty and change. Success in this environment will depend upon manufacturers ability to anticipate markets and to design and produce products that provide high value to the customers. The quality activities of the previous generations assumed product specifications to be accurate translations of customer needs. In reality they were more the engineers or designers perception of customer needs.

The third generation of quality activities, focuses on the first step in a product life cycle, the design and development stage to get the product as process right from the beginning. The new motto being “ Design quality into the product ”.Customer needs all activities, and the “ voice of engineer ” is replaced with “ voice of the customer “.

Quality Function Deployment (QFD) is one of the emerging techniques at this new environment. The market place of the future will belong to companies that get credible new products faster than anyone else. QFD, appropriately applied is a powerful tool for product development that can make an organization more responsive to the needs of the customers.

QFD differs from traditional quality tools. It doesn't refer to quality in the narrow sense of statistical conformance to product specifications. Rather, it means quality in the sense of “ Every good thing the product can be “, from the point of view of both product producer and product user.

1.2 Linking a Company with its customers.

Businesses are usually started because their founders recognize a customer need and believe that they can satisfy it better than other companies. They may offer a highly innovative service or product. At the time of its introduction it may be essentially unique to the industry. Initially, the product or service they offer is highly competitive because of this advantage. No matter how effectively a company meets the initial needs of its customer, it must remain constantly alert and responsive to its customers continuing wants and needs. If the company is not responsive to these changing needs, the passage of time will erode its early advantages.

Most of the companies have not made an aggressive effort to understand their customer's wants and needs. Many companies depend on their warranty programs, customer complaints, and inputs from their sales staffs to keep in touch with their customers. The result is a focus on what is wrong with the existing product with little or no focus on what the customer wants and expects in new product offerings. Furthermore, without the benefit of the customer surveys, companies have little idea about how customers rate their company and how they rate the performance of their competitors.

Determinations made from sales and marketing inputs are usually based on conversations rather than any structured and consistent questioning approach. They are essentially random responses and can be highly misleading. The complaints about existing products represent the dissatisfaction of the customers with the existing products features, performance and service. However, correcting the problem does not provide assurance that the customer will repurchase the product or recommend it to others. Furthermore these

complaints provide little insight what the customer really wants and needs in a product. They simply reflect what the customer dislikes in the present product or service.

Many companies have experienced the agonizing problem of introducing a new or revised product that did not meet with the customer acceptance. Because the products are planned and brought to market without a real firsthand knowledge of the potential customer's wants and needs. The products designed without knowledge of the potential customer's requirements will frequently fail to satisfy their needs.

To ensure continued business success, every company should have processes to constantly monitor and update its knowledge of its customers wants needs and level of satisfaction. Failure to properly understand the customer's voice – their wants and needs, the introduction of new product is often disappointing. Also redesigning the product will lead to more expensive and time consuming. For small companies, this can represent a major investment to monitor the customer voice. So a methodology should be adopted for this purpose. The Quality Function Deployment can be used as a suitable methodology for monitoring of customer voice.

The QFD employs the customer's wants and needs as its basic inputs. The customer wants and needs become the drivers for the development of requirements for the new or revised product or services. The companies decided to use QFD method find that they must determine the customer voice and examine its response to this voice through an organized team approach. In effect this links the company with its customers.

CHAPTER - 2

LITERATURE SURVEY

2.LITERATURE SURVEY.

When Customers are more Quality Conscious, the concept of quality emerged and thus statistical quality control came into existence. P.R.Lakshmi kantan [9], suggest Six-sigma concept as a business quality strategy in successful companies. Because Six sigma is a concept which starts and ends with the customer. In six sigma approach the fundamental reasons for problems are fathomed so that pinpointed corrective action can be initiated.

Ayob Amed Wali[10], expresses that in the present context of Globalization of economy, Indian organizations face challenges, which didn't exist before when there was not much emphasis on quality of products, systems and procedures. After the "liberalization process, customer focus has become importance for the very survival of any organization. He conducted a case study to explore quality initiatives in one of the Agro processing products manufacturing organization. He used the questionnaires technique for his study. Imperatives for quality initiatives are to maintain /sustain competitive edge, streamline processes and cut down costs. Ability to meet customer needs understanding of the organizational processes and ability to reduce waste have been considered most important in their quality improvement journey.

R.P.Saxena [11], made a case study to understand the customer behavior. The purpose is to understand the customer and to create customer. He made an attempt to understand the reference group that influences the buying behavior of car and scooter. The survey done to the owners by some questionnaires. As a result he says the reference group have greater influence on buyer behavior in purchase of both car and scooter. So the reference group people should be satisfied with our products.

M.A.Sahaf[14], suggest the Integrated strategy of four C's will help for management of customer defection. Firms spend time and effort on acquiring customers. It is perhaps even more important, to devote effort to customer retention. Customer retention helps a firm to increase its profitability and understand consumer preferences and needs. To keep customers delighted, the marketers should use differential marketing formed by integrating four C's- Cooperative spirit, Customization, Customer service and customer value.

To manage customer defection a co-operative spirit between the marketers and customer is essential. He says that the customer retention rate can have a dramatic impact on boosting the profit of an organization. As the customer becomes conscious of his position in the market, his preference and needs become more complicated and demanding.

S.S.Mahpatra[8], explains that application of Total Quality Management (TQM) in manufacturing organizations is a way of life these days. He says that the implementation level of TQM principles in service sector is not encouraging due to lack of identification of end customers as in the case of educational establishments. He made a study to define the customers in an educational setting and to apply QFD an important tool of TQM, for collecting the voice of the customers. QFD process enables to translate the voice of customer into system design requirements and provides valuable information that helps policy makers to assess the existing system and adopt new policies to have competitive edge in the market place. He also made a case study in an educational establishment demonstrate the application of QFD method.

By using QFD method, a complex process becomes manageable and vital information is obtained from problem development through issue resolution. QFD is quality assurance system that helps to ensure that the voice of customer is clearly heard and followed in the development of a product or service. He[8] concludes that one should not be content with one time study. QFD serves as a powerful process, which is highly successful in eliciting the strengths and highlighting areas that require attention. The steps for improvement should be practiced for overall improvement of the education setting.

Gary A Maddux[5], have analyzed the QFD as a strategic planning tool in organizations. The QFD can be used successfully as a strategic planning tool for the design of an intangible product such as program or activity. He refers QFD as a system for designing a product or service based on the customer demands and involving all members of the producer or supplier organisation. QFD's three fundamental objectives are to identify the customers, what the customer wants and how to fulfill the customer's wants. He describes tat QFD can be used to formulate strategies for the management of programs. It combines the qualitative knowledge of management and customer, and the means to quantify these findings to justify decision making of the many new tools currently available to support the decision making process, QFD may offer the biggest 'bay for the back" of them all.

Chia-hao chang [4], discussed in his paper, Quality Function Deployment and its importance to become competitive in the market. He has classified the customer requirements into two types such as primary requirements and secondary requirements. The relationships of the requirements are identified and its strengths are analysed with respect to quality features. The counterpart characteristics are generated based on customer specified quality features. He

proposed an integrated total quality information system involving the QFD. The QFD have changed dramatically from providing defect free products to customer driven or desired products.

Johnson A. Edosomwan[6], discussed in his paper the three levels of customer. They are self-unit customer, the internal customer and the external customer. He suggested a model called "PEAD" for improving the quality of the products. Dilworth Lyman and Ken Richter analysed the teams, personality types and QFD to promote clarity and understanding of problems for sound, pragmatic and robust design for quality. Robert Hales [7] had attempted to stress the need for using this powerful tool QFD to implement simultaneous engineering philosophy.

Though the QFD focused on new product development in an engineering environment, the QFD technique is equally at home on product improvement efforts and even when developing a manufacturing approach organisation that use QFD, successfully prepare numerous matrices for the product-concept development phase, detailed design work and various phases of production. The approach is the same focus on the customers needs and expectations and develops everything else in a manner that optimally satisfies these needs and expectations [15].

The first application of QFD was at Mitsubishi, Heavy industries Ltd., in the Kobe Shipyard, Japan in 1972. After four years of case study development, refinement and training, QFD was successfully implemented in the production of mini-vans by Toyota. Dr.Clausing of Xerox first introduced QFD in the United States in 1984. QFD can be applied to practically any manufacturing or service industry. It has become a standard practice by most leading organizations, who also require it of their suppliers [22].

M.L.Single [12], describes in his paper, The computer-communications technology is an all pervasive organizational phenomenon in the contemporary business environment. Seeds of technology, which were sown in the Indian economic soil about 10 years back have nurtured into full trees. The question of "What we can do with IT" is likely to assume greater significance as compared to "What IT can do for us". Innovation in use of this technology will be the most pertinent issue in management of IT. The author takes stock of the impediments in the exploitation of IT and suggests some measure to combat these limitations. He also evaluates How IT can be leveraged for supply chain management towards gaining competitive advantages and highlights the role of emerging technologies such as geographical information system.

"Emerging IT based solution will be marked by the "new" fusion of information technology and telecommunications [12]. "IT can become an effective driver, facilitator and coordinator of business processes. In public administration, IT can play a pivotal role facilitating better levels of service.

The websites [1],[2],[3] are the important website for quality area. In this information's about quality events, details regarding the development of quality function deployment are given with live/recent examples.

The author presented the QFD analysis approach and several QFD advantages in this project. These include identifying customer needs and expectations, determining how to meet them, defining quantified goals and methodologies for identifying and resolving conflicting requirements. One of the advantages of QFD analysis is that it deploys the "voice of the customer", and forces product-development teams to focus on customer needs and expectations not just what the developers feel is important. As mentioned QFD is relatively

advanced TQM concept and is probably best employed when used in conjunction with other previously implemented TQM disciplines such as Quality measurement, Taguchi design of experiments, Statistical Process Control and others.

Quality Function Deployment has been used worldwide since 1966 by the organisation to bring new products to market faster, better and cheaper. The earliest QFD models focused on assuring quality in the factory so that production process would process would deliver goods as designed. As early QFD adopters became proficient with the methodology their improvement focus moved upstream in order to improve the quality of the designs themselves. In recent years, QFD has continued this upstream move towards improving the quality of understanding the customer requirements that drives the design. The latest tools and techniques, called voice of customer analysis, are the subject of this project.



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CHAPTER - 3

OBJECTIVES

3. OBJECTIVE

3.1 Introduction.

Many of the companies don't have a well-defined new product development process. They used to copy the market block busters products, which will not meet the customers needs and wants and lead to a failure of the product. A lack of well-defined product development process in R&D can be a root cause for the ruination of the company. The company can achieve only when the product satisfy the needs and wants of the customer.

3.2 Problem Definition.

Now a days all the manufacturing and service industries are in a situation to survive in global competition. They have to work towards the customer satisfaction. But they often fail to bridge the gap between the customers wants and delivery of goods and services, and they are bound to face the problems.

In product development process the customer wants and needs are not actually taken into account. It is very difficult to get all requirements of the customers and to satisfy their needs unless we have a right tool. There has been lack of available tools that makes this process easier and faster. Some of the tools need more processing time and costly.

Hence it is considered above as the problem and an attempt is made to use the Quality Function Deployment (QFD) as an appropriate tool for product development and for continuous improvement. A cost effective software package is the need of the hour to automate the process of QFD.

3.3 Aim of the Project.

- ✎ To develop a user friendly software package with necessary graphical output for simplifying the process of product planning process.

- ✎ To verify the efficiency of the software package for various products by conducting case study.

- ✎ Reduce the cycle time and cost incurred for product development process.

- ✎ To meet the customer requirements through continuous improvements.

CHAPTER - 4

METHODOLOGY

4. METHODOLOGY

4.1 Introduction.

Quality Function has been chosen as an efficient tool to solve the problem described in previous section. Because the QFD employs the customer wants and needs as its basic input. If the companies could be encouraged to use QFD as a methodology during product development, It would force them to listen to their customers. Thus many companies would be put in touch with existing and prospective customers and the knowledge gained would help them develop more competitive, state-of- the-art products for their markets.

QFD is a process that puts companies in touch with their customers and helps them develop products that are more customers oriented and responsive. QFD provides a formal process to understand user needs and to weave these needs across the entire product development cycle including manufacturing. Also it is a process to increase competitiveness and develop a base of satisfied customers.

For many industries threatened by global competition, this level of customer focus and response is necessary for survival. IT advancements will be used to automate the QFD tool to visualize the positive and negative points or aspects of play with graphical output.

4.2 What is QFD.

QFD is a practice for designing your process in response to customer needs. QFD translates what the customer wants into what the organization produces. It enables an organization to prioritize customer needs,

find innovative response to those needs and improve process to maximum effectiveness. QFD is a practice that leads to process improvement that enable an organization to exceed the expectations of the customer.

QFD is very systematic and organization approach of taking customer needs and demands into consideration when designing new product and service or when improving existing products or services.

QFD is also known as customer-driven engineering because the voice of the customer is diffused throughout the product development life cycle. QFD is a planning tool that defines a process for developing products or services.

4.3 History of QFD

QFD was originally developed in Japan and used at the KOBE SHIPYARD in the 1960^s. It's use spread throughout Japan, and it is still widely used there in both manufacturing and service settings. Xerox originally brought QFD to the United States in the MID-1980's. It has not yet achieved wide scale adoption in the United States, but it is being used by both manufacturing organization such as HEWLETT-PACKARD and service organizations such as St. Clair hospital in Pittsburgh, Pennsylvania).

QFD is an approach to design of equipment and was introduced in Japan in 1966 by YOJI AKAO. In October, 1983 he introduced QFD to the US., through the monthly journal of the American Society of Quality. Today QFD is a major force in the effort of quality management in US.

In 1978 AKAO edited a textbook, which led to a major increase in the use of QFD. In the early 1980's AKAO integrates QFD with value Engg., through his research he also integrated QFD with new technologies like reliability Engg., and neck engineering.

Toyota used the technique in developing automobiles and from Toyota it spread to the American automobiles industry, most notably Ford Motor company. QFD is now making headway in other high-technology areas. QFD began as an engineering tool to ensure that the development process resulted in a product meeting consumer needs and expectations but because it does so, it also provides strong marketing advantages to those organizations choose to use it.

4.4 Structure of QFD

The QFD uses a matrix format to capture a number of uses pertinent and vital to the planning process. The matrix presents an outline form, which permits the organization to examine the information in a multidimensional manner.

The structure of the QFD matrix is shown in fig. The QFD matrix has two principal parts. They are.

- ✎ The customer information portion

- ✎ The technical information portion.

A BASIC QFD MATRIX SHOWING THE VARIOUS COMPONENTS:

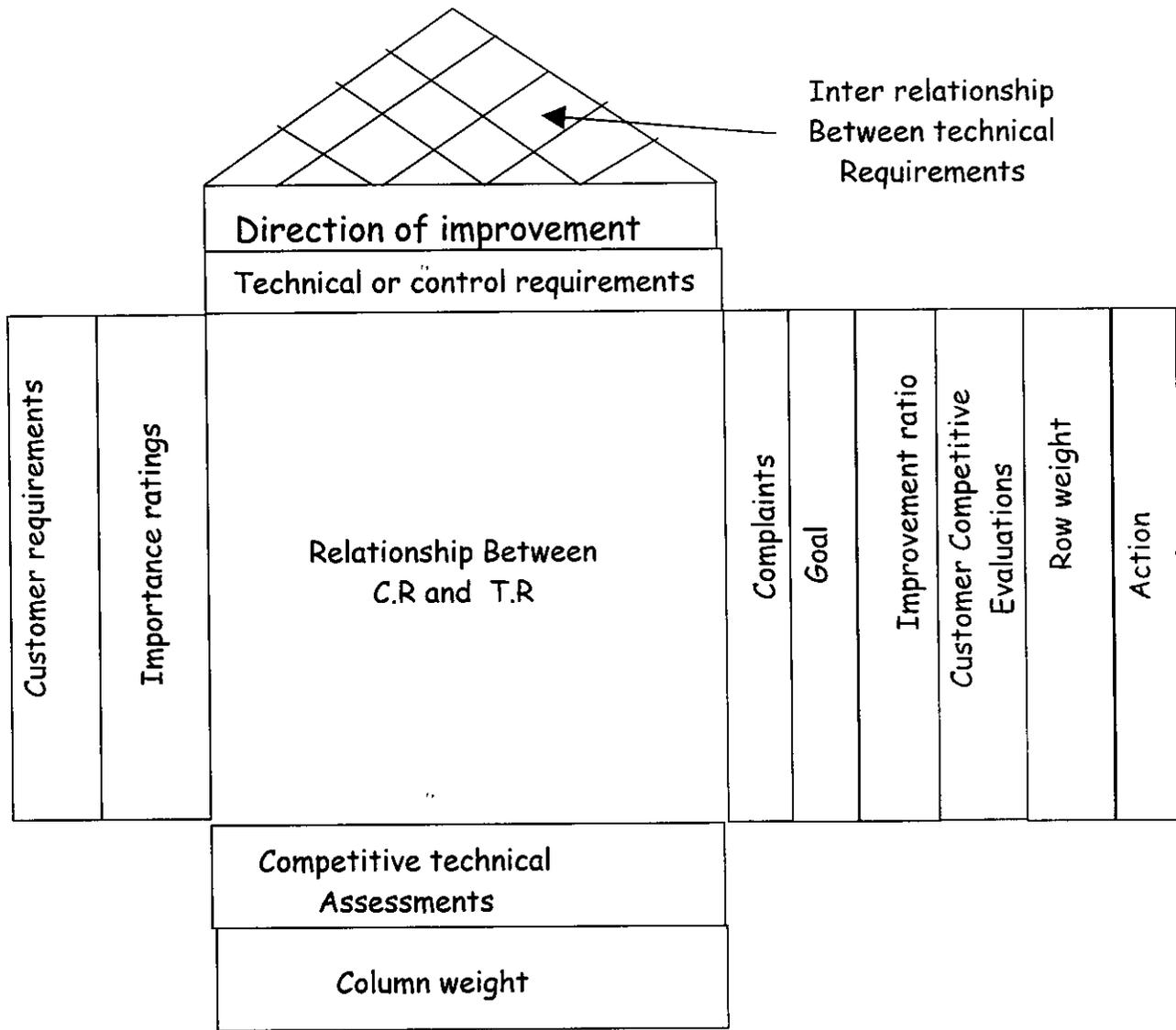


Fig.1. House of Quality.

4.4.1 Developing QFD matrix – The customer information portion.

The horizontal portion of the matrix shown in fig.1 contains information relative to the customer and is known as the customer portion. The voice of the customer is the basic input required to begin QFD project. The customer expresses their wants and needs in their own languages. Companies have to change these customer's words into language that they can use internally to describe and measure the item. The customer voice can be obtained by some approaches like focus groups, Interviews, mail questionnaires, product clinics, murmurs, observations and root wants.

Importance ratings:

The customer importance rating is a measure of the relative importance that customers assign to each of the voices. A scale of 1 to 9 is used to rate the voices. Here 1, representing low importance and 9, representing high importance.

Complaints:

These represent cases in which customers have taken time to write or call the company to express their dissatisfaction with the product or service. Any complaints that customer have personally registered with the company serve as an indication of dissatisfaction. Thus, they help punctuate the importance of specific voices. This information helps to determine which of the customer voices are the priority issues for the company.

4.4.2 Developing QFD matrix – The technical information portion.

The first step in beginning the technical portion of the matrix is the translation of the customer voices into technical requirements. The voices must be translated into the type of language that company uses to describe its products for decision, processing and manufacturing. The technical requirements are placed across the top of the matrix.

Relationships:

The center of the matrix where the customer and technical portions intersect provides an opportunity to record the presence and strength of relationships between these inputs and action items. These relationships are found based on the test results that conducted from customers. The decisions are recorded in the matrix using symbols and numerical digits. The values 1,3,5 are used to indicate weak, moderate, strong relationship respectively. The various symbols used are given as

 - For weak relationship

 - For moderate relationship

 - For strong relationship

..

4.4.3 Reviewing the matrix for priority items

Goal:

It is used to record the results of team's judgment concerning the customer satisfaction goals for the new product. For example the goal of 4.5 means that the team believes its company should strive to improve this requirements. So that the customer evaluation of the new product would average 4.5 on the 1 to 5 scale in using a column for goals. Some managers still have a mindset that to establish a target less than the maximum represents some form of weakness for the organization. If the organization's personality is such that establishing any goal less than 5 would be judged as improper, then there is no value in using this column.

Sales point:

This should be used to highlight those rows in which action to improve the product can provide a competitive edge. In these cases, the company can advertise this competitive edge. The advertising should have a significant effect because these items had high levels of importance coupled with current low to moderate customer competitive evaluations. An arbitrary weight can be assigned to the presence of sales point and used in calculation of the row weight.

Improvement ratio:

It is a calculated measure representing the scope of the improvement required to achieve the goal shown in the goal column.

$$\text{Improvement ratio} = \frac{\text{Goal}}{\text{Customer competitive evaluation ratings}}$$

The improvement ratio is 1, then no further improvement action is required.

Row weight:

It is the product of three columns such as the customer level of importance, sales point and the improvement ratio.

$$\text{Row weight} = \text{Importance} \times \text{sales point} \times \text{Improvement ratio.}$$

These row weights can help an organization evaluate the relative significance of rows. These can assist a team by lending some quantitative value to use in conjunction with judgments about competitive evaluations complaints and other data such as marketing and sales trends and changing special issue and demographics.

Action:

The action column represents priorities for increasing customer satisfaction with the next generation of products. Action column is filled with some coding A, B, C

A – Examine competitor’s current product.

B – Examine competition plus other concepts.

C – Competitive opportunity – develops new ideas.

Column weight:

The weight can be calculated for each column that represents a combination of both the customers' level of importance and the strength of the relationship. This is accomplished by using the product of the relationship strength and the importance.

The customer importance rating value is specified by W_i and the performance value is specified by R_i . Usually W_i values are from 1 to 9 and R_i values are 1, 3, and 5. From the above values,

$$\text{Column weight} = \sum W_i \times R_i \quad \text{for } i = 1 \text{ to } n$$

The column weight values are the guiding factor for the next phase of QFD. Higher the values of column weight more the concentration required to get better results.

If the column weight value is very less and if the supplier feels there is nothing to improve further the quality characteristics, those quality characteristics can be dropped at this stage. This is not of major significance of the team continues to recognize that these calculation of goals, ratios, and row weight are simply to help in the decision process. They are not a substitute for common sense. They are not algorithms that replace judgments. They are simply aids in the decision process.

4.5 QFD process – Overview

4.5.1 Objective of QFD Process.

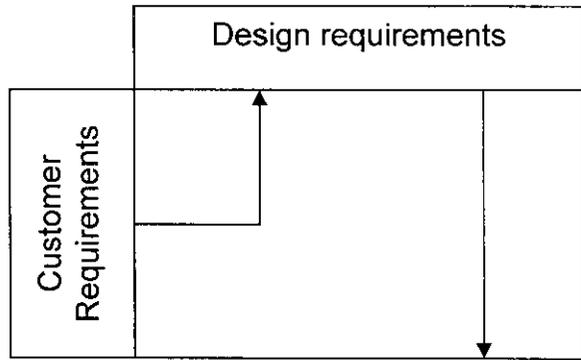
QFD should be viewed from a very global perspective as a methodology that will link a company with its customer and assist the organization in its planning processes. The purpose of QFD process is to get in touch with the customers and to use this knowledge to develop products, which satisfy the customer. The QFD process will help in the organization and analysis of all the pertinent information associated with a project. The priority items selected from the matrix during its analysis are items that will measurably improve the level of customer satisfaction.

4.5.2. Overview of QFD Process.

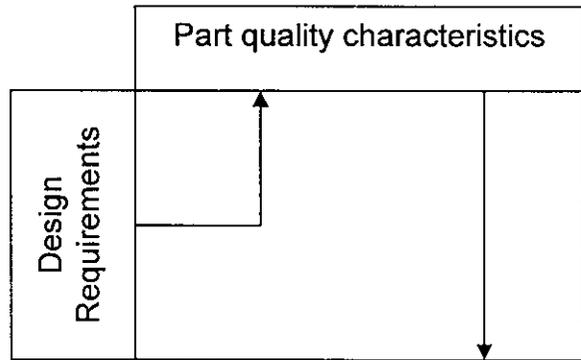
The QFD matrix (house of quality) is the basis for all future matrices needed for the QFD method. Although each house of quality chart now contains a large amount of information, it is still necessary to refine the technical descriptors further until an actionable level of detail is achieved. Often, more than one matrix will be needed, depending on the complexity of the project. The process is accomplished by creating a new chart in which the Hows (technical descriptors) of the previous chart become the WHATs (customer requirements) of the new chart. This process continues until each objective is redefined to an actionable level. The HOWMUCH (prioritized technical descriptors) values are usually carried along to the next chart to facilitate communication. This action ensures that target values are not lost during the QFD process.

A flow diagram of the complete QFD process from the beginning to the end is shown in Fig.2.

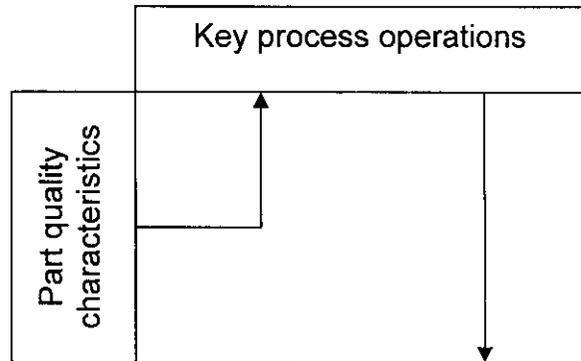
Phase - I
Product Planning



Phase - II
Part Development



Phase - III
Process Planning



Phase - IV
Production Planning

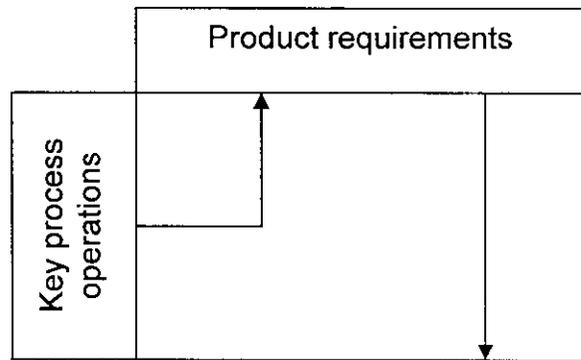


Fig. 2. The QFD Process.

The first chart in the Fig.2 is for the product-planning phase. For each customer requirements, a set of design requirements is determined, which, if satisfied, will result in achieving customer requirements. The next chart is for part development. Design requirements from the first chart are carried to the next chart to establish part quality characteristics. This chart breaks down the design requirements into specific part details. The next chart is for process planning, where key process operations are determined from part quality characteristics. Finally production requirements are determined from the key process operation.

4.6. BENEFITS OF QFD.

The ultimate benefit of QFD for any company is its contribution to meeting and exceeding customer needs. Thus obtaining higher market share and profits. There are, however many other tangible benefits that participants can experience. Some of them are listed below.

- ✎ Products definition is firmer and takes place earlier in the new product development life cycle. This minimizes engineering changes and results in better quality.
- ✎ QFD addresses major issues and complaints expressed by customers during the early stages of product definition. Hence, the number of complaints about and dissatisfaction with new products decreases with time. This benefit is seen after several product cycles.
- ✎ Cross-functional wall break down with QFD since the team must address issues that affect all departments. Sub-optimization of resources in a company is minimized and communication between departments improve

- ✎ Team members develop a deeper understanding of customer needs and have the customer's voice as basis for making trade-offs, resulting in superior decisions for the organisation.
- ✎ The analytic vigor of QFD causes streamlining or elimination of many internal processes that do not add value to the new product development process.
- ✎ Customer needs are evaluated with respect to competitive products and services. This allows process that needs improvement to stay competitive.
- ✎ Documentation is an essential ingredient of QFD. Hence one of the greatest benefits is that we build product intelligence.
- ✎ QFD is beneficial in understanding and identifying a market niche where customer needs are not being met.
- ✎ QFD provides an excellent framework for cross-functional deployment of quality, cost and delivery.
- ✎ QFD allows for quick changes, which is very important for the new product development process.

All of the above benefits result in a robust new product development cycle and minimize difficulties and problems. QFD is one of the best ways to introduce TQM to the marketing, design and manufacturing environments.

CHAPTER - 5

SOFTWARE DESIGN

5. SOFTWARE DESIGN

5.1 Introduction.

Manual calculations become a tedious job when there is any change in the system and the process. Hence computerization is necessary to do calculation in a SIMPLE WAY. The QFD process involves various calculations and according to variations in the calculations the graph should be modified. So it is proposed and developed a software package to make easy of the QFD process.

The general-purpose software package developed can be used for both manufacturing and service industries. The software developed is user-friendlier and it gives necessary graphical outputs. This package can be used by the industries in the new product development and also in modifying the existing product. So that it reduces the product development cycle time, cost incurred in product development and increases the efficiency of the product or service.

Using Visual Basic 6.0 as a front-end tool and Microsoft Access 97 as the back end tool develops this package. The structure of the package is given in Appendix – A and the output results of case studies are given in Appendix – B.

5.1.1. Features of Visual Basic.

Visual basic is a tool of choice when programming in windows. There are few programs that take Visual Basic in to areas that we may not thought possible. Visual Basic refers to the method used to create the graphical user interface. Rather than writing numerous lines of code to describe the appearance and location of interface elements pre-built objects are simply added into place on screen. The salient features of VB are as follows.

and location of interface elements pre-built objects are simply added into place on screen. The salient features of VB are as follows.

a. It is a very User-friendly GUI (graphical User Interface) Language.

The try icon properly holds the icon that will be displayed in the system tray. It holds a string of text that will be displayed above the icon in the tool bar, when the mouse pointer hovers over the icon for about a second or so.

b. Building Screen Savers

This constitute of creating the display portion, declaring module level variable, displaying the form in full screen mode, adding a configuration form, adjusting the program's properties and adding a module and a subroutine.

c. Creating Forms Dynamically.

The most fundamental object in Visual Basic program is the form collection. This object contains one property count and one method item. To demonstrate the techniques using the collection and creating forms dynamically, this program performs three basic tasks namely,

- ☒ Create new forms.
- ☒ List all forms in the application.
- ☒ Delete all the newly created forms.

d. It is easy to connect with Microsoft Office application.

The final requirement is the chart is displayed in the MS Excel form. By adding a command button to the form with events this can be done.

e. Easy for Coding.

f. Easy File accessibility

g. Event Driven Programming.

When programming in Visual Basic the application developer must decide how the application interacts with the user. The user may click a mouse on various controls, or press a key or key combination on the user interface. These are known as events. The application developer must decide how the application must react of the user actions. This is called event driven programming.

h. Microsoft Developer Network (MSDN) is used for on line help facility.

i. Interactive help features.

Like Auto List Members and Auto Quick info that no longer wait for user interact ant interface.

5.2 Algorithm developed

The Algorithm developed for QFD software consists of major 7 steps. They are explained below.

STEP: - 1.

Select in to the product master form. Enter the data of Product code, Product name, No. of customer requirements, No. of technical requirements, No. of competitors, Name of competitors. By using save option the data are stored in database and matrix is created. Modify option is used to change the above inputs. List option is used to list out the input data that is stored in database.

STEP: - 2

Select the Requirements entry form. Then select the product name and name of the company for which the data is to be entered. Using Edit/View option go to the matrix form and then enter the Customer requirements in rows and technical requirements in column. Also enter the Importance ratings, Relationship values, Complaints, Goal, Sales point values. By using save option save these details in to the respective database.

STEP: - 3

Make all the necessary calculations using their formulae. Customer competitive evaluation (CCE) and Technical competitive evaluation (TCE) are calculated and plotted in the graph. Also Improvement ratio (IR), column weight, Row weight are calculated and stored in database.

CCE = Average of the relationship values in that particular column.

TCE = Average of the relationship values in that particular row.

$$\text{Improvement ratio (IR)} = \frac{\text{Goal}}{\text{Customer competitive evaluation}}$$

Row weight = Importance X sales point X Improvement ratio.

Column weight = Sum of (Importance ratings X Relationship value)

STEP: - 4

Select view requirements form. Then select the name of product and name of the company. By using Edit/view option the QFD matrix with the graph is displayed. Action column can be entered in this form directly and saved. Print option is given to take print of the QFD matrix.

STEP: - 5

Select comparison chart form. Then choose the product name, company and competitor name to view the comparison of customer evaluation graph and technical evaluation graph. This form can be taken print out using print option.

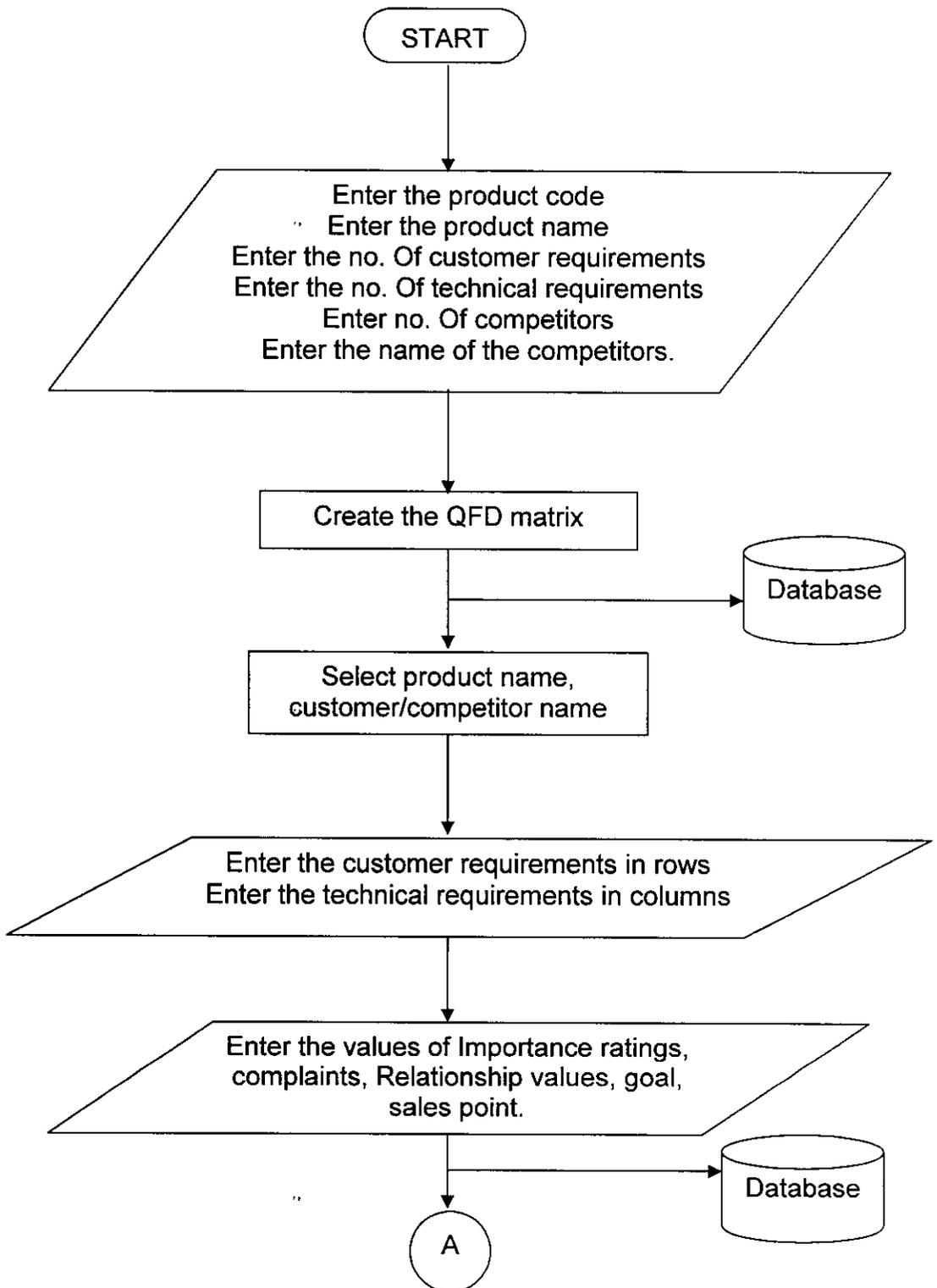
STEP: - 6

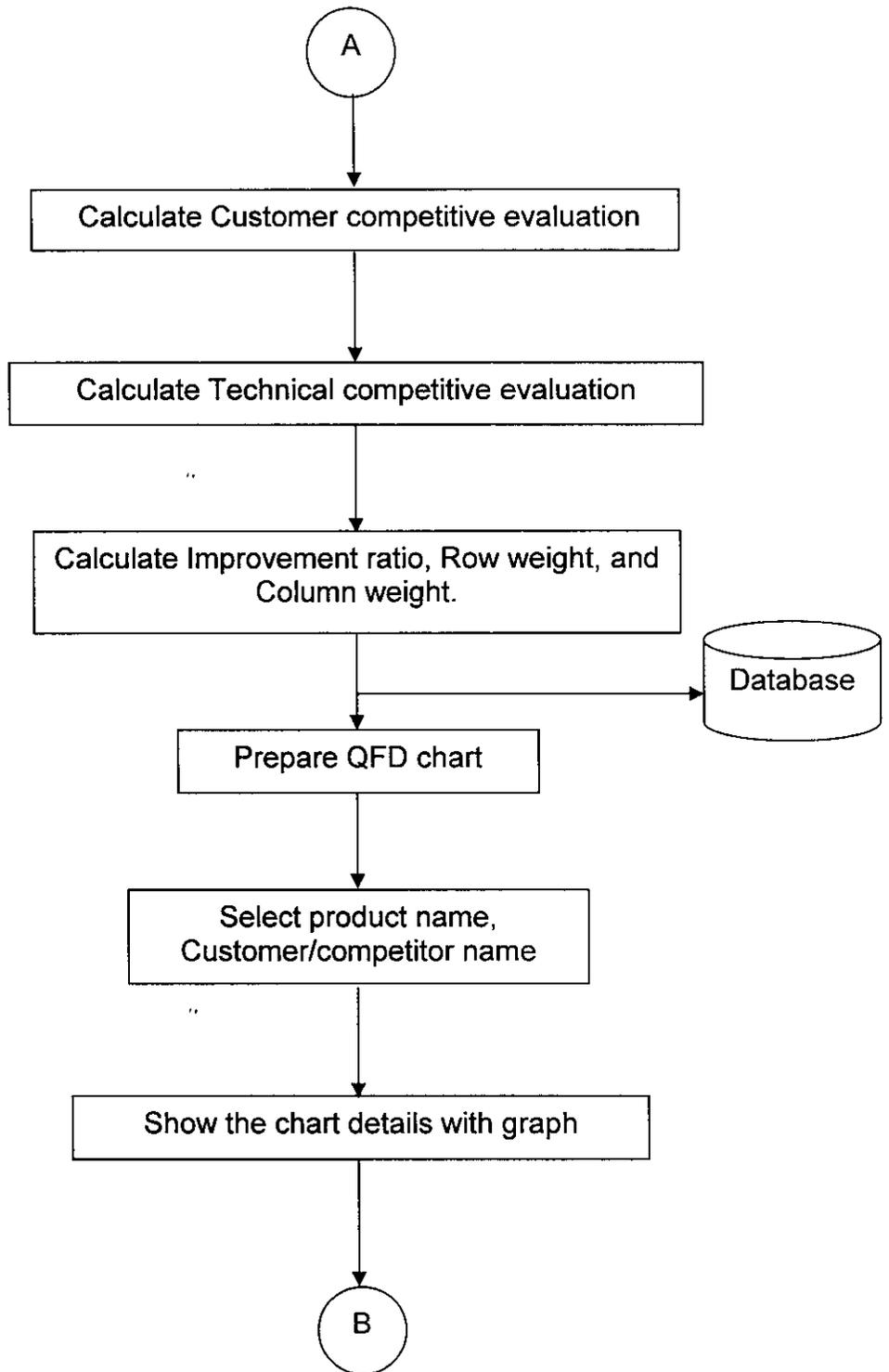
Select the comparison table form. Then choose product name. Company and competitor name to view the comparison of row weight of both companies. This table can be taken print out using print option.

STEP: - 7

Exit option is used to quit the software. Also help option is given to know the details about the software and system configuration.

5.3 Flow chart





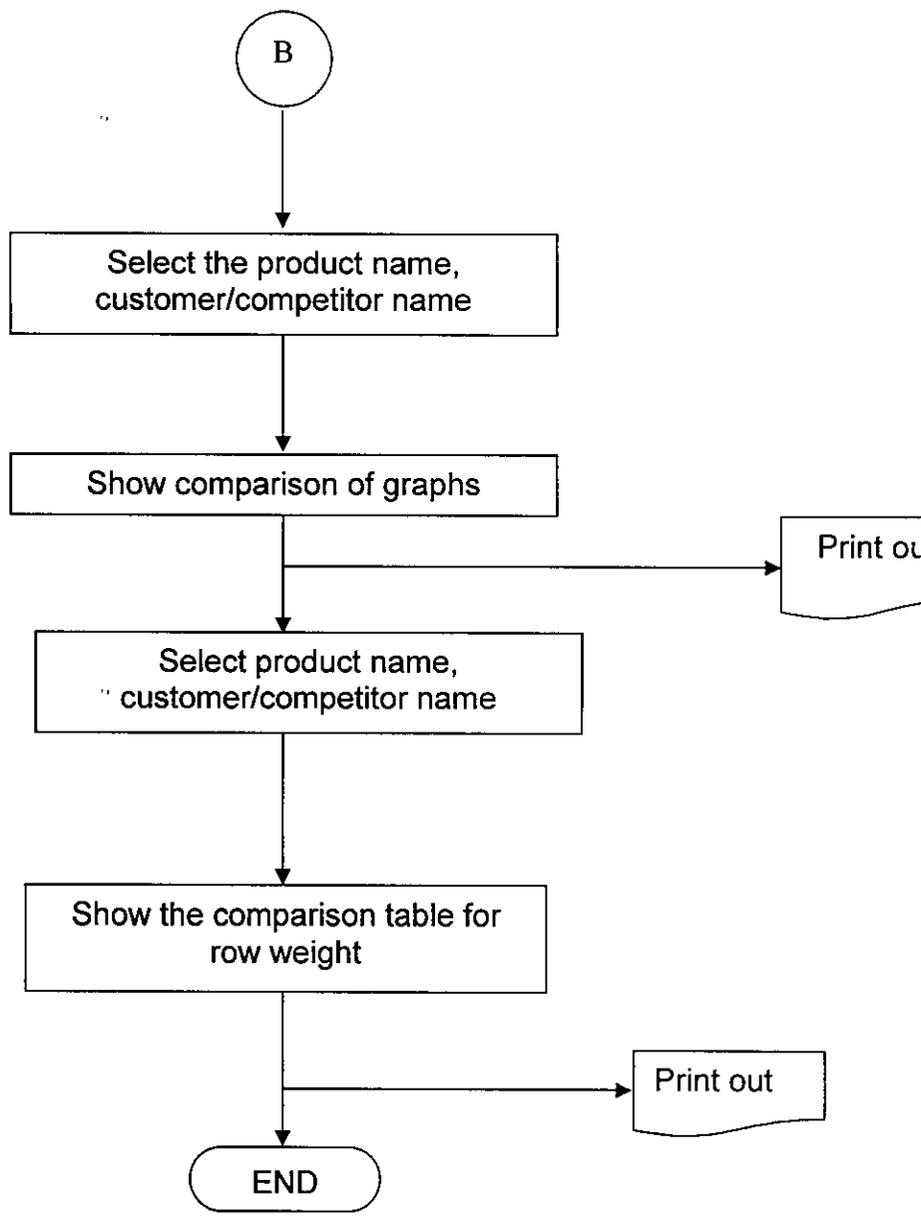


Fig. 3. Flow chart.

5.4 DATABASE DESIGN

A database is a repository of collection of related data or facts. It arranges them in a specific structure. Data in a database is most commonly viewed in one or more two-dimensional tables, each consisting of columns and rows. The entire collection of related data in one table is referred to as a file or Table. Each row in a table represents a Record, which is a set of data for each database entry. Each table column represents a Field, which groups each piece or item of data among the records into specific categories or type of data.

The data are stored in back end i.e., MS Access 97. MS Access is very easy to use. It costs less because it is coming along with windows. The various table that are created namely,

- a. Competitor
- b. Product
- c. Customer
- d. Technical
- e. Matrix
- f. Survey

5.4.1 Database Structure.

Based on the conceptual structures, the database can be classified as follows.

- a. Flat-File database
- b. Relational database
- c. Hierarchical database
- d. Network database
- e. Object-oriented database.

The relational database structure is the most prevalent database. A relational structure represents a database made up of related tables. In this project work, relational type of database is used. In relational type of database, one or more common fields existing in two or more tables create a relationship between these tables. The common fields called the keys.

Various fields are created in each of the tables along with their data type. This help full in fetching all details of the process. Database structures of the tables are shown in the following tables.

Table no: -1 Competitor.

The competitor table is used to store the details of Product code (Pcode), competitor code (comp_code) and competitor name (comp_name).

PCODE	COMP_CODE	COMP_NAME

Table no: - 2 Product.

The Product table is used to store the details of Product code (Pcode), Product name (Pname), No of customer requirements (Cust_req), No of technical requirements (tech_req) and Customer name (cust_name).

PCODE	PNAME	CUST_REQ	TECH_REQ	CUST_NAME

Table no: - 3 Customer.

The Customer table is used to store the details of Product code (Pcode), customer requirement code (Custreq_code) and the description of customer requirements (Description).

PCODE	CUSTREQ_CODE	DESCRIPTION

Table no: - 4 Technical.

The Technical table is used to store the details of Product code (Pcode), Technical requirement code (Techreq_code) and the description of Technical requirements (Description).

PCODE	TECHREQ_CODE	DESCRIPTION

Table no: - 5 Matrix.

The Matrix table is used to store the details of Product code (Pcode), Customer requirement code (Custreq_code) Technical requirement code (Techreq_code) and the relationship value (mvalue).

PCODE	CUSTREQ_CODE	TECHREQ_CODE	MVALUE

Table no: - 6 Survey.

The Survey table is used to store the details of Product code (Pcode), Customer requirement code (Custreq_code), Importance ratings (Importance), No of Complaints (Complaints), Goal (Goal), Sales point (Sales_point) and Action (Action).

PCODE	CUSTREQ_CODE	IMPORTANCE	COMPLAINTS	GOAL	SALES_POINT	ACTION

5.5 HOW TO WORK ON SOFTWARE.

1. Select product master from the File menu. Enter all the details in the product master and then save.
2. Select requirements entry from file menu, then enter the details of product, name of the company/competitor in product selection menu and then click on Edit/View button.
3. Enter the customer requirements details in rows and technical requirements in columns. Also enter the values of Importance, goal, sales point, complaints and relationship values. Using save button record these data to database.
4. Select View requirements from file menu, then enter the details of product, name of the company/competitor in product selection menu and then click on Edit/View button
5. Fill the Action column with required data and save it to database.
6. Select comparison chart from file menu, then enter the details of product, name of the company/competitor in product selection menu for those we need to see comparison and then click on Edit/View button
7. Select comparison tables from file menu, then enter the details of product, name of the company/competitor in product selection menu for those we need to compare the row weight details and then click on Edit/View button
8. The Requirements display form, Comparison & Evaluation form, Row weight form all can be taken printout using print button.
9. Help command is used to provide the details about the software and system configuration.
10. The Exit command is used to quit the QFD software.

CHAPTER - 6

CASE STUDY

6. CASE STUDY – CASTING INDUSTRY

6.1 Introduction to Casting Process.

We can use different methods to shape materials into useful products. Making parts by casting molten metal into a mold and letting it solidify is a logical choice. Casting is one of the oldest manufacturing processes which dates back to approximately 4000 B.C. Earlier casting were probably made out of gold, copper, silver, bronze etc. in 1709, Abraham Darby got succeeded in melting in the coke blast furnace and this opened a route for the massive use of cast iron in construction. The middle part of the twentieth century saw marked developments in foundry technology.

In the broad sense, casting is a process that is applied not only to metals but also to non-metallic materials. Plastics, ceramics and glasses are also cast into shapes. Basically, metal casting processes involves the introduction of molten metal into a mold cavity where, upon solidification, the metal takes the shape of cavity. The casting process is thus capable of producing intricate shapes in a single piece, including those with internal cavities. Very large or hollow parts can be produced economically by casting techniques. Typical cast products are engine block, crankshaft, pistons, valves railroad wheels and ornamental artifacts.

Casting is the process of producing metal / alloy component parts of desired shapes by pouring the molten metal / alloy into a prepared mould and then allowing the metal / alloy to cool and solidify. The solidified piece of metal / alloy is known as a casting.

Today, large quantity of casting is produced through sand casting. There is certain limitation to these castings. This can be overcome by using special casting techniques to improve dimensional accuracy, higher metallurgical quality, ability to cast extremely thin sections.

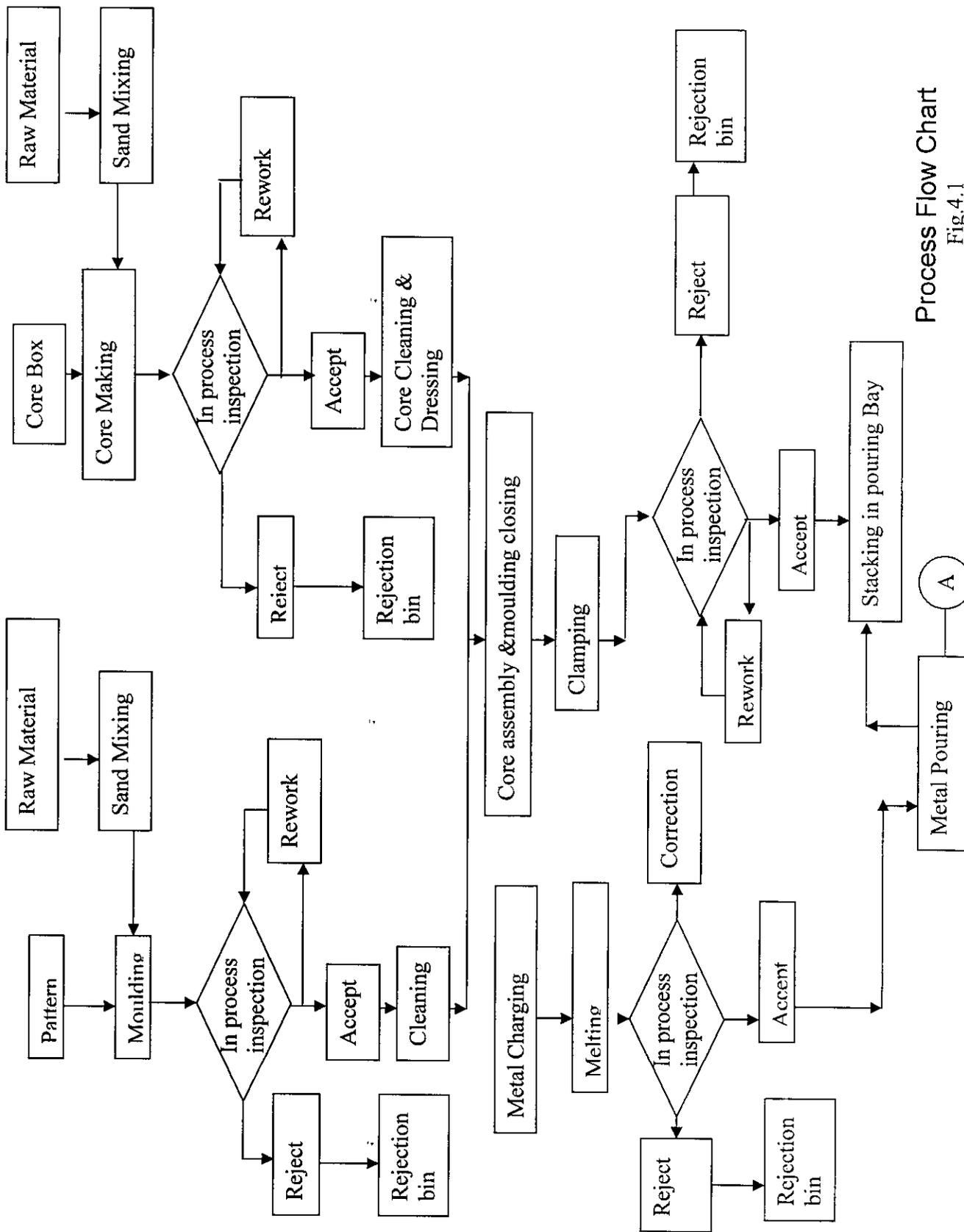
Under this special casting techniques, cironing or C process, now commonly known as the shell process was developed by Dr. CRONING in Hamburg, Germany during World War II. Castings as thin as 1.5 mm and of high definition can be cast satisfactorily. Shell moulding is suited to ferrous and non-ferrous alloy casting in the range 0.1 to 10Kg. tolerance of the order of 0.002 to 0.003 mm per mm are possible to obtain in shell mould castings.

For casting automotive rocker arms, valves, camshafts, bushings, valve bodies, spacers, brackets, manifolds, bearing caps, shafts and gears, it is very useful method to get accurate casting dimension. Various alloys, which can be satisfactorily cast by shell moldings, are aluminum alloys, copper alloys, cast irons and stainless steels.

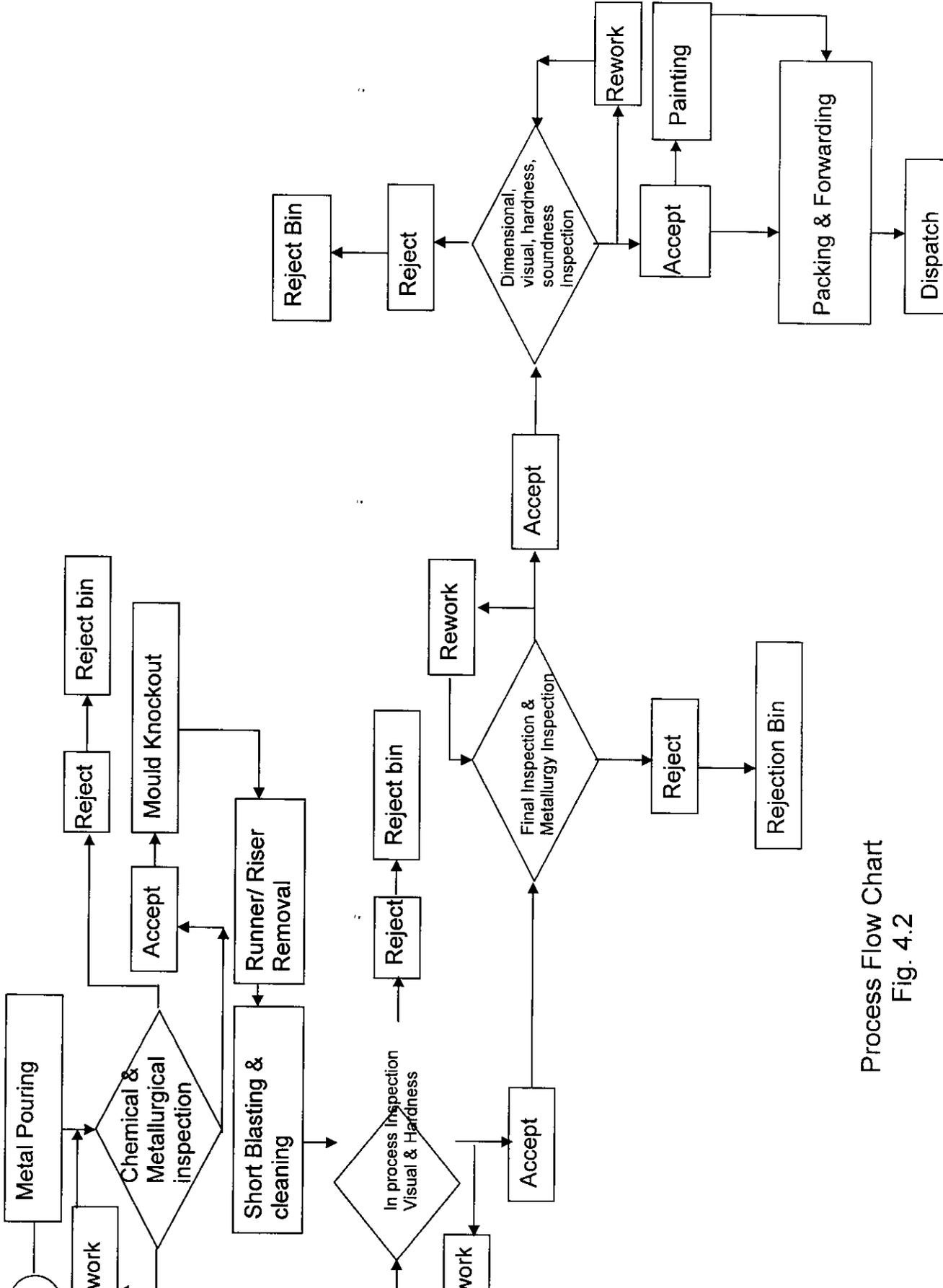
Almost all the metals can be cast into final shape desired, often with only minor finishes required. This capability places casting among important net shape manufacturing technologies.

6.2 Flow process of Casting.

The various stages in the casting process are shown in fig.4.1, 4.2 in detail as a flow chart for easy understanding.



Process Flow Chart
Fig.4.1



Process Flow Chart
Fig. 4.2

6.3. Analysis.

A case study has been conducted on the Casting industry producing spheroidal cast iron. A brain storming session had been conducted in order to know the various customer requirements and the parameters by which the quality of the castings can be increased. The customer requirements are identified by analyzing the design and end use of the castings.

The customer requirements are classified into External and Internal requirements. The Internal requirements are further classified into department basis such as Pattern shop, Core shop, Moulding shop and Quality control. Then based on the discussion with the engineers and workers the various control parameters or technical requirements to achieve the customer requirements are determined. Then customer requirements are assigned with various importance ratings values. The customer requirements, technical requirements and importance rating values are listed in the following tables.

External requirements:

S.No.	Customer requirements	Importance	Technical requirements
1	Nodularity	8	≥ 150 nos/sq. Cm.
2	Uniformity of casting	7	Pouring test/witness test
3	Timely delivery	8	Schedule as per order
4	After sales service	8	Field compliance study
5	Surface roughness of castings	7	Roughness value
6	Expec.Chemical composition of material	8	Chemical composition (Ci,Si,Mn.S,P,Fe)
7	Compressive/yield strength	7	15 tonnes/sq. Cm
8	Type of matrix & Graphite size	6	Matrix of pearlite, Ferrite or Austenite
9	Graphite size	7	Graphite Flakes 0.05 to 0.1 mm

10	Free from visual defects	8	Inspection
11	Free from Dimensional deviation	7	Machining
12	Free from fins	8	High Ramming of mould
13	Good surface finish	8	Sand preparation
14	Hardness	8	Brinell Hardness Number
15	Place part no.in specified area.	7	Design of pattern & Construction
16	Draft allowance	6	1 deg. External 1mm in 100mm 2.5 deg.
17	Damping capacity/shock resistance	6	Silicon, Low in sulphur, Phosphorous

Internal requirements:

Pattern shop & Melting:

S.No	Customer requirements	Importance	Technical requirements
1	Adequate space for pattern in match plate	8	Selection of material
2	Easily worked shaped & joined	6	Availability of skilled labour
3	Light in weight	8	Design of pattern
4	Strong, hard & durable	8	Pattern making
5	Resistance to corrosion & chemical action	7	Provision of core print
6	Availability at low cost	8	Pouring temperature
7	Repaired or even reused	6	Core additives
8	Life expectancy of pattern	7	Borings, Scrap, Steel
9	Adequate surface finish	7	Chemicals (Si, C, Mn, S, P, Fe)
10	Quantity and quality of castings	8	Increase in % of carbon
11	Core location	7	
12	Grade of castings	7	
13	Pouring temp.of molten metal	7	

14	Expe. Chemical composition of metal	8	
15	Fluidity of castings	7	
16	Resistance to wear & abrasion	7	

Moulding shop:

S.No.	Customer requirements	Importance	Technical requirements
1	Remove oxidation of metal	6	Routine sand testing program
2	Thermal stability	7	Method of moulding process
3	Fine collapsibility	7	Moisture content-sand
4	Dry strength of sand	7	Sand additives
5	Chemical resistivity	8	Mess size (sand)
6	Bonding action to clay	6	Coal dust, Sea coal, Silica flour Wood flour, dextris
7	Sand grain size	6	Addition of clay, water
8	Mould hardness	6	

Core shop:

S.No.	Customer requirements	Importance	Technical requirements
1	Collapsibility	7	Mesh size
2	Dimensional accuracy	8	Reinforcement
3	High productivity	8	Additives
4	Section (thin, thick)	6	Venting in core print
5	Core hardness	6	Fine ramming of core
6	Strength of core	8	Oven temperature
7	Surface finish	8	Pouring temperature
8	Uniform baking	7	
9	Quality of casting due to core	7	

Quality control:

S.No	Customer requirements	Importance	Technical requirements
1	Chemical analysis	7	Laboratory testing (spectrometer analysis)
2	Dimensional analysis	7	Inspection
3	Grade	7	Brillnel Hardness Number
4	Hardness	8	
5	Matrix (pearlite, Ferrite) structure	6	
6	Mechanical properties	7	
7	Physical properties	7	
8	Tensile strength/% of elongation	8	

The inter relationship between the customer requirements and technical requirements are studied in detail and values are assigned as 1, 3, 5 for weak, moderate and strong relationships respectively. Then goal points are assigned to each customer requirements. In this study 5 point is assigned to all. It may vary 1 to 5 depends on the focus of the company. Then the sales point values are assigned to the customer requirements. The values are 1 or 1.2. Here 1.2 is assigned to those requirements, which will have more impact on the sales of the product or service.

Finally the customer requirements, technical requirements and the values of Importance ratings, relationship values, sales point, goal and no of complaints are given as input to the software package developed for QFD. The software do all necessary calculations and plots the graph for customer competitive evaluation and technical competitive evaluation. The values of Improvement ration, row weight, column weight are calculated and displayed in the final form. This procedure is used for all department details. This can be taken print out for further discussion and analysis. These results are enclosed in Appendix B

CHAPTER - 7

RESULT AND DISCUSSION

7. RESULTS AND DISCUSSION.

The Casting Industry is studied in detail for continuous improvement. Based on the results we obtained from the QFD software, the following suggestions are arrived for various departments.

External Customer Requirements:

There are 17 customer requirements and 17 technical requirements are identified with reference to external customer. The customer requirements timely delivery, graphite size, free from dimensional deviation and surface finish are the areas in which the improvements are expected because they are indicated by higher row weight values. The column weight values indicate that design of pattern, sand preparation, chemical composition are most important control parameters need to be attended for improvement of quality while they continue to maintain other parameters. A hypothetical data is used to prepare the QFD matrix for a competitor and comparison is made.

Internal Customer Requirements:

Pattern shop & Melting:

There are 16 customer requirements and 10 technical requirements are identified with reference to Internal customer requirements in pattern shop and melting. The customer requirements Available at low cost, life expectancy of pattern, core location adequate surface finish are the areas in which the improvements are expected because they are indicated by higher row weight values. The column weight values indicate that design of pattern, selection of material pattern making and chemicals are most important control parameters need to be attended for improvement of quality.

Moulding shop:

There are 8 customer requirements and 7 technical requirements are identified with reference to moulding shop. The customer requirements mould hardness, fine collapsibility bonding action of clay are the areas in which the improvements are expected because they are indicated by higher row weight values. The column weight values indicate that routine sand testing procedure, sand additives moisture content of sand are most important control parameters need to be attended for improvement of quality while they continue to maintain other parameters.

Core shop:

There are 9 customer requirements and 8 technical requirements are identified with reference to core shop. The customer requirements dimensional accuracy, strength of core, surface finish are the areas in which the improvements are expected because they are indicated by higher row weight values. The column weight values indicate that reinforcement, mesh size, fine ramming are most important control parameters need to be attended for improvement of quality.

Quality control:

There are 8 customer requirements and 3 technical requirements are identified with reference to the quality control. The customer requirements tensile strength, dimensional analysis, mechanical properties are the areas in which the improvements are expected because they are indicated by higher row weight values. The column weight values indicate that laboratory testing, inspection are most important control parameters need to be attended for improvement of quality while they continue to maintain other parameters.

CHAPTER - 8

CONCLUSION

8. CONCLUSION

Quality Function Deployment is an effective management tool in which customer expectations are used to drive the design process. QFD forces the entire organisation to constantly be aware of the customer requirements. Every QFD chart is result of the original customer requirement that are not lost through interpretation or lack of communication. Marketing benefits because specific sales points that have been identified by the customer can be stressed. Most importantly, implementing QFD results in a satisfied customer.

The author developed a software model for QFD process with all necessary graphical output. The software has been designed using visual basic 6.0 and MS Access as the tools. A case study on casting industry is made to validate the software. Based on the results the various areas that need improvement are identified and suggestions are made. The company can use this software to compare its position with their competitors, if the data are available with them. A hypothetical data has been used and a comparison has been made in competitor analysis.

Further improvement:

The features such as Inter relationship between technical requirements, direction of improvement provision for n-number of customer and technical requirements can be incorporated in the software package. A case study for comparison of two companies can be made in future.

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APPENDIX - A: SOFTWARE
FORMS

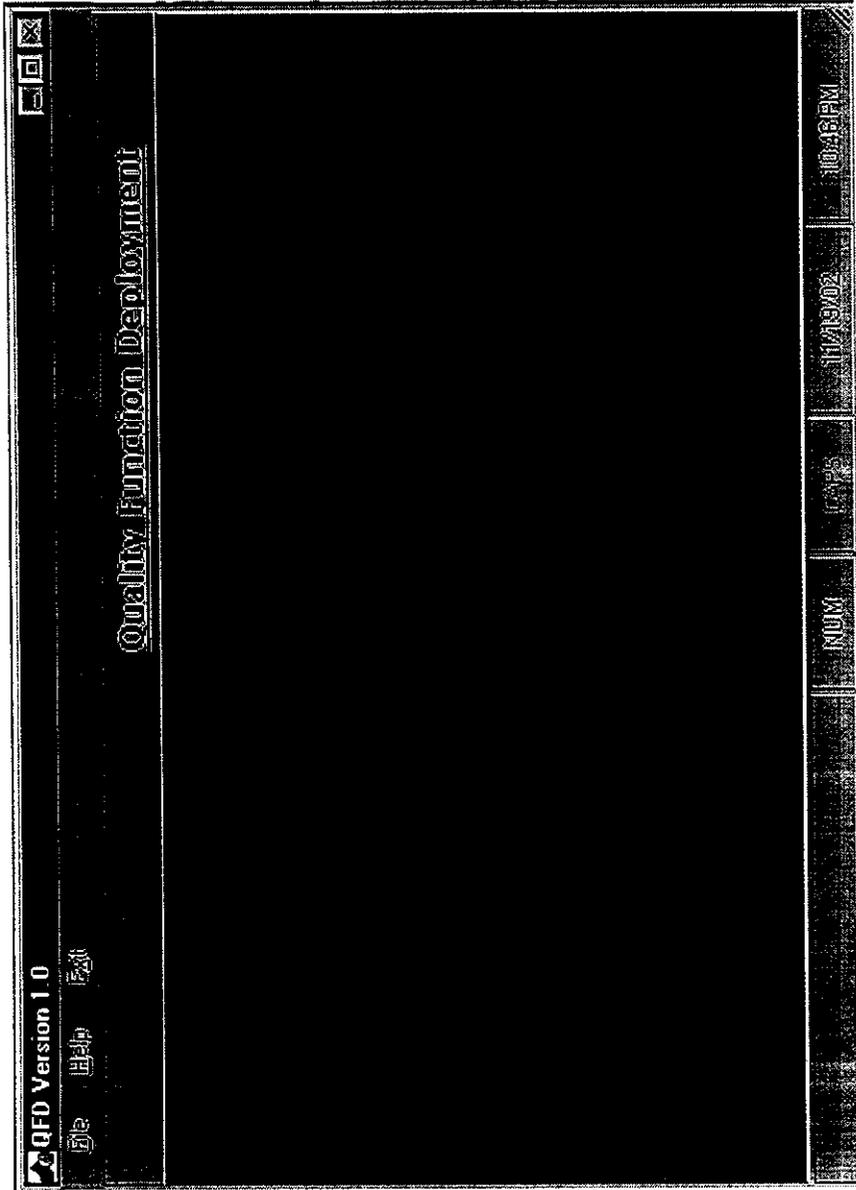


Fig. 5.1. Main menu.

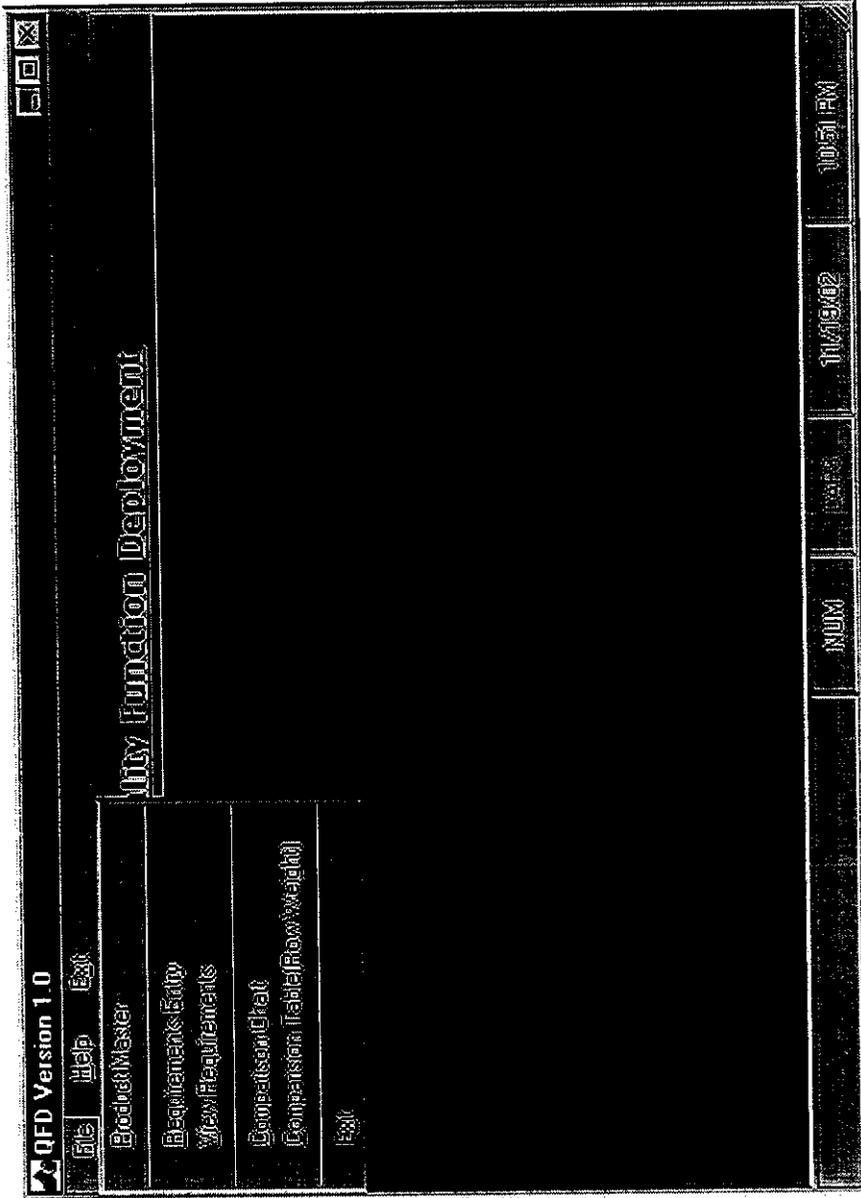


Fig. 5.2 File menu options

Product Master
✕

Product Master

Product Code

Product Name

Customer Requirements

Technical Requirements

Company Name

No. of Competitors

Competitors Names

S.No	Competitors Name

< Press Enter Key >

Save

Modify

Delete

List

Quit

Fig. 5.3 Product master entry form

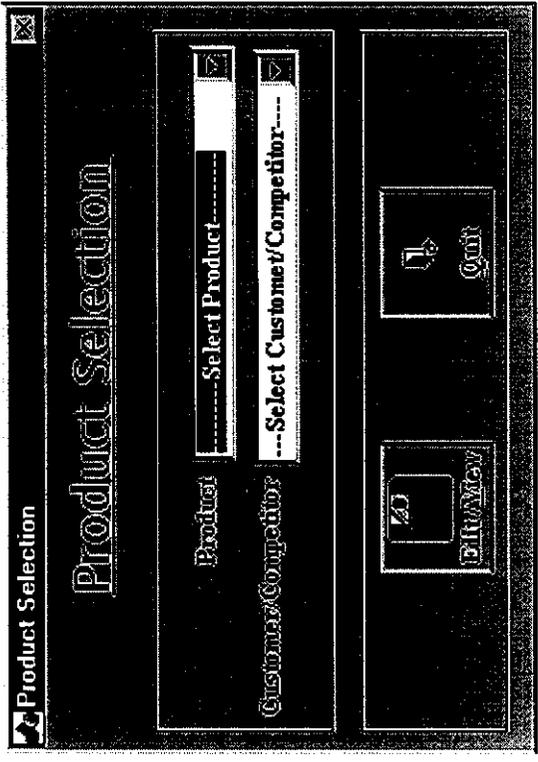


Fig. 5.4 Product selection form

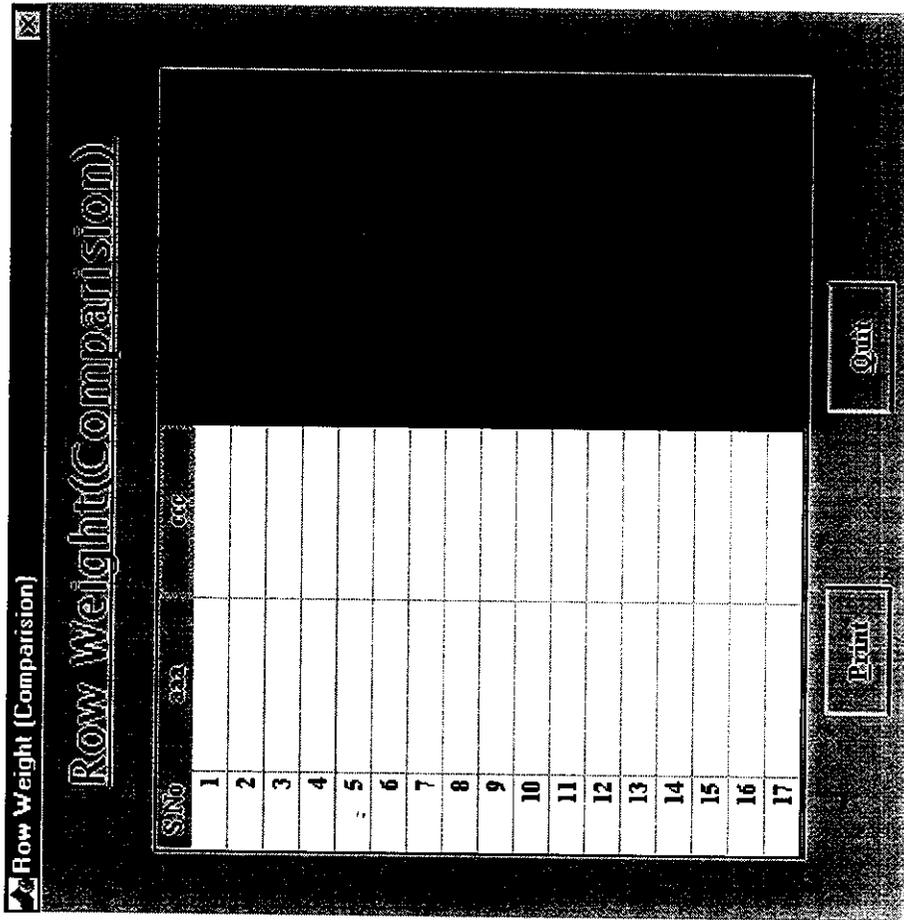


Fig.5.8 Row weight comparison.

APPENDIX - B: RESULTS

Requirements Display

		Product Name: External requirements, Competitor: XYZ Casting										Row			
		Company: ABC										Col			
		Customer Requirements										Row			
		Included Requirements										Col			
		Customer Requirements										Row			
		Included Requirements										Col			
Notularity	1 8 5											5	1	1	8
Uniformity of castings	2 7 5											5	1	1	7
Timely delivery	3 8											5	12	167	16
After sales service	4 8											5	1	1	8
Surface roughness of castings	5 7											5	1	1	7
Spec.chem.compos.of material	6 8											5	1	1	8
Compressive/yield strength	7 7											5	1	1	7
Type of matrix & graphite size	8 6											5	1	1	6
Graphite size	9 7											5	12	167	14
Free from visual defects	10 8											5	1	1	8
Free from dimensional deviatiti	11 7											5	1	167	167
Free from fins	12 8											5	1	1	8
Good surface finish	13 8											5	12	125	12
Hardness	14 8											5	1	1	8
Place part no. in speci. area in	15 7											5	1	1	7
Draft allowance	16 6											5	1	1	6
Damping capacity/shock resist	17 6											5	1	1	6

Column Weight

4	3	2	4	6	2	4	4	5	3
0	5	4	0	5	0	1	0	1	4
0	5	4	0	5	0	1	0	1	4
0	5	4	0	5	0	1	0	1	4
0	5	4	0	5	0	1	0	1	4
0	5	4	0	5	0	1	0	1	4
0	5	4	0	5	0	1	0	1	4
0	5	4	0	5	0	1	0	1	4
0	5	4	0	5	0	1	0	1	4
0	5	4	0	5	0	1	0	1	4

Editor Print
 BWP Edit
 Save
 Quit

Fig.6.1. External requirements

