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Design of an Integrated CAD and Quality Function Deployment (QFD) Product Data Management System (PDM).

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Abstract. New product development, a function that traditionally fell under marketing responsibility, should encompass in its scope every process from marketing, planning, design, production preparation, inspection, and selling from the perspective of management of new product development. Quality Function Deployment (QFD) offers a way to manage the upstream end of the development process. The challenge of the future is to advance this method to build a trouble-free way to churn out new products efficiently, at low cost, and in a short time. The format of the QFD template present challenges to its users especially when completed manually for products with many customer requirements and the subsequent technical requirements. The paper reviewed literature on QFD, Computer Aided Design (CAD), and Product Data Management (PDM) and their integration. Software based on VB 2005 was developed that allows interaction with the end user through a graphical interface. The software automatically constructs Houses of Quality (HoQ) to the fourth level. A Microsoft Access database was used as the system backbone and linked to the AutoCAD 2010 software. The database kept product data, customer requirements and technical requirements. Drawing files for the product were handled by the CAD module integrated with QFD and PDM system. An integrated system was developed that aid to reduce time to market while maintaining voice of the customer.

Keywords: Quality Function Deployment (QFD), Product Development, Computer Aided Design (CAD), Product Data Management (PDM)

1. Introduction

This paper is about a research on new product development, in particular the tools used to improve the quality and efficiency of the design process. Major work undertaken in the research project was development of an integrated tool. The literature such as Quality Function Deployment (QFD) concept, Computer Aided Design (CAD) and product Data Management System (PDM) was considered to support the development of the tool. The design process is articulated in the methodology section. In conclusion the paper highlighted the system developed by examples of screen dumps and output tables.

2. Literature Review

2.1. Product Design

Product design is the process of defining all of the companies' product characteristics [1]. The process must support product manufacturability (the ease with which a product can be made). Product design defines a product's characteristics which are appearance, materials, dimensions, tolerance, and performance standards.

2.2. Six Phases of the Generic Product Development Process

The generic product development process consists of six phases. The process begins with a planning phase, which is the link to advanced research and technology development activities. The conclusion of the

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product development process is the product launch where the product becomes available for purchase in the market. The complete six phases are as follows [2];

- Phase 0: Planning
- Phase 1: Concept development
- Phase 2: System-level design
- Phase 3: Detail design
- Phase 4: Testing and refinement
- Phase 5: Production ramp-up

2.3. Quality Function Deployment

QFD is a customer-driven planning process to guide the design, manufacturing, and marketing of goods [3]. At the strategic level, QFD presents a challenge and an opportunity for top management to break out of its traditional narrow focus on "results," which can only be measured after the fact, and to view the broader process of how results are obtained. Under QFD, all operations of a company are driven by the voice of the customer, rather than by edicts of top management or the opinions or desires of design engineers.

QFD benefits companies through improved communication and teamwork across all constituencies in the production process, such as between marketing, design, manufacturing, purchasing and suppliers. Product objectives are better understood and interpreted during the production process. Use of QFD determines the causes of customer dissatisfaction, making it a useful tool for competitive analysis of product quality by top management. Productivity as well as quality improvements generally follow QFD. More significantly, QFD reduces the time for new product development, and allows companies to simulate the effects of new design ideas and concepts. Some work highlighted the application of Data Quality within QFD but did not have an integrated approach [4].

2.4. Computer Aided Design (CAD)

Technical drawing is the major design method by which ideas about the shape, form, dimensions, materials, machining methods and finishes of articles being made or constructed are passed between those working in the manufacturing and building industries. There are many CAD software packages available at the present day for use on a computer. For the purpose of describing CAD, we will only deal with AutoCAD. This software is capable of producing any technical drawing, no matter how complicated in the hands of a skilled operator.

AutoCAD drawings are actually mathematical databases. The position of each object in a drawing is stored as a co-ordinate in a database. The database is then translated into an image on the screen. AutoCAD is a general purpose Computer Aided Design program to prepare and store a wide variety of two-dimensional (2-D) drawings and three-dimensional (3-D) models [5]. It will increase speed and accuracy as compared to traditional methods.

2.5. Product Data Management Systems

Product Data Management (PDM) systems are file repositories or "vaults" that hold mechanical CAD files, including parts and assembly models as well as drawing files [6]. The PDM vault allows mechanical engineers to better manage the complex interrelationships between the part, assembly and drawing files. PDM or Product Information Management (PIM) systems provide the tools to control access to and manage all product definition data. This environment is depicted in Fig 1.

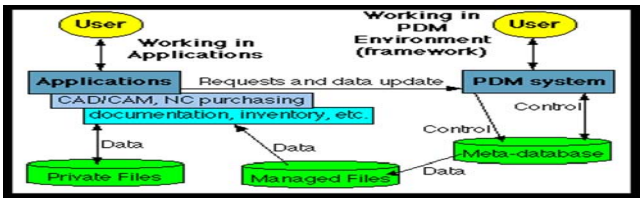

Fig 1: Product Data Management Environment.

3. Methodology and Design

3.1. Information flow model in concurrent innovation, design and development

A synchronized information flow diagram that depicts the integrated approach which is the major thrust of the project was proposed. The flow diagram captures activities and functions that must be accomplished in the design and manufacture of a product, referred to as the *Product Cycle.* The synchronized information flow model is illustrated in Fig 2 below.

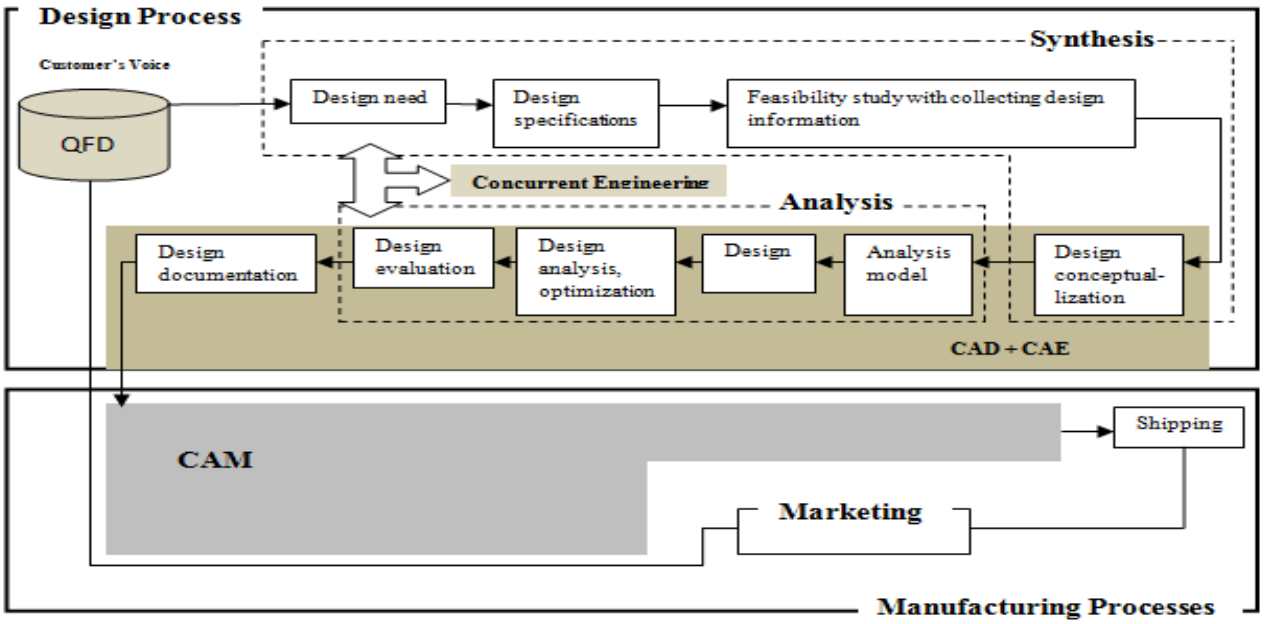

Fig 2: A synchronized information model for concurrent innovation, product design and development

3.2. Database Design

QFD uses cross-functional teams to identify, understand and document unrealized knowledge involved in planning products, processes, services and strategies which become better than what the competition has to offer. A central database is the backbone of an integrated CAD, QFD and PDM. The designed system database was built on Microsoft Access system.

3.3. Graphical User Interface (GUI) Design

The interface to be used by different departments was designed using forms. Forms are user friendly and help in integrating the entire system [7]. VB 2005 was used to design the front-end system. The main form (parent) has menu options that manipulate all the other modules of the system.

3.4. QFD Decision Module

The software incorporates a decision module, rather than a single House of Quality (HoQ). The decision module can set up and interlink a collection of lists, matrices, and documents to construct a decision making model for a project [8]. This decision making model can be high level (a single HoQ) or detailed (many HoQs cascaded from one to another). The QFD decision model enable users to collect, analyze and manage qualitative data to give an accurate understanding of the company's competition space, customer expectations, and business needs. Microsoft Excel was used as the development platform for generating the QFD matrices. The matrices are designed as templates with multiple links to automate the subsequent generation of Houses of Quality (HoQs). These excel templates easily allow users to obtain print-outs and work with blank chart templates which are useful as documents-in-progress during team meetings.

4. Results

4.1. System Interface

Fig 3 shows a screenshot of the main user interface. It acts like a control panel that holds all the keys which the user needs in order to access functions of the system. The parent form has all the menu options that call all other forms needed by users who are working with the system. It also links the user to other two

main application programs necessary for the complete functionality of the system, notably, AutoCAD and Excel.

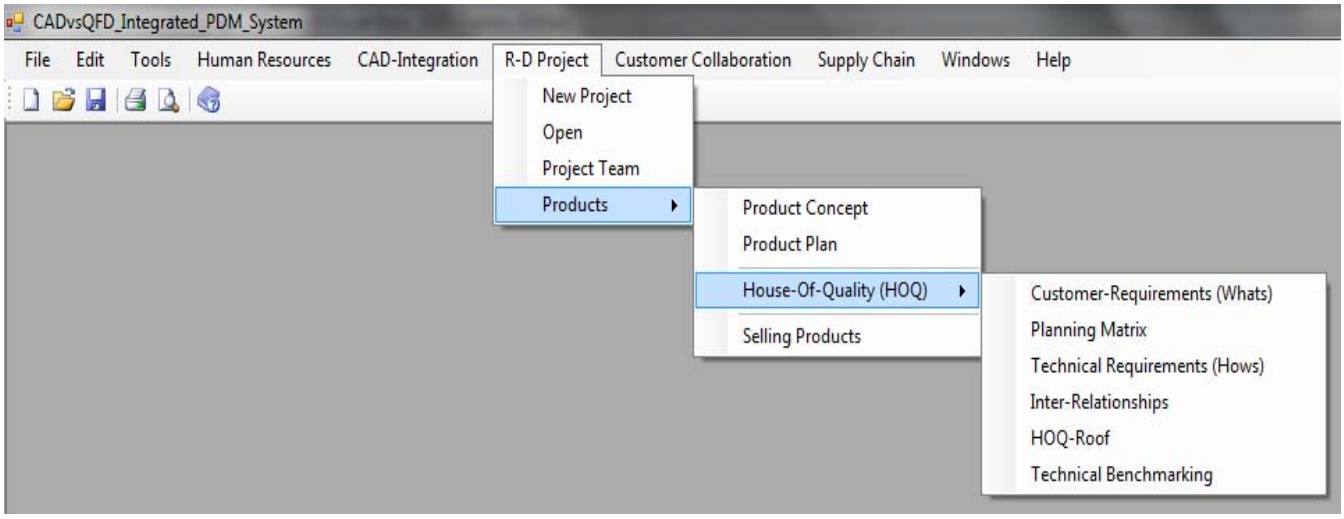

Fig. 3: System Parent Form

4.2. CAD Integration

AutoCAD is used to facilitate the integration. CAD drawings are linked to the database and such connectivity allows data exchange between the two systems.

The dbConnect Manager shows currently open projects, links for the drawing objects, label templates, Queries, and data sources. The data sources can be expanded to show the complete database structure. The user can view records linked to objects by selecting the object followed by choosing the "view linked records" option. AutoCAD highlights the data row as shown in Fig 4 below.

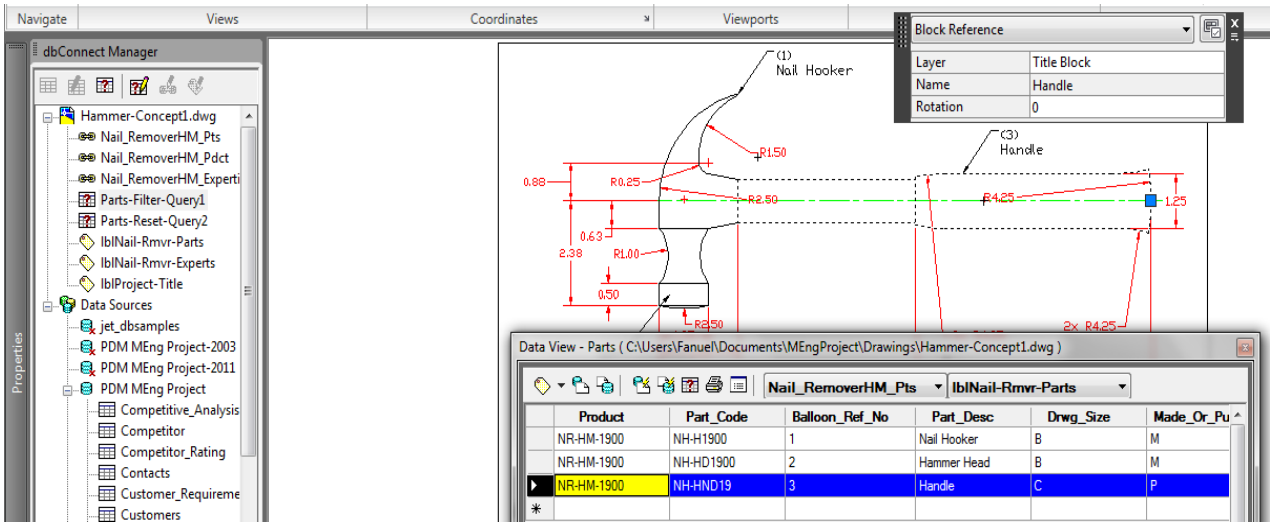

Fig 4: Record Linked to the Handle Object

4.3. House of Quality

Due to the ability of the Ms Excel application to link cells together, the HoQ template automatically picks the customer requirements and builds a relationship matrix with the product metrics. The product metrics will be cascaded to form the first matrix in the second house of quality (HoQ2). Such cascading will continue until a satisfactory analysis is done for individual components making up a product. A complete HOQ is shown in Fig 5 on the following page.

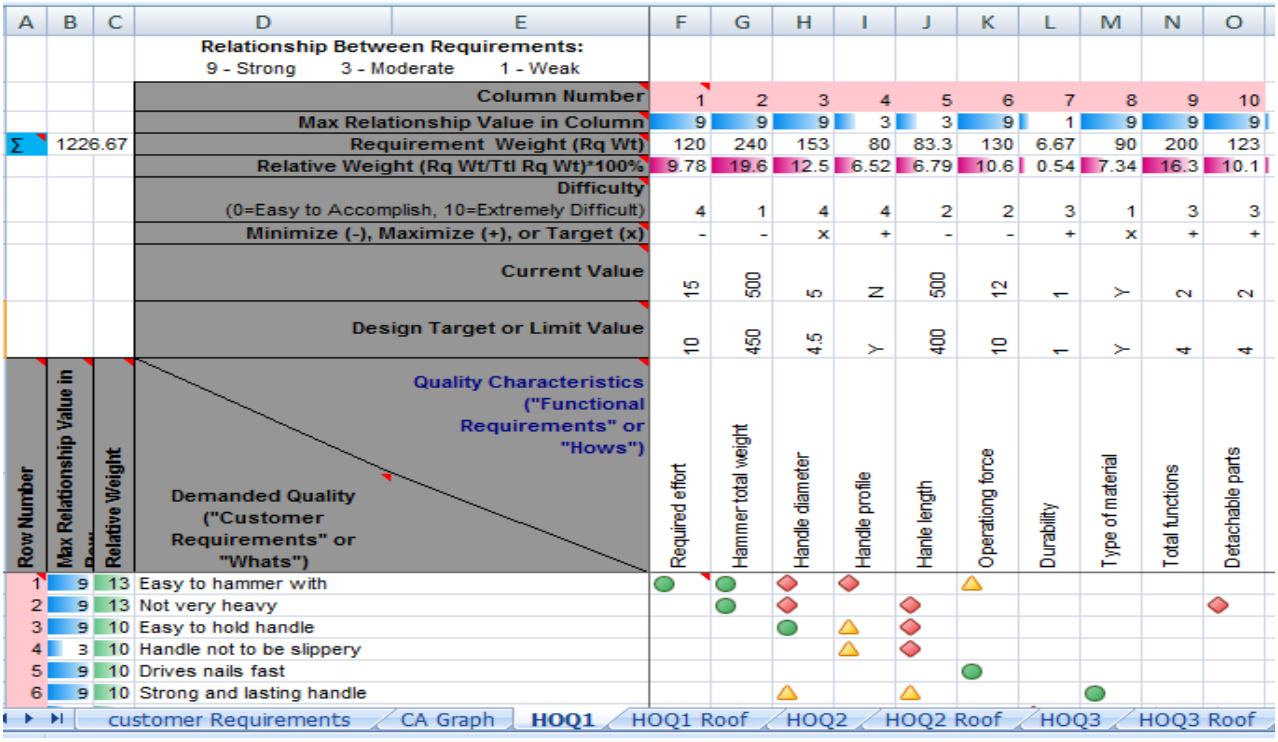

Fig 5: House of Quality Matrix

5. Conclusion

The integrated CAD and QFD, Product Data Management System (PDM), provides the user with a complete visibility of the design process right through the end product without switching into other systems. The software package improves the speed of the whole design process through automation of tasks traditionally done manually like completing the HoQ templates. With advancements in the computer world, customer's voice can be tapped through internet connectivity and fed directly into the system for subsequent processing.

6. References

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