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The use of quality function deployment in systems development: A case study

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ABSTRACT

It is now generally recognized that organizations need great flexibility to remain competitive. This paper looks at one company's attempt to mandate flexibility by the use of a technique known as Quality Function Deployment (QFD). QFD is a customer-driven planning and communication process for designing, developing or improving products or services, and is a particular implementation of the Total Quality Management philosophy. The QFD approach is multi-functional--various stakeholders in the design process come together from the project's inception to concurrently plan, design and produce a product or service. In this particular case the company has not only applied the principles of QFD to manufacturing processes; the QFD approach has also been applied to other areas of the business including information systems development. This paper discusses how the application of a QFD approach to information systems development has changed the relationship between the IS department and users, and the process of systems development itself.

INTRODUCTION

In recent years it has become clear that organizations are becoming increasingly concerned by their ability or inability to reshape themselves in order to remain competitive. In the 1990s a major challenge has become to enable organizational flexibility and transformation (Scott-Morton, 1991). This paper looks at one company's attempt to mandate flexibility by the use of a technique known as Quality Function Deployment (QFD). This technique, which is a specific implementation of the Total Quality Management philosophy, has been applied not only in the company's manufacturing operations, but in information systems development also.

In most information systems textbooks, variations of the Systems Development Lifecycle (SDLC) are presented as the normal or 'traditional' way of doing systems development. In the research literature on IS development, however, many different methodologies and approaches have been suggested in order to try to overcome some of the shortcomings of the SDLC approach. Some of the most well known systems development methodologies are the family of

Structured Methodologies (e.g., Yourdon, 1989; Downs et al., 1988), Mumford's ETHICS (Mumford, 1983) and Checkland's Soft Systems Methodology (Checkland & Scholes, 1990). Some other less well known approaches to IS development are the DEMOS project (Carlson et al., 1978; Ehn & Sandberg, 1983), the UTOPIA project (Ehn et al., 1983), the MARS project (Mathiassen & Bogh-Andersen, 1987), PORGI (Oppelland & Kolf, 1980), MULTIVIEW (Avison & Wood-Harper, 1990) and SAMPO (Auramaki et al., 1992). Each of these development methodologies involves making a number of implicit and explicit assumptions about the IS development process (Hirshheim & Klein, 1989).

This paper describes an alternative approach to systems development called QFD. In this particular case, however, the company used the technique in other areas of the business first. It was only subsequent to it being used elsewhere that it was then used as an alternative approach to IS development. In essence, the QFD approach is a cross-organizational team approach to IS development and explicitly addresses the communications barriers within organizations. The case study looks at the impact of QFD on the IT function, and shows how the application of a QFD approach to information systems development has changed the relationship between the IS department and users, and the systems development process itself.

The research methodology adopted was a contextualized, interpretive one, employing the techniques of case study research. The case study material was collected from unstructured interviews, company documents, and newspaper and magazine reports (see Sheffield & Myers, 1992). The company studied is a medium-sized manufacturing company in New Zealand called Fisher & Paykel Ltd. Fisher & Paykel designs, manufactures, markets and sells whiteware products (such as refrigerators, autowashers, etc.) to markets in Australia, New Zealand and overseas.

The paper proceeds as follows: The following section describes the Quality Function Deployment methodology. Section 3 describes the company which is the focus of the case study. Section 4 looks at the impact of QFD on information systems development in the firm. The final section presents the conclusions.

QUALITY FUNCTION DEPLOYMENT

This section briefly describes Quality Function Deployment (QFD). QFD is a customer-driven planning and communication process for designing, developing and improving products or services (see also Maddux, Amos & Wyskida, 1991; Hauser & Clausing, 1988). It can be seen as one of the approaches to Total Quality Management (TQM), where the focus is on customer satisfaction and continuous quality improvement. The aid of QFD is to capture and preserve the needs and wants of customers, known as the Voice of the Customer (VOC), through the design and development process. The QFD approach is multi-functional - various stakeholders in the design process (marketing people, planners, R & D, designers, engineers, manufacturers and so on) come together from a project's inception to concurrently plan, design and produce a product or service. One of the key assumptions of QFD is that there are communications barriers in most

organizations, and these barriers can be overcome by the use of cross-organizational teams. Although it was initially applied to manufacturing, QFD applications are growing rapidly in the service industry.

The use of QFD in information systems development overcomes some of the limitations of the traditional systems development lifecycle (SDLC) approach to ISD. QFD can be contrasted with the SDLC in a number of ways.

Firstly, the focus of development in the SDLC approach is typically on individual projects, which are driven by the individual functional areas of the business (e.g., marketing may promote the development of a marketing information system). A disadvantage of this approach is that it can lead to a lack of integration between systems and the various functions (Scott-Morton, 1991). The QFD approach tries to address this by the use of cross-functional teams in all projects; the assumption is that these project teams will tend to promote systems which encourage integration across functions.

Secondly, the SDLC approach typically assumes that development occurs in sequential fashion; any project is required to go through a series of distinct stages or phases, and a later stage must always be completed before an earlier one (e.g., analysis before design). The main limitation of sequential development, however, is the assumption that one stage can be perfectly completed before the next; often this is not possible (e.g., in many cases user requirements only become clear at a later stage). The QFD approach tries to overcome this limitation by the use of concurrent development and prototyping.

These and some other differences between QFD and the "phase review" approach of the SDLC are summarized in Table 1.

Table 1. Comparison of QFD and Phase Review Approaches

<u>PHASE REVIEW</u>	<u>QFD</u>
Functional driven	Cross-functional teams
Sequential development	Concurrent development
Technology driven	Customer and technology driven
Senior management veto power	Team leadership and consensus
Poor communication	Synergistic communication
Distortion of information	Retention of information
Mostly cost driven	Quality, cost and delivery driven

Some researchers have found that QFD has helped organizations to achieve, amongst other things, shorter time to market; lower life-cycle costs; higher quality of products, processes and services; increased cross-functional communication and cooperation; and greater ownership of projects (Hauser & Clausing, 1988; Maddux et al., 1991). Much research still needs to be done, however, as QFD is still relatively new.

QFD was first developed in Japan by Dr. Yoji Akao in 1966. The following is a brief chronology of QFD development.

- 1966 Dr Yoji Akao first proposed the concept of QFD
- 1972 First application of QFD was developed at Mitsubishi's Kobe shipyard
- 1974 Dr. Akao founded the JSQC research committee on QFD
- 1977 Toyota used QFD to resolve a persistent rust problem with its cars
- 1984 Dr. Don Clausing of MIT introduced QFD to Xerox
- 1986 Ford Motor Company began using QFD
- 1993 Widespread applications of QFD in manufacturing, services and government

The object of QFD is to translate and deploy the Voice of the Customer to the successive stages of the development process. The QFD process consists of a number of stages, known as the Houses of Quality (HOQ). The segments of each "house" are outlined in Table 2.

Table 2. Basic Segments of the House of Quality

Customer Requirements (Voice of the Customer)	Entrance
Internal Analysis	Walls
Relationship Matrix	Inside
Competitive Analysis	Back Yard
Trade-off analysis	Roof
Goals and Targets	Basement

The Voice of the Customer is the customers' needs and wants expressed in their own language. This information can be gathered in a variety of ways, some of which are one-on-one interviews, surveys, focus groups, customer complaints, front-line staff and industry organizations. When collecting the VOC it is important that all three dimensions of customer requirements are captured. These dimensions are explained below.

One-dimensional. Those requirements that are directly proportional to customer satisfaction.

Must-be. Those characteristics whose inclusion would not add to customer satisfaction but whose absence will reduce customer satisfaction.

Attractive. Those characteristics whose addition will increase customer satisfaction but whose absence would not reduce customer satisfaction.

Once VOCs are collected, they need to be structured in a hierarchy. Typically, customer characteristics are grouped into Primary, Secondary and Tertiary requirements. Special statistical tools such as Cluster Analysis, or techniques like the Affinity (K-J) Diagram, are used for grouping customer characteristics. During this process missed characteristics may be identified. It is the tertiary requirements that are normally entered into the House of Quality. In order to identify the relative weights of customer characteristics, an importance rating is assigned to each customer characteristic.

Internal analysis is the step in which capabilities or technical characteristics are identified and matched with customer characteristics. All company capabilities that impact each customer characteristic are identified and are listed along the columns of the House. A Fishbone diagram can be used to organize the relevant company capabilities for each voice of customer characteristic.

The relationship matrix is the main body of the HOQ and shows the degree of dependency or correlation between customer characteristics and technical characteristics. This can be measured subjectively by the cross-functional team. Typically, three degrees of correlation are identified:

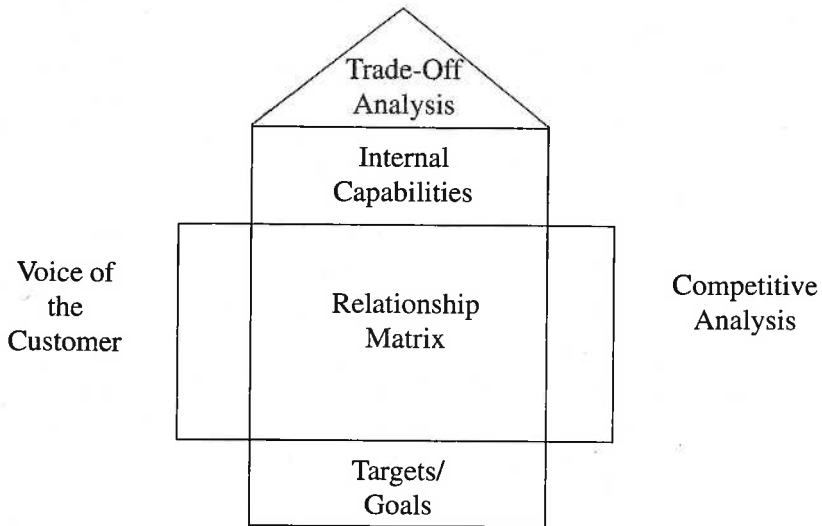
- Strong correlation
- Weak correlation
- No correlation

Competitive analysis, also known as "perceptual mapping," tries to position the company with respect to each and every customer attribute relative to the competition. In this process each customer attribute is compared to that of the competition and a ranking is established.

In trade-off analysis, conflicting customer requirements which necessitate that trade-off decisions be made with respect to company (or technical) characteristics are negatively correlated. The strategic implications of this analysis are quite significant. Identifying design trade-offs for a product or service provides fresh grounds for creativity and innovation. Conversely, in many instances internal capabilities (technical characteristics) are positively correlated. This indicates that these characteristics are mutually reinforcing and may have a synergistic effect on customer requirements.

The outcome of the HOQ analysis is specific goals and targets for action. These targets and goals represent opportunities for improvement and competitive advantage. This section may contain information on technical difficulties, relative costs and other optional information. A generic house of quality showing the different elements is shown in Figure 1.

FIGURE 1. A GENERIC HOUSE OF QUALITY



THE FISHER & PAYKEL CASE STUDY

This section describes the company which is the focus of the case study. The company, Fisher & Paykel Ltd., has for some time applied the principles of TQM to all aspects of its business. More recently QFD has been applied to the design and manufacture of its products and services, and parts of the QFD methodology have now started to be applied to information systems development.

Fisher & Paykel Industries Limited (F&P), with a turnover in 1994 of NZ\$670 million, designs, manufactures, markets and sells whiteware products (refrigerators, autowashers, etc.) to markets in Australia, New Zealand and overseas. F&P also markets the Panasonic range of products in New Zealand and has an Electronics Division which designs and builds electronics for F & P's own whiteware and healthcare products.

The company has a flat structure comprised of multiple, and largely autonomous, business units which specialize in operational competencies such as marketing, distribution and so on. Multiple business units exist within many of these functional disciplines where further subdivision is aligned to market segment or retail channels (in the case of marketing groups) or product types (in the case of manufacturing groups) and to geographic regions within any one marketing and sales sector. The divisions of F & P are shown in Table 3. It is worth noting that Group Systems (Information Systems) is a division of corporate services.

Table 3. Divisions of Fisher & Paykel Ltd.

<u>Major Appliances</u>	<u>Panasonic</u>	<u>Services</u>	<u>Corporate Services</u>
Refrigeration division	Consumer Electronics	Customer Services	Finance
Laundry products division	Office Automation	Division	Legal
Range and dishwasher division	Communications and industrial	Distribution Division	Personnel
Domestic sales and marketing			Group systems
International division			Corporate affairs

As a company, Fisher & Paykel endeavors to produce technologically advanced products and services so that it will continue to grow in both whiteware and healthcare products. In the 1994 financial year (ending 31 March 1994), the company achieved a 12% increase in overseas revenue as compared with the previous year (*Fisher & Paykel Annual Report*, 1994). In New Zealand, F&P was voted the "most admired" business by readers of the *National Business Review* magazine in 1993. Readers "praised Fisher & Paykel for the quality of products or services provided, and the degree of customer focus" (*New Zealand Herald*, 22 October 1993). In Australia, Fisher & Paykel has been voted Supplier of the Year by the Australian appliance industry for three years in a row (1991-1993) in *Mingays* magazine, and the Fisher & Paykel Smart Drive 601 Autowasher, the 913T Soft Touch Dishwasher and Freestanding Range were voted Products of the Year in their respective categories.

Fisher & Paykel has adopted a number of manufacturing strategies. One such strategy is to use flexible manufacturing techniques in which one production line can manufacture the entire range of any one of the F&P product categories. For example, the Refrigeration Division currently has the capability to manufacture over 1500 different models on an every-model-every-day basis in order to meet the requirements of customer orders. Another strategy has been to adopt the "Just in Time" (JIT) inventory management system. With JIT, Fisher & Paykel has reduced finished goods inventory to almost zero, and has less than one day's Work-In-Progress inventory. A third strategy has been to adopt the Total Quality Management approach, where there is a commitment to continuous improvement in all areas. The QFD methodology reflects the way in which TQM has been implemented with some areas at F&P. QFD was implemented first of all in product development and in the product quality group; it has subsequently been adopted in some other areas as well, including information systems.

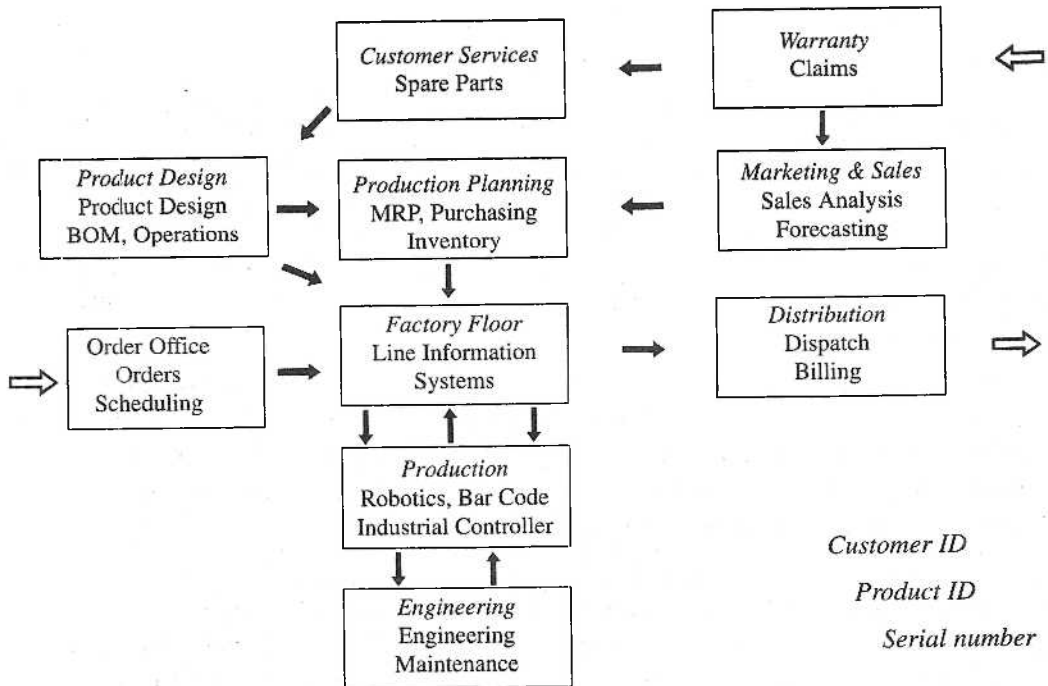
In order to understand how QFD has been used in information systems development at Fisher & Paykel, it is first of all necessary to briefly review how the IT strategy at Fisher & Paykel developed. By the mid-1980s information technology had evolved within the various business units with little regard for either the interdependence between dissimilar functions, or for the commonality of function and data structure that were required by the business units performing similar functions, especially manufacturing. Divergent systems were used inde-

pendently in different business units with little standardization (Caldwell, 1994). In the mid-1980s, however, Porter's value chain analysis was adapted to build a "system model" of the company, which simply grouped business units by operating function within the value chain. The model determined for the core business units the various layers of the value chain. By mapping the appropriate transactions from the core business units on to the system model, it became apparent that the information involved related to the same consumer, retail outlet, product type, unique appliance, and parts and materials, not only from the initiation of demand through to dispatch of product, but for the rest of the life of the appliance through its warranty period and subsequent use out of warranty. As a result of this analysis the IS division adopted an IS strategy as follows: *The provision of an integrated set of applications which would share a common, distributed database using Client/Server architecture on an Open Systems platform.*

Four major application categories were identified for management purposes as being based on specialized areas of expertise, all of which are interrelated by the major identifiers (customer, product, serial number). The four application categories are design, manufacturing and logistics, commercial and factory systems (Caldwell, 1994).

Since the late 1980s all information systems at Fisher & Paykel have been developed in accordance with the IS strategy outlined above. Today Fisher & Paykel has a shared database which links the order office, the factory floor, distribution and so on. This means that common data such as customer ID, product ID, and serial number are shared throughout Fisher & Paykel (see Figure 2). Fisher & Paykel uses a number of CAD/CAM software packages in the design and manufacture of products. The company has also developed what it calls the "Line Information System." This system controls the production process and interfaces to F&P's business systems as well as to NC machines and robots on the factory floor.

(Figure 2 on next page)

Figure 2. Fisher & Paykel's Shared Database

QFD IN INFORMATION SYSTEMS DEVELOPMENT

As previously mentioned, Quality Function Deployment was initially used by Fisher & Paykel in the design and manufacture of its products. In recent years, however, QFD has also been applied to other areas of the business including information systems. The IS Division has adopted those parts of the QFD approach which were deemed by the staff to be the most useful, adapting the approach to an information systems environment. The steps within the method which they decided to use (and added and/or expanded over the traditional SDLC approach) included:

- Defining a clear vision with clear goals
- Cross-functional teams involving users from the start
- Training key users in system modeling techniques
- Using CASE tools to assist the documentation of business models in systems terms (with major emphasis on data modeling)
- Prototyping to involve users and maximize their participation

So far, it has been found that the QFD approach has changed the relationship between the IS department and users, and the systems development process (for a prescriptive discussion of TQM in software development, see Zadzorny and Tumanic, 1992; see also Zuttner, 1993).

The application of QFD has changed the relationship between the IS department and users. One of the cornerstones of QFD is to have a customer-driven focus; now the IS department sees all employees in other areas of the business as "customers." With the term "user" and "customer" now synonymous, the staff in the IS Department have experienced a cultural change in which they now find they have to try to find ways of predicting and assessing whether new systems will satisfy users' ("customers' ") needs as well as meeting technological requirements. The IS Department sees itself as seeking to "provide customers with systems," and it is in the process of introducing "measures" along with internal service-level agreements to make sure that the systems meet users' needs.

One of the benefits of having formal agreements with systems customers (users) is that the users themselves become accountable for aspects of their own system's efforts in the areas of skill levels, provision of operational staff and in some cases being responsible for some software development and support. At the same time, any deficiencies in the quality of system delivery by the central IT group are identified and rectified.

Another area in which the systems development process has changed is in the area of the "control" of systems development. Unlike the traditional systems development lifecycle approach, where the development of an information systems project is usually managed by a single person in the IS department (project leader or systems developer), in QFD a project is controlled by a cross-organizational team. QFD mandates that representatives of all stakeholders must be on a project team, and this includes representatives from the various functional areas of the company (e.g., sales, finance, IS, etc.). An important element in this is that the communication and team skills of the individual members of the team are vital. F&P tries to encourage the development of cross-functional skills in the IS staff by constantly exposing them to other areas of the business, with active promotion of participation in interest groups and in the derivation and improvement of standards. IS staff are given explicit recognition and reward for efforts in these areas.

It has been found that the use of cross-organizational teams in systems development has an impact on the related issue of the perceived "ownership" of a system. In QFD, "ownership" of the system by customers (i.e., users) is seen as vitally important, and ideally ownership is established as early as possible in the project lifecycle. As far as Fisher & Paykel is concerned, the Group Information Systems Manager comments that "We get users together early, so that we establish ownership of the system by them right back at the modeling stage." This means that before starting a project, a project champion must be identified. The first stage of development involves preparing a "Vision Document" which customers (users) must sign before any work begins. The agreement of all the interested parties to specific goals avoids the "back room" approach to developing and installing systems.

Recently, the information systems department invented the term "group therapy" to describe how an information systems project is now developed at F&P. Instead of a single person (project leader or systems analyst) being responsible for documenting user requirements, managing the project and so on, Fisher & Paykel now use "group therapy sessions" in an attempt to capture and share the emerging vision of a system by users and developers alike. A clear vision where people can see the "big picture" eliminates misunderstandings, false starts or a fatal lack of commitment by future users (Caldwell, 1994). As part of Corporate Services, the IS Department's role has become to act as a facilitator (rather than controller) of information systems development, although in practice the IS Department still has to ensure that all development conforms to F&P's corporate standards.

CONCLUSIONS

This paper has looked at the application of Quality Function Deployment (QFD) as an alternative approach to information systems development. In essence, the QFD approach is a cross-organizational team approach to IS development and assumes that there are communications barriers within organizations which need to be addressed. QFD, as a particular implementation of the Total Quality Management philosophy, relies on a *social* model of the firm. QFD mandates that representatives of all the stakeholders be included in the development of a new product or process; the focus is on business processes and continuous improvement by all employees, not just managers.

As Fisher & Paykel has only recently started using the QFD methodology in information systems development, it is perhaps too early to determine its long term impact. A possible limitation of this research is that, because of the novelty of QFD in the IS Department, the users of the methodology may be somewhat overenthusiastic as to its real value. Another limitation of this research is that no "objective" measures were available from the company as yet; almost all of the information about the company's systems development practices was obtained through unstructured interviews and company documents.

However, Fisher & Paykel's implementation of TQM philosophies in manufacturing has had a positive impact on customer and supplier perceptions of the company and its products in Australia and New Zealand. Further research is now needed to examine the impact of TQM philosophies and QFD in particular on IS development over time.

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