Computers & Industrial Engineering 58 (2010) 672–679

Contents lists available at ScienceDirect

Computers & Industrial Engineering

journal homepage: www.elsevier.com/locate/caie

Application of quality function deployment in the semiconductor industry: A case study

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ARTICLE INFO

Article history:
Received 16 February 2007
Received in revised form 26 October 2009
Accepted 12 January 2010
Available online 21 January 2010

Keywords:
Quality function deployment (QFD)
Semiconductor industry
Process management
Voice of customer
Customer satisfaction

ABSTRACT

In quality function deployment (QFD), the voice of the customer (VOC) is the critical factor in developing and producing a product that will meet or exceed customer requirements. This study integrates quality function deployment (QFD), management techniques to optimise product-design investment, process improvement, and phase-into meet customer requirements and company goals. QFD uses systematic multi-level development and evaluation to translate customer requirements into the design of product characteristics and manufacturing processes that will satisfy the customer and minimise potential failure costs. 'Process management', which is one of the pivotal Six Sigma implementation criteria, is used to construct an 'integrated product and process development' (IPPD) model by product type to enhance the effectiveness of QFD. This model, combined with a company's customer satisfaction strategy and QFD techniques, provides process management through built-in IPPD and appropriate changes in organisational culture. This paper presents a case study from the semiconductor industry to demonstrate the model's applicability and suitability.

1. Introduction

A wide variety of management and engineering techniques are currently used in attempts to improve the performance and efficiency of organisations. These include business process reengineering, process improvement, activity-based management, and change management. The common element in most of these techniques is a focus on improving the performance of individual business processes and/or improving the overall performance of a system or network of processes (Hammer, 1996; Thomson, 1995). However, the relative independence of many company departments and the poor communication that often exists among those departments has meant that many traditionally organised companies face difficulties improving their performance, especially with regard to attempts to become more 'customer-oriented'. The fundamental problem has been that their communication problems have led to a narrow, function-focused approach to operational improvement. To overcome these problems, modern companies are increasingly being organised in terms of integrated *processes* (rather than individual business functions). This enables organisations to focus on their customers because such a 'process approach' enables cross-functional and cross-company teams to contribute combinations of products and services that add value for customers (Copacino, 1997; Schorr, 1998; Stahl & Grigsby, 1997; Weele, 2000).

In this regard, quality function deployment (QFD) is of particular interest as a potential process-improvement mechanism. QFD, which is essentially the adaptation of tools used in total quality management (TQM), facilitates the formulation of business problems and possible solutions through effective communication among the members of a product development team (Cohen, 1995). QFD originated in the late 1960s in Mitsubishi's Kobe (Japan) shipyard to support the product-design process. Although it was originally used for the design of large ships, QFD has evolved to apply to any planning process (including service development) in which a team seeks to prioritise possible solutions to achieve a given set of objectives (Urban & Hauser, 1993). Since the introduction of QFD in the USA in the early 1980s, it has spread widely among a variety of industries in the Western world. Prominent users of QFD have included Ford, Procter and Gamble, Campbell's Soups, IBM, Xerox, Hewlett–Packard, Kodak, and 3 M Corporation (Benner, Linnermann, Jongen, & Folstar, 2003; Cohen, 1995; Evans & Lindsay, 2005; Griffin & Hauser, 1993).

This study proposes a novel development in QFD methodology utilising process-management techniques. The aim of the study is to provide some insights into the potential benefits of this integrated methodology for the semiconductor industry.

2. Literature review

Product development is usually considered to be a set of activities beginning with the perception of a market opportunity and ending in

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doi:10.1016/j.cie.2010.01.011

the production, sale, and delivery of a product (Ulrich & Eppinger, 1995). In this process, the product-design phase is recognised as being crucial for a product's performance over its entire life cycle. As a result, a new research area, which has been variously called 'life cycle engineering', 'concurrent engineering', or 'integrated product and process development' (IPPD), has been receiving increased attention from researchers in both industry and academia (Syan & Menon, 1994). A variety of research issues have been raised in this area, including (Yan, Zhou, & Sebastian, 1999):

- design for manufacture (DFM);
- design for assembly (DFA);
- rapid prototyping; and
- quality function deployment (QFD).

As a first step in new product development, the right business strategy is required to meet the challenges of the present and future market. A manufacturing organisation must understand what customers want and must develop internal mechanisms to respond promptly to any changes in products demanded by customers. This requires a paradigm shift in manufacturing because it is no longer sufficient for manufacturers to rely on the use of state-of-the-art concepts and technologies to deliver new products that will inevitably be successful; rather, they must also, in effect, think in the 'reverse direction' (Davido & Malone, 1992) by developing products that faithfully realise the expectations of their customers. Contemporary customer demands include greater customisation and shorter product lead-times, which requires manufacturers to set appropriate control criteria and zones of tolerance for critical design variables (Singh, 2002). Global competition to meet these demands has resulted in the introduction of various new manufacturing concepts, practices, and technologies. Integrated product and process development (IPPD) is one such management process that aims to reduce product lead-time and cost, while simultaneously ensuring that product quality is maintained in accordance with customer requirements.

IPPD integrates all activities from product concept through production to field support. It utilises a multifunctional team to optimise the design and manufacturing processes of a product to meet cost and performance objectives. The premise of IPPD is that product quality and user satisfaction can best be achieved by integrating all design elements and processes (Mervyn, Kumar, Bok, & Nee, 2004). According to Curran, Raghunathan, and Price (2004), the aim of IPPD is to ensure that task information originating within individual engineering functions is shared among all relevant design and manufacturing operations to facilitate and control cooperative decision-making.

The quality and reliability of a product are predominantly determined in the early phases of the development process, and the relationship between customer requirements and design characteristics is the driving force of QFD methodology. The details of the methodology are set out in the works of Akao (1990), King (1989), Govers (2001), and Chakraborty and Dey (2007); however, for the purposes of the present study it is sufficient to observe that QFD enables an organisation to build quality into a product and control the development process from conception to the commencement of manufacturing operations.

QFD is thus a customer-driven, forward-thinking, and action-oriented strategic planning technique that is applicable to the develop-

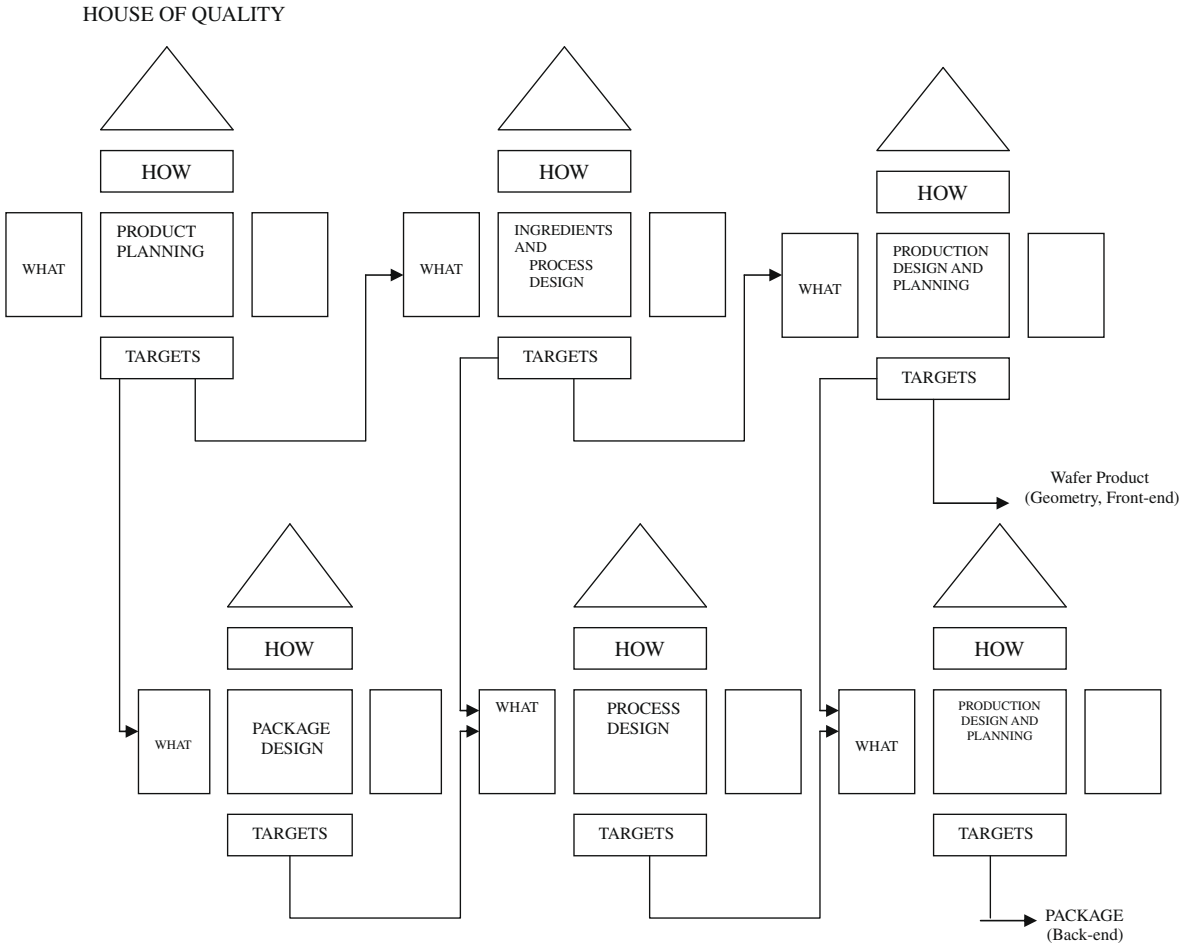

Fig. 1. Quality function deployment in the semiconductor industry.