QFD's Evolution in Japan and the West

by **Jui-Chin Jiang, Ming-Li Shiu and Mao-Hsiung Tu**

Even though the initial theory of quality originated in the United States, early industrial applications predominantly took place at Japanese companies.

At first, Japanese companies used quality control in manufacturing and inspection areas. But, the Japanese automobile industry recognized the importance of designing quality into new products in late 1960s, when it was in the midst of rapid growth as it developed many new products and changed models.

Yoji Akao conceived quality function deployment (QFD), a concept and method that served as a vital management tool for new product development.[1]

The ultimate benefits of QFD are lower product development costs, increased customer satisfaction and increased market share. It has been well documented that using QFD can result in the following:[2, 3, 4]

- Reduction of development time by 50%.
- Reduction of the number of engineering changes by 50%.
- Reduction of start-up and engineering costs by 30%.
- Reduction of warranty claims up to 50%.
- Increased customer satisfaction.
- Systematic retention of product development knowledge so it can be easily applied to similar future designs.

In 50 Words Or Less

- **The historical development of quality function deployment (QFD) in Japan and the West evolved through three generations.**
- **QFD will become an integral quality assurance architecture that can be implemented concurrently with product development processes, instead of existing as a mere series of matrices.**

Definition

QFD refers to the combination of quality deployment and narrowly defined QFD.[5, 6] This definition is depicted in Figure 1.

Quality deployment converts customer demands

into the design quality of the finished product. It covers design targets and major quality assurance points, which are the key points and control items in achieving sales and preventing a recurrence of past and potential new product design and development problem areas.

Quality deployment is used at all levels of product architecture and during process design. The purpose of quality deployment, therefore, is to establish a quality network that can ensure the quality of a product itself.

This network includes both quality of physical elements—subsystems, component units, parts and materials—that constitute a product architecture, and quality of production processes that manufacture and assemble partly finished products into finished products. This is illustrated in the quality deployment section of Figure 1.

Narrowly defined QFD is derived by extending the concept of value engineering that is originally applied to defining the functions of a product to the deployment of business process functions.[7]

Therefore, the word "function" in QFD refers to the job functions of a product development process, rather than to the functions of the product itself. Then, job functions that can create product

FIGURE 1 Quality Deployment and Narrowly Defined Quality Function Deployment

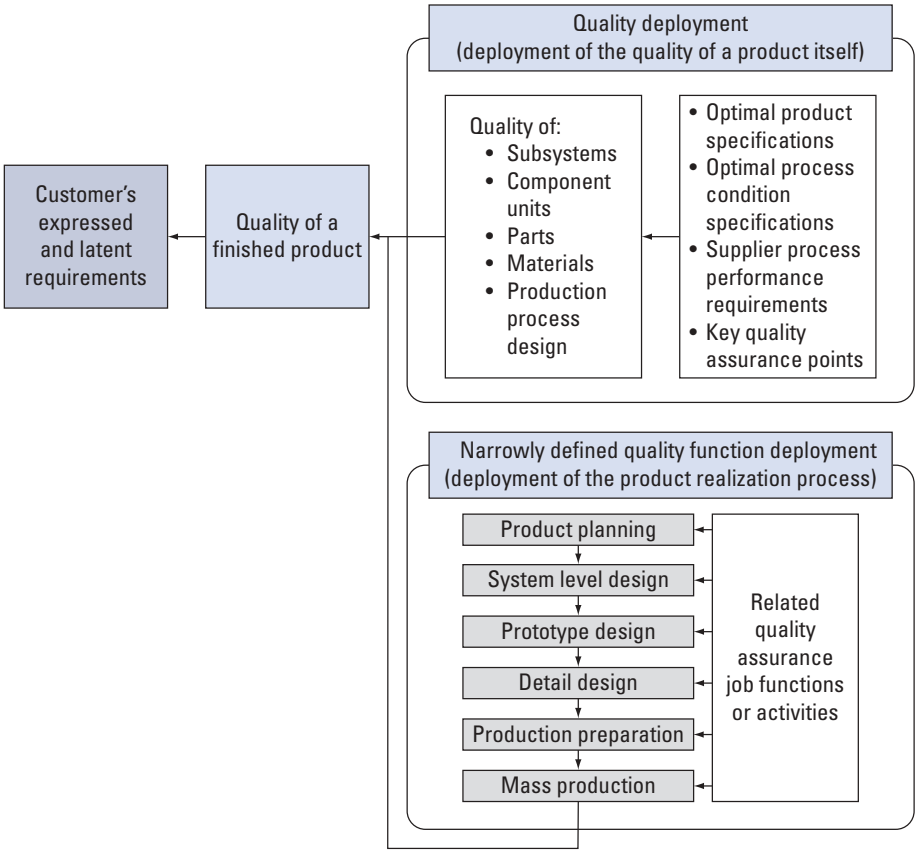
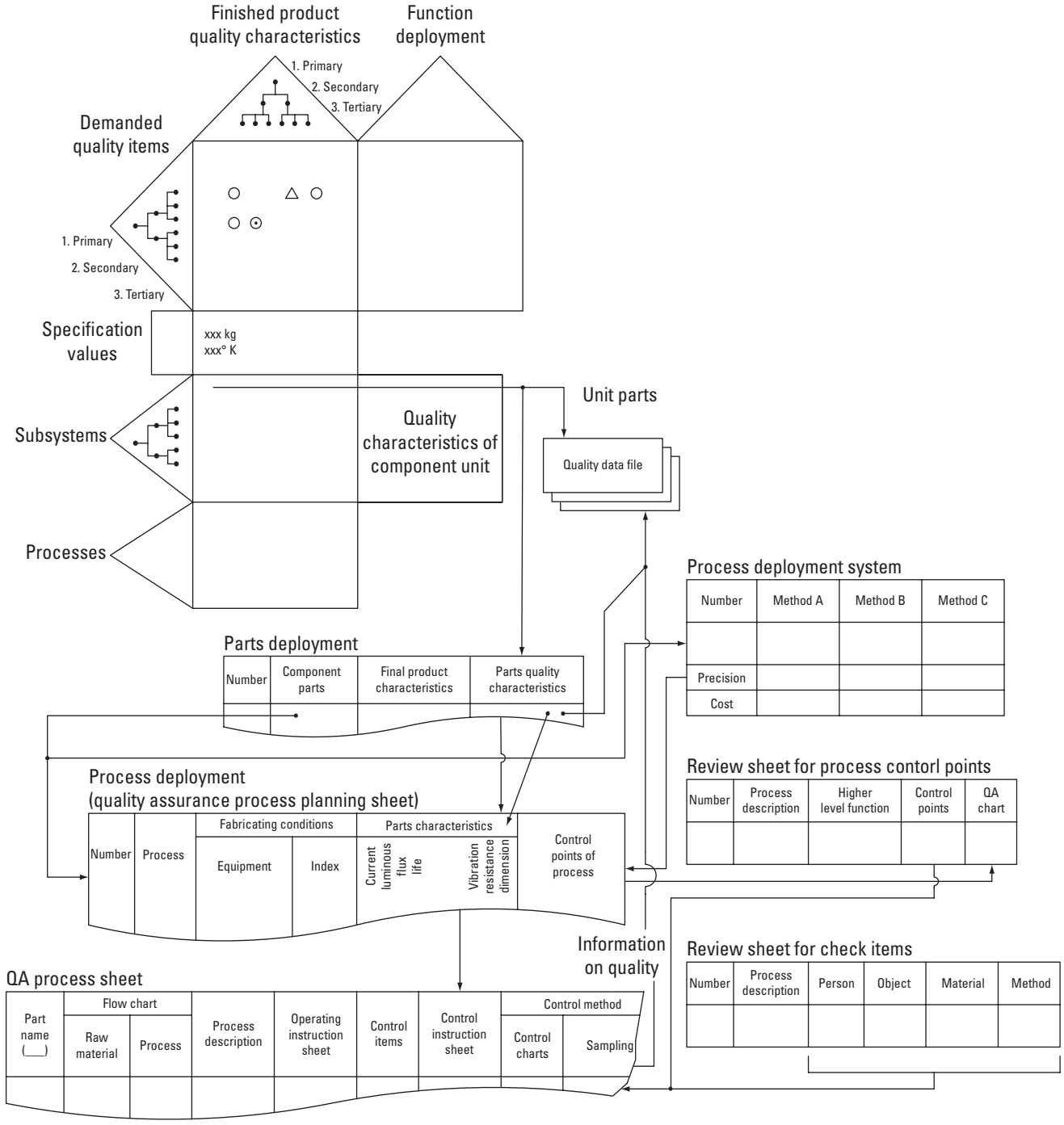


FIGURE 2 Original Quality Function Deployment Design



quality are called quality functions.

The purpose of narrowly defined QFD is to establish a procedure network that is formed by various planning and operational quality assurance activities and procedure flows to achieve product quality.

This network includes activities at all stages of the product realization process, from product and technology development planning, system level design, prototype design and detail design to production preparation and mass production. This is illustrated in the narrowly defined QFD section of Figure 1.

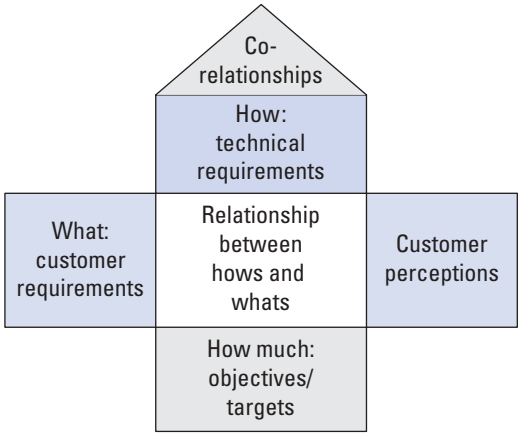
QFD is the most complete, systematic and convincing method for designing products with the quality that fulfills expressed and latent requirements of customers.

QFD's Evolution

When QFD was conceived in Japan in the late 1960s, the Japanese recognized that it was important to design quality into new products. But they lacked guidance on how this could be achieved.

Akao was the first person in Japan to propose QFD to address the design situation.[8] Akao's original QFD design, shown in Figure 2, represents the first generation of QFD in Japan. He and Shigeru Mizuno published the first book on the topic in 1978.[9]

FIGURE 3 House of Quality



The steps to a QFD system were defined as including:

- The establishment of a quality chart to convert customer demands into substitute quality characteristics and determine their design targets.
- The deployments of subsystems, parts and processes.
- The deployment of related job functions.

QFD is the most complete, systematic and convincing method for designing products with the quality that fulfills customer requirements.

The first article that introduced QFD to the West was published in *Quality Progress* in 1983.[10] In the same year, a comprehensive system of QFD, including technology, cost and reliability—which reflects quality, technology, cost and reliability considerations necessarily involved in product development—was presented in Japan.[11]

Apart from the quality deployment, the system also includes:

- Ensuring that any bottleneck technology that hinders the realization of design quality is extracted and solved at the earliest possible time.
- Preventing potential failures and their effects through early prediction.
- Achieving target costs balanced with quality.

This comprehensive QFD system represents the second generation of QFD in Japan.

In the meantime, Western authors introduced the quality chart, or house of quality (HOQ), as the main tool of QFD.[12, 13]

The HOQ in Figure 3 illustrates how to use a quality chart to convert customer demands (whats) into quality characteristics (hows) and determine

their design targets (how much) in great detail.

But these Western writers used only a simple conceptual model of linked houses of quality, as shown in Figure 4 (p. 35), to show how a quality chart can be combined with the other deployments, such as subsystems, parts and process deployments

Although the linked houses of quality tool is the earliest QFD model made by Western researchers (the first generation of QFD in the West) and the most recognized QFD form today in the West, the tool was oversimplified and left out much important information from the original QFD.

TABLE 1 QFD Evolution in Japan and the West

Evolution	Japan	The West
First generation	Original quality function deployment (QFD)	Four linked houses of quality
Second generation	Comprehensive system of QFD—including technology, cost and reliability	30-matrix model of QFD
Third generation	Real-time database QFD	Critical parameter management
Evolutionary direction	**Toward adding value to every activity in the product development process to competitively improve product quality**	**Toward integrating various design tools and methods to competitively improve product quality**

Despite the passage of time since the comprehensive QFD system was introduced, few books and articles have been written on the topic in English. A notable exception is Bob King's 30-matrix model of QFD.[14] This model can be viewed as the most complete (including technology, cost and reliability) QFD model made by Western researchers, and as the second generation of QFD in the West.

When QFD was spread internationally, some misunderstandings about the original QFD were gradually engendered and publicized. The common misunderstandings include the following:

Quality deployment is equivalent to a quality chart. Although QFD has been simplified in the form of linked houses of quality in the West, the majority of QFD applications stop with the completion of the first matrix, the quality chart.[15, 16, 17]

C.A. Cox says no more than 5% of companies go beyond the quality chart.[18] However, most Japanese companies not only go beyond the quality chart to use the subsystems deployment chart, parts deployment chart and process deployment chart (all known as quality deployment), but also implement technology deployment, cost deployment and reliability deployment.

QFD is equivalent to quality deployment. As already noted, broadly defined QFD refers to the combination of quality deployment and narrowly defined QFD. Although narrowly defined QFD is the essential part for QFD to gaining long-term buy-in, implementation and compliance, the term QFD has been used to mean quality deployment in itself, and narrowly defined QFD has been completely overlooked by most QFD practitioners outside Japan.[19]

Different Directions

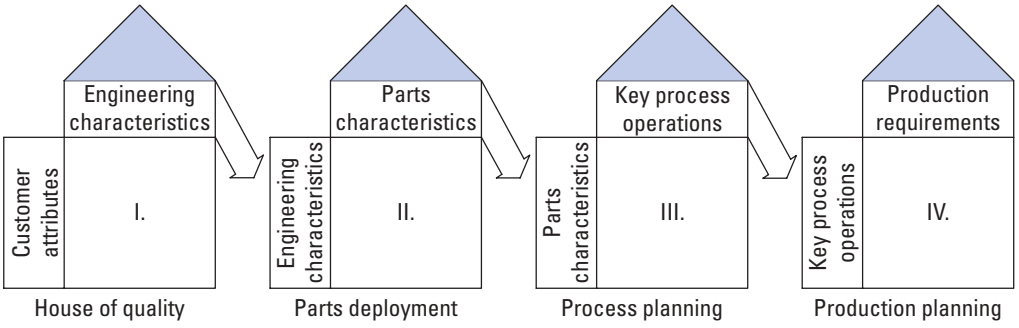
In the past, although some misperceptions about the essence of QFD did exist, Western QFD basically developed following the model of Japanese QFD. However, the difference between the current development of the so-called third generation of QFD in Japan and the West can be considered a change in which they have begun to develop QFD in different directions.

The current Japanese QFD is based on narrowly defined QFD. Also known as the deployment of a new product development process for implementation, this version of QFD is known as real-time database QFD (Rdb-QFD). Its original concept was proposed by Tadashi Ohfuji, who says all quality deployment charts should be retrievable in real time from a computer database according to needs during each stage of product development.

Western QFD has now combined with TRIZ, Kano analysis and the Taguchi method and is used by Six Sigma experts.

TRIZ is a Russian acronym for a theory of inventive problem solving. Kano analysis stratifies the importance of demanded qualities based on customer perception. Genichi Taguchi's method has been further developed into a form of critical para-

FIGURE 4 Linked Houses of Quality



meter management by Six Sigma experts and is used in implementing design for Six Sigma activities as the basis for the define, measure, analyze, design and verify model.

The biggest difference between the latest developments of QFD in Japan and the West is that the former's QFD, in concept and method, points toward how to add value to every activity in the product development process to competitively improve product quality. On the other hand, the latter's QFD points toward how to integrate various design tools and methods to competitively improve product quality. Table 1 summarizes these differences.

Future of QFD

QFD must become an integral quality assurance architecture that can be concurrently implemented within the product development process, not as merely a series of matrices. The word "integral," in this context, means integrating both Japanese and Western approaches to QFD, as shown in Figure 4, by combining various design tools and methods with QFD to strengthen the quality deployment process itself, as in the following examples:

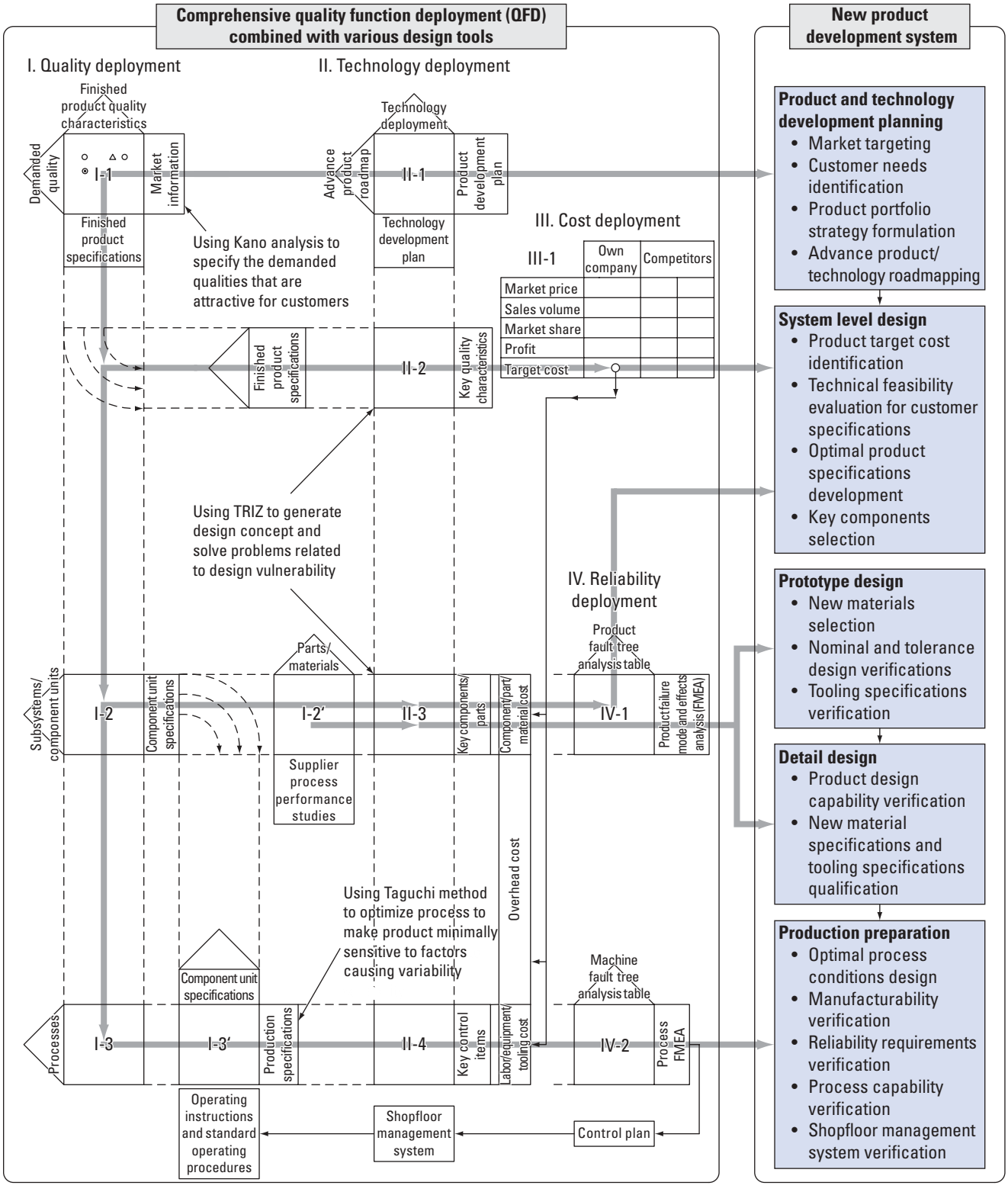
- In deploying demanded qualities, Kano analysis can be introduced to get a better understanding of the customer's perception.
- In deploying finished product quality characteristics and subsystems, TRIZ can be used to enhance creativity in design concept generation and design problem solving.
- In deploying processes, the Taguchi method can be adopted to determine optimal process conditions more effectively.

When deploying the quality assurance activities (narrowly defined QFD) in new product development processes, various quality deployment charts are made and linked at each process stage, as in the various sections of Figure 5 (p. 36):

- I-1 and II-1 can be used to identify customer needs and formulate advance technology development plans during the product and technology development planning stage.
- II-2 and III-1 can provide information on technical feasibility evaluation and target costs needed for the system level design stage of product development.
- I-2, II-3 and IV-1 help to develop optimal product specifications and select key components.
- I-2′ and II-3 can be used to choose materials, tooling and product specifications and conduct their verification during the prototype-design and detail-design stages.

Although QFD has been simplified in the form of linked houses of quality in the West, the majority of QFD applications stop with the completion of the first matrix, the quality chart.

FIGURE 5 QFD: Integral Quality Assurance Architecture for New Product Development



- I-3, I-3′, II-4 and IV-2 can be used to evaluate and verify optimal process conditions, product manufacturability and process capability during the production preparation stage.

QFD is generally implemented through a project approach, but the trend toward a conceptual model, shown in Figure 4, that is implemented through a more process oriented approach, will add real value to any new product development system and thus result in more systematic innovation.

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