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Chan Yin Ping
Abstract

In the past two decades, Hong Kong’s economic activities have markedly shifted from manufacturing to services. The economic shift has led to a radical change of manpower demand, which has brought great challenges to industrial training. Besides many new jobs created by the services industries, the upgrade from production to provision of services of the manufacturing industries requires new industrial training programmes in order to avoid the occurrence of a skill and knowledge gap. On the surface, it seems to be simply a matter of content rearrangement and material recompilation. However, the new job nature, the changed incumbents’ background and the altered use of learnt material indicate that a new curriculum development method is needed in order to design effective industrial training courses for the knowledge-based job incumbents of today’s professional services industries.

Besides the fact that the traditional solution-driven, teaching-oriented curriculum development method, which is used for skill training, might not be appropriate for knowledge training, the implementation of TQM is also imperative to the industrial training institutions to bring about change so that they may continue to support the manpower development of the industries. In regard to the needs of the industrial training industry, the aim of the study was to adopt the basic principles of QFD, a proven methodology for achieving customer satisfaction and a useful production development technique, to develop an industrial training curriculum development model for enhancing the industry-specific knowledge required by the job incumbents of the service-oriented manufacturing industries in Hong Kong.
Firmly adhering to the QFD principles, the model was characterized by the performance-focused and job-incumbent-centred approach. Recognizing the importance of dually meeting the job performance requirements and the knowledge needs of the incumbents, the model emphasizes that both the employers’ and individuals’ voices have to be carefully listened to and provides a mechanism for appropriately incorporating the voices into the development process so as to yield a curriculum that would satisfy the respective needs of the two parties. In addition to assisting managers to define the “Whats” and job incumbents to identify the important “Hows”, the industry training practitioners’ job is to synthesize the materials into a coherent curriculum for meeting their needs. Through logical task appropriation, the model creates an all-win situation for the parties concerned.

Using the clothing industry in Hong Kong as the ground for study, a quasi-experiment and two field applications were conducted to demonstrate the applicability of the model. In addition to the high customer satisfaction levels (over 82%) recorded for the industrial training curriculum developed using the model, a number of positive comments were received from those who had used the model in empirical studies. All of the data obtained from the empirical studies provided practical evidence for illustrating that the model is useful for developing industrial training curricula.

As can be seen from above, the model developed in the course of the study may be used by practitioners to develop curricula for industrial training. In addition, by implementing the process and the method adopted for the model, industrial training institutions will find it possible to implement TQM. Last but not least, the validity of the model supported the applicability of QFD in vocational education and training.
enterprises.
Publications Arising from the Thesis

Journal Papers:


   * Received an exclusive journalistic review in: Designs on better distance learning. *Training Strategies for Tomorrow, 16*(6), 6-9.


Conference Papers:


* Winner of the Best Paper Award under the sub-theme of “5-S, Lean Management, QFD, and QC Tools”


* Winner of Akao Scholarship 2007


* Winner of the Best Paper Award under the sub-theme of “5-S, Lean Management, QFD, and QC Tools”


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Chapter 1
Overview
1. Introduction

Over the past two decades, Hong Kong’s economic activities have markedly shifted from manufacturing to services. Since the 1980s, the Mainland’s open-door policy and economic reform not only has provided an enormous production hinterland and market outlet for Hong Kong’s manufacturers but also has created abundant business opportunities for a wide range of services. The share of the secondary production in Gross Domestic Product (GDP) diminished from 29.3% in 1986 to 8.8% in 2006 and that in total employment shrank from 42.4% in 1987 to 13.2% in 2007. On the contrary, the share of the tertiary production in GDP significantly went up from 70.1% in 1986 to 91.2% in 2006 and that in total employment greatly increased from 55.6% in 1987 to 86.6% in 2007. Given the rapidly changing global and regional economic environment and prompted by the closer integration with the Mainland, Hong Kong’s economy will continue to move towards services. On the one hand, the ample business opportunities provided by the thriving Mainland economy will lead to the emergence of more new services industries. On the other hand, the availability of cheaper land and labour on the Mainland and its rising productivity will drive the existing industries to provide more value-added services.

The economic shift from manufacturing to services has led to a radical change of manpower demand. This manpower change has brought great challenges to industrial training, which has been important to job incumbents on acquiring the kinds of skill and knowledge which are specific to the industries that they serve. Besides many new jobs created by the newly emerged services industries, more importantly, the upgrade from production to provision of services of the manufacturing industries requires new industrial training programmes in order to
avoid the occurrence of a skill and knowledge gap. On the surface, it seems to be simply a matter of content rearrangement and material recompilation. However, the new job nature, the changed incumbents’ background and the altered use of learnt material indicate that a new curriculum development method is needed in order to design effective industrial training courses for the knowledge-based job incumbents of today’s professional services industries.

The traditional solution-driven, teaching-oriented curriculum development method, which is used for skill training, might not be appropriate for knowledge training. Individuals enter industrial training is to learn the material that would help them to solve the industry-specific problems in their workplaces. If the content is mainly based on the suggestions or the experience of the instructors, then the course that is subsequently developed may not be that suitable and easy for the individuals to apply to their actual practice. Therefore, the process should begin from taking the individuals’ perspective to think about their working needs. Using the clothing industry as the ground, the preliminary aim of this study was to devise an appropriate way to develop industrial training curricula, in particular for enhancing the industry-specific knowledge required by the job incumbents of the service-oriented manufacturing industries in Hong Kong.

2. Clothing Industry in Hong Kong

Since the 1960s, the clothing industry has been one of the important industries and a major export earner of Hong Kong. In the last two decades, similar to other traditional industries in Hong Kong, the clothing industry has restructured from manufacturing to services (Ho, 1992; Wong, 1994). In response to rising
production costs, increasing protectionism of the importing countries and growing competition from other newly industrialised economies, the clothing industry has made use of its own comparative advantages and utilized every available opportunity to move up the value chain (Lui & Chiu, 1994; Tuan & Ng, 1994). The industrial restructuring was successful. On the one hand, it has brought a tremendous growth to its merchandise exports. From 1990 to 2005, Hong Kong’s clothing merchandise exports almost doubled, from US$15,406 million to US$27,292 million. On the other hand, it has contributed to the overall development of services exports of Hong Kong. From 1997 to 2006, Hong Kong’s merchanting and other trade-related services exports increased from HK$73.4 billion to HK$181.4 billion.

As an outgrowth of the textile industry, the clothing industry started in the form of garment production in the mid-1950s. The communist takeover in 1949 caused a huge influx of refugees and many entrepreneurs to flee from the Mainland to Hong Kong. Among the entrepreneurs, there were a number of textile industrialists from Shanghai. They brought with them the technical know-how, capital and machinery to Hong Kong to set up textile mills. In the early 1950s, although the outbreak of the Korean War provided the textile industry an excellent opportunity for exporting cotton yarns and fabrics to the overseas markets, the import restrictions imposed by the United Kingdom resulted in a surplus of textile products (Szczepanik, 1958, pp. 45-57). The availability of yarns and fabrics promoted the development of garment production. With the abundant supply of labour and facilitated by the privilege of the British Commonwealth Preferential Tariff, garment production growth was extraordinarily rapid (Ancrum & Rothman, 1987; Wu, 1992, p. 110). During the years from 1955 to 1964, the value of the clothing exports increased five-fold, from HK$330 million to HK$1,642 million, and the employment of the sector sharply
rose from about 7,000 to around 60,000. In the early 1960s, the clothing industry overtook the textile industry to become the largest manufacturing sector of Hong Kong. Despite the major markets, such as the USA and EC, which had increasingly imposed import restrictions, the clothing manufacturing of Hong Kong prospered in the 1970s and 1980s. In 1975, the value of the clothing domestic exports was HK$10,202 million, which accounted for 44.6% of Hong Kong’s total domestic exports. In the same year, the sector employed 238,958 persons, representing 35.2% of the total manufacturing workforce. Except for 1978 and 1979, Hong Kong was the world’s largest clothing exporter from 1973 to 1985.

In the 1970s, after more than two decade’s of rapid growth, the increasing competition from the lower cost countries, such as Pakistan, Sri Lanka and Bangladesh, caused the export-oriented clothing industry in Hong Kong to develop offshore production (Young & Hood, 1985). On the one hand, the increasing trade protectionism drove many clothing companies to seek production in other developing countries in order to obtain the quotas to export their goods to the major markets in the western countries (Chadha, 1992; Au & Yeung, 1999). On the other hand, the rising land prices and factory rents as well as the increasing labour wages and material costs forced the clothing manufacturers to look for cheaper production sites in order to sustain their competitiveness (KSA, 1988; Leung, 1996). In order to overcome the quota and the cost problems, some clothing manufacturers chose to relocate their production to South East Asian and Latin American countries and some others took the opportunity of the open-door policy of the Mainland for moving their labour-intensive production across the border (Steele, 1990; Khanna, 1993). Since the massive transfer of assembly lines out of the region in the 1980s, many clothing manufacturers have shifted or expanded their business to merchandising. The
clothing industry in Hong Kong has correspondingly restructured from a production
centre to an export centre (Yip, 1991).

With the transformation from “Made in Hong Kong” to “Made by Hong Kong”, the
clothing industry has entered into the new services era (Berger & Lester, 1997). The
vast expansion of offshore production has switched the major business activity
of the industry from production to provision of various kinds of value-added
merchandising services, ranging from order coordination, product development,
quality assurance and technical advice to logistics (Au & Yeung, 1997a, 1997b). With the increase of global sourcing of the developed countries and China’s
accession to World Trade Organization (WTO), more and more overseas buyers have
increased their purchases of clothing merchandise from this “world factory” as well
as some other developing countries (Yam, 2000; Zhao & Wong, 2003). The
established offshore production, coupled with other factors such as manufacturing
expertise and extensive network, have enabled the clothing industry in Hong Kong
further develop its merchandising services from offering production services to
provision of sourcing services (Glasse, 1994; KSA, 1996). In the current
millennium, Hong Kong has become an international trade and global sourcing
centre of clothing merchandise.

In 2005, Hong Kong was the third largest clothing exporter of the world. The value
of clothing merchandise exports was US$27,292 million, accounting for 11.9% of
the world’s total value of clothing exports.
3. **Industrial Training for Clothing Industry**

The establishment of the Clothing Industry Training Authority (CITA) in 1975 started the provision of formal industrial training for the clothing industry in Hong Kong (Wu, 1992, pp. 152-153). It is one of the two levy-funded training schemes initiated by the government for supporting industrial growth. Since the 1950s, given a number of favourable factors, including the supply of abundant low-cost labour and availability of capital, the manufacturing industries in Hong Kong have developed extraordinarily rapidly (Riedel, 1974). Nevertheless, the increasing competition from other developing countries forced the manufacturing industries to raise their productivity and produce more sophisticated products if expansion was to be maintained. In the mid-1960s, companies were in need of skilled workers to improve their product quality and to diversify their product ranges in order to stay competitive in the market. Since insufficient training was provided to keep pace with the industrial expansion, the increasing demand for skilled workers thus turned into an acute labour shortage (ITAC, 1966). In order to sustain industrial growth, the government appointed the Industrial Training Advisory Committee (ITAC) to examine the problem and review its policy on industrial training.

The Final Report of the ITAC revealed that the manpower shortage had been negatively affected the manufacturing industries. It had brought the employers a vicious cycle in which not only the labour cost was raised but the production quality was also lowered:

“The shortage caused many employers to resort to the throat-cutting method of poaching trained workers from other firms by offering higher wages. On the
other hand, the fear of losing their own trained workers to others has deterred many employers from training. A serious side effect of the shortage is the dilution of skill. An anxious employer may employ a semi-trained worker to perform skilled work and an apprentice may be tempted to leave training and pose as a skilled worker.”

(ITAC, 1971, p. 11)

Besides fear of losing the trained workers to other companies, Ng (1987) added that the lack of know-how and resources were also the major reasons why the employers did not want to earmark funds for training purposes. Upon understanding the problem, the government took up the role of coordination and assisted the employers of various industries to provide training for their workforce (England & Rear, 1975, pp. 38-40). Besides the Apprenticeship Ordinance for promoting and regulating apprentice training in designated trades, the government also enacted the ordinances for establishing the Construction Industry Training Authority and the Clothing Industry Training Authority (Tam, 1991). These two training authorities were financed by respective levies to provide training for their industries. The levy for CITA is 0.03% on the Free-on-Board value of clothing and footwear items produced in and exported from Hong Kong.

Towards the end of the 1970s, the increasing competition from the cheaper cost producing areas and the growing pressure of quota restrictions on textile and garment imports in the major markets forced the manufacturing industries in Hong Kong to further diversify their product ranges and to “trade-up” as well (Sit & Wong, 1989, p. 18). By the early 1980s, Hong Kong started to enter the period of internationalisation (Redding, 1994). In view of the change, the government
decided to centralize the provision of industrial training so that the supply of manpower could be strategically planned for supporting the new economic development of Hong Kong (Ashton et al., 1999, pp. 109-118). Although the levy scheme provided an organized way for the industries to arrange the required training for their workforce, the government was advised that it might be inadequate for meeting the overall manpower demand of Hong Kong:

“We find there is considerable scope for improving the existing arrangements for industrial training. As we have noted, few commercial or industrial concerns in Hong Kong have either the space or expertise to provide the training required by their staff. Thus, individual industries and firms have not generally accepted the responsibility for training assigned to them by Government policy. There are, as yet, two industrial training centres. We consider that this lack of industrial training facilities will hamper industry’s ability to remain competitive in world markets in the 1980s.”

(Report of the Advisory Committee on Diversification 1979, p. 239)

In 1982, the government formed the vocational education and training system and established the Vocational Training Council (VTC). In order to improve the coordination and to facilitate the implementation of a more sophisticated form of manpower planning, technical education and industrial training was put under the management of the VTC. In this policy change, both the clothing and construction industries were given the option of having their schemes financed from general revenues but they preferred to retain their levies (Waters, 1982).
Over the years, the progressively more sophisticated training programmes on offer and the upgrading of the in-service personnel of CITA have contributed to the success of the clothing industry in Hong Kong. However, the massive transfer of production lines elsewhere in the late 1980s drastically reduced the levy received by CITA because of the decreased garment domestic exports. Between 2001 and 2007, the levy dropped more than 45%, from HK$21.7 million to HK$11.8 million (CITA, 2001, 2007). When quota abolition is completely implemented in 2009, garment domestic exports are expected to decrease sharply. The continuously reduced income from levy indicates that CITA, at least to a degree, needs to be financially independent. Rather than a threat, it would be an opportunity for CITA to develop its own business. However, it has to formulate a long-term strategy in order to run its business successfully.

4. Total Quality Management for Education

As early as the 1970s, the public educational institutions in the western countries began to face a number of problems, including changing demographics, reduced governmental funding and increased demand for quality services. In order to maintain their services, educational institutions focused on improving their financial situation. However, the real problem with the educational institutions was that of the quality gap between what was required and what was offered. The gap led to a negative cycle that affected all parties involved in the supply chain. In addition to the fact that individuals could not effectively promote personal growth and self-fulfilment through education, it was seen that business competitiveness and the nation’s competitiveness would also deteriorate (Robinson III et al., 1991; Schargel, 1993; Feigenbaum, 1994; Logothetis, 1995).
Total quality management (TQM) was introduced to education in the 1980s, with the result that there was overwhelming interest during the early 1990s (Marchese, 1993). In view of the success achieved by the advanced corporations, many quality management practitioners and campus pioneers suggested using TQM to perform dramatic turnabouts in education. Skinner (1986) highlighted the importance of quality improvement to educational institutions. Spanbauer and Tyler (1990) suggested that quality improvement would be an answer to school reform. Robinson and Long (1987) suggested that educational institutions should shift their marketing strategy from an emphasis on products (courses) to customers (students). Bonser (1992) claimed that educational institutions have to reconsider their purposes and functions in order to adapt to the new environment. Rhodes (1992) contended that TQM could provide the continuing information and management support for schools to adapt to the changing environment. Hittman (1993) recommended educational institutions to use the methods of TQM and continuous quality improvement (CQI) to respond to the deficiencies in quality cited by internal and external critics. Matthews (1993) underlined the importance of introducing quality and excellence into all aspects of academic life in order to provide appropriate educational direction and support to industry and business. Bonstingl (1994) emphasized the importance of quality education, as it would create success for all – individuals, corporations, institutions and the society as a whole.

Many educational institutions initiated their TQM efforts at the time they faced a series of acute problems. Maricopa County Community College District implemented the Quantum Quality project at the time it was experiencing fiscal constraints and budget cuts which had been forecasted to continue for at least two
more years (Assar, 1993). Similarly, Oregon State University and Auburn University introduced TQM to boost quality and cut costs (McMillen, 1991; Coate, 1991; Coate, 1993; Muse & Burkhalter, 1998). According to Cowles and Gilbreath (1993), Virginia Commonwealth University undertook a large-scale TQM effort because it suffered from a number of problems that resulted from deep budget cuts, including low morale, decreased productivity and poor services.

Numerous ideas were put forward to put TQM to work in education. Marchese (1991) and Spanbauer (1995) suggested using the key concepts, techniques and tools of TQM to reactivate education. Rhodes (1990a, 1990b), Bonstingl (1992a, 1992b) and Blankstein (1992) proposed using Deming’s principles to achieve fundamental instead of incremental changes in public education. Brigham (1993) analyzed the success and failure of TQM applications in industrial settings to facilitate educational institutions to fashion their own versions. Sutcliffe and Pollock (1992) interpreted the commercial concepts and TQM principles used in industry to adopt them in higher education. Hill and Taylor examined the applicability of TQM to higher education and identified the key issues for successful implementation (Hill & Taylor, 1991; Taylor & Hill, 1992, 1993). Harvey and Green (1993) analyzed the concepts of quality to facilitate the determination of criteria for assessing quality in higher education. Falk et al. (1993) proposed a conceptual framework to install and administer TQM for business schools; and, Perotti (1995) suggested business colleges use the total quality service (TQS) approach to achieve customer satisfaction. Karapetrovic and Willborn (1997) employed the quality assurance concepts to explain how universities could create “zero-defect” students; and, Ensby and Mahmoodi (1997) suggested using the Baldrige Award criteria for improving knowledge delivery in college classrooms. Divoky and Taylor (1996) offered a
model to guide curriculum evaluation and change process based on TQM concepts. Zairi (1995) developed an approach which integrated the elements of three broad categories: (1) leadership in education for excellence, (2) process-driven delivery systems, and, (3) winning formula for success, to assist the education and training providers to implement total quality education. Owlia and Aspinwall (1996) presented a framework for the dimensions of quality in higher education based on the quality factors found in literature. Motwani and Kumar (1997) suggested a five-step model for universities to implement TQM; and, Sakthivel and Raju (2006) used nine quality constructs to formulate a model to help the engineering institutions to improve education quality. Furthermore, Srikanthan and Dalrymple (2003, 2004) synthesized the features of various quality management models for higher education into the basic elements for quality in education of universities.

With increased understanding of quality, more and more educational institutions became aware that the greater benefit of TQM was that it could help them to revitalize. Different kinds of TQM projects of various educational institutions were therefore undertaken to pursue continuous improvement. The Public Schools in Newtown, Connecticut blended elements of Deming’s 14 Points with Glasser’s approach to quality to develop its own model to achieve quality (Freeston, 1992). Conroe Independent School District implemented TQM to optimize the functions of all units that operated within the school system (Sharples et al., 1996). A college of further education in the United Kingdom used TQM to improve its student services (Morris & Haigh, 1996), whilst the City of Burlington Public Schools in New Jersey initiated its TQM efforts by using the technique of quality improvement story to improve the high school attendance problem (Abernethy & Serfass, 1992). Lamar University used the planning phase of the plan-do-check-act (PDCA) cycle to
improve the student admission process (Montano & Utter, 1999). Ulster University made use of the idea of quality assurance to develop quality teaching (Ellis, 1993). The Vaal Triangle Campus of the Potchefstroom University for Christian Higher Education applied quality management principles to improve the teaching of operations research (Zadelhoff et al., 1995). Indiana University Southeast conducted a project to improve service quality with the aim of providing students with high-quality experiences (Canic & McCarthy, 2000). At the University of Pennsylvania, TQM principles were applied to improve the university’s administration as well as the MBA curriculum of the Wharton School (Kleindorfer, 1994). Indian Hill, a public school system in suburban Cincinnati of Ohio, used the Malcolm Baldrige National Award criteria as the framework for making quality improvement (Quattrone, 1999). The University of Southern Colorado’s Hasan School of Business applied quality management concepts to restructure into a more student-centred, outcome-oriented and learning-based institution (Ward & Chandler, 1999). At Rochester Institute of Technology’s College of Business, a quality management framework was developed to identify opportunities for research, teaching and operational improvement (Mergen et al., 2000). As a start to implement TQM in business schools, a study was conducted at two universities in the north-east region of the USA on using SERVQUAL to identify the determinants of service quality (Pariseau & McDaniel, 1997). Last but not least, at University College Dublin (National University of Ireland-Dublin), a pilot project on quality evaluation in higher education was undertaken in the disciplines of engineering and arts for driving the issue of quality assessment in the university sector of Ireland (Byrne, 1998).
TQM brought fruitful results to educational institutions. The survey on the initiatives for quality management of 22 colleges and universities revealed that the ten key benefits of TQM were giving people a voice, less explaining and more listening, cutting down steps, a change in climate, willingness to “sweat the details”, bringing people together, a common language, knowing what we are about, reduced rework and scrap, and declining dollars (Seymour, 1991). Furthermore, the practice of TQM at George Westinghouse Vocational and Technical High School improved school performance, reflected in the decreased student drop-out rate, increased percentage of graduates who went on to college and higher student involvement in the school (Schargel, 1996). Four Swedish schools used TQM to improve their operations and received positive results for their personnel, including greater job satisfaction, better communication at all levels, increased participation, enhanced cooperation, improved leadership, more effective and comprehensive evaluations and increased ability to implement actions (Lagrosen, 1999). Additionally, the application of TQM to adult learning of a community college demonstrated that a powerful partnership was created in the classroom (Bierema, 1996).

5. Quality-driven Business Strategy for Industrial Training Institutions

TQM has been found to be effective in helping various educational institutions adapt to new environments and meet new challenges. It would be equally effective in assisting the transformation of industrial training institutions from subsidized training units into business enterprises. In the open market, industrial training institutions have to adopt achieving quality as part of their business strategies in order to attain long-term success.
Figure 1-1 shows the template used to devise the business strategy for industrial training institutions. It is a business system in the simplest form. The rationale is based on the notion that a business being brought into existence is for the sake of certain intended purposes. The operation comprises two basic elements, input and output, and a relation, process. The mechanism is divided into two parts. Firstly, the purposes determine the policies and functions for navigating the operation of the system so as to achieve the defined goals and objectives in exchange for existence. Secondly, the performance indicators are fed back to the system for evaluation; and, if necessary, the original purposes will be modified in order to maintain the existence. These two parts could be considered separately, but they must work complementarily so as to maintain a good balance of the system with its environment.
Figure 1-1: Template used to devise business strategy for industrial training institutions
The original aim of the government when setting up the vocational education and training system in the 1970-80s was to provide coordinated and centralized training for meeting the manpower needs of the industries. To achieve this aim, the training boards conducted periodic manpower surveys to update the statistics, detect the changing needs and make the necessary forecasts (HKTC, 1977; Man, 1999). Training centres then made use of the aggregate demands revealed by the manpower survey reports to organize training schemes and courses accordingly (Ho, 1997). By providing infrastructure, training facilities and staff, the “raw labour” was turned into skilled workers. The operation of the training centre was similar to that of a production system (Karapetrovic et al., 1999). Their primary customers were industrial companies and the output was trained workers (graduates). The kinds and number of training courses being organized as well as the number of trainees (students) enrolled and being placed upon completion were the key performance indicators of the training centres.

At a time when production was emphasised, training centres were a pull system in which the demand drove the supply. They could easily satisfy industries’ needs for workers by expanding the training capacity to increase the number of graduates. As long as the lines were balanced, the system would function properly and harmoniously. However, when the industries shifted from production to services, the supply of trained workers outstripped the demand. Training centres became a push system. Instead of a guaranteed number of places for their employment, they had to actively promote their graduates to the industries.

Given the prospect of becoming financially independent, the short-term goal of the industrial training institutions was to obtain sufficient income to sustain survival.
To achieve this goal, the most direct and immediate way was to increase the number of students and, when necessary, to raise the tuition fee. This was to improve the sales and production by making use of the principles of “economies of scale” and “economy of effort” to generate a greater amount of revenue (Figure 1-2). Other possible methods of achieving the financial goal included expansion of the market abroad, collaboration with other education and training organizations, offering a greater variety of courses, maximization of the use of facilities and manpower, etc. However, these methods were only effective in improving the financial situation, and they were insufficient for the achievement of lasting success.
Figure 1-2: Short-term business planning for industrial training institutions
The central message of the change is that individuals, instead of the companies of the industry, would be the primary customers of the industrial training institutions. Individuals acquire industrial knowledge and skills from the training centres so as to enhance their competency to perform their jobs. In other words, the business of the industrial training institutions is to provide industrial training services. Their primary purpose is to effectively enhance the job incumbents’ requisite industrial knowledge and skills. Quality is the major concern. Customer satisfaction is the ultimate source of income for sustaining business success. Figure 1-3 displays the new objective and the logic of the business strategy for the industrial training institutions to win long-term prosperity in the open market.

Last but not least, the two loops depicted in Figure 1-3 are the counterparts of the double-loop learning cycle that keeps the business system viable in the dynamic environment. Marketing and product development is the primary loop whilst the sales and production is the secondary or feedback loop. This basic mechanism of continuous improvement allows the business system of the industrial training institutions to learn to adapt to the changes of the environment.
Course Design & Product Development
Enhance Individuals’ Competency
Supply Manpower to Industry
Marketing & Product Development
Sales & Production
Course Design
Training Delivery
Input
Process
Output
Purpose
Existence

Figure 1-3: Quality-driven business strategy for industrial training institutions
6. **Importance of Curriculum Development in Achieving Quality**

From the quality-driven business strategy exhibited above, it could be seen that course design is no longer an administrative but a strategic function of the business of the industrial training institutions. To support this important function, the institutions have to focus on marketing and product development. Although manpower survey reports are essential and have been useful for planning the kinds and the number of courses to be offered, it is not the customer surveys that provide the basis for planning course design. The challenge to the institutions lies in the fact that individuals do not have the knowledge to inform them of what exactly they want to have. The primary responsibility of marketing is not simply to serve the sales for promotion or to serve the production for placement. More importantly, it is to identify the customers, to listen to their voices, to interpret and incorporate their needs into curriculum development and provide corresponding training services. Curriculum development is a central issue for achieving total quality education (Koch, 2003).

It has become clear that devising a methodology for developing industrial training curricula would not only help in enhancing the competency of the job incumbents but also assist the industrial training institutions in running their business more successfully.

7. **Quality Function Deployment**

Quality function deployment (QFD) was introduced in Japan in the mid-1960s as an approach for design. Its aim is to provide better quality planning. There were two
motives that drove the development of QFD. The first one was to study how to determine design quality and the second one was to move the preparation of quality control points upstream so as to assure quality at the front end (Akao, 1997). These two motives reveal an important purpose of QFD – to develop a theory and to provide a methodology for operating product development. As an upstream approach, QFD advocates companies to work back from objectives to means for achieving those objectives for product development and is proposed as a planning process for guiding the design of a product or service. It is a pointed way of listening to customers to learn exactly what they want, and then using a logical system to determine how best to fulfill those needs (Guinta & Praizler, 1993, p. 5). Conceptually, QFD is a philosophy that advocates listening first to the customers and then translating their requirements all the way back in any business process to ensure that the end product or service actually satisfies those demands (Hill, 1994). Operationally, QFD is a structured method for product development. It relates market demand via engineering specifications to parts specifications and to production process variables and thus to production operations planning (Govers, 1996). Collectively speaking, QFD melds three important concepts of product development: (1) transition from the voice of the customer (VOC) into technical specifics, (2) rational representations of linkages between customers and the design, and, (3) knowledge gained from a multifunctional and interactive design team, into one single design process model (ReVelle et al., 1998, pp. 7-8).

QFD allows for preventive action rather than a reactive action to customer demands. It enables the launch of a new product or service to go more smoothly because customer issues and expectations have been dealt with in advance (Summers, 2006, p. 552). First, QFD provides key action items for improving customer satisfaction
thus could help to stop companies developing products and services based solely on their own interpretation of what the customer wants. Second, the organized and systematic approach that QFD provides enables companies to align their processes for effectively meeting their customers’ needs in a quicker and more economical way (Terninko, 1997, p. 3). The belief in customer focus and the mechanism for addressing subjective needs in a more objective way of QFD result in bringing an all-win virtuous cycle for those parties involved in the supply chain.

Since its introduction, QFD has been extensively applied by many leading companies of different industries for making various kinds of quality improvement (King, 1987). With more than 40 years’ practice and research, QFD has been proven to be an effective methodology for achieving customer satisfaction and a useful production development technique (Mazur, 2006).

8. **Aim of the Study**

In view of the need for an improved curriculum development method for industrial training and the appropriateness of applying QFD to curriculum development, the aim of the study was as follows:

*To develop a QFD-based industrial training curriculum development model for enhancing the industry-specific knowledge to be required by the job incumbents of the service-oriented manufacturing industries in Hong Kong.*
9. **Contributions of the Study**

The study will contribute in the following three ways:

1) The model developed will improve the curriculum development methodology for industrial training,

2) The process and the method of the model will facilitate the industrial training institutions to implement TQM, and,

3) The validity of the model will support the applicability of QFD in vocational education and training enterprises.

10. **Organization of the Thesis**

The thesis of this study consists of six chapters. Chapter 1 introduces the rationale for conducting the study and the background information, and, states the aim of the study. Chapter 2 is a comprehensive literature review of QFD applications. It serves to illustrate the purposes and areas of QFD applications and to identify the useful elements from field practice for building the curriculum development model. Chapter 3 explains the conceptualization and operation of the model. Chapter 4 states the details of the research methodology. In addition, the reasons for choosing the multi-method approach and the arrangements of the empirical studies are explained. Chapter 5 reports the quasi-experiment and the field applications which were conducted for this study. Lastly, Chapter 6 presents the conclusion. Besides the outcomes and the limitations of the study, suggestions for further study are also discussed in this chapter.
Chapter 2

Literature Review of QFD Applications
1. **Introduction**

QFD is a disciplined approach for the implementation of TQM. As Sullivan (1986b) described, QFD serves as the “operational definition” of companywide quality control (CWQC), the Japanese-style total quality control. The central theme of CWQC is quality assurance, which is represented by Ishikawa (1990, p. 335) as a type of promise or contract with the consumer regarding quality. QFD was developed in the mid-1960s as a strategy for assuring that quality is built into new products. At that time, the major industries of Japan sought to build a system that would assure quality throughout the flow from design to production so as to increase competitiveness (Kogure & Akao, 1983). Akao, one of the founders of QFD, explained that the fundamental aim of QFD is to clarify and solve all major issues of quality assurance in new product development long before the programme goes into the full-scale production stage. He added that establishing control points prior to production start-up is the central idea of QFD for assuring product quality (Akao, 1990b). QFD manages product quality via two dimensions. The first dimension is to assure the true customer needs are properly deployed throughout the design, build and delivery of a new product whilst the second dimension is to improve the product development process itself (Akao & Mazur, 2003). As the deployment technique for assuring product quality is equally applicable to managing business process, QFD uses the same approach to facilitate the operation of *hoshin kanri*, that is, policy management (Burn, 1990). *Hoshin kanri* is a participative quality planning and management method which was developed in Japan in the early 1970s (Kondo, 1998). It is an important pillar of CWQC and its aim is to quickly and effectively bring the organizational goals and activities in alignment with environmental changes and rapid societal development. QFD assists organizations
in practicing *hoshin kanri* by providing the methodology for setting the policy at the management level and deploying the set policy to the operation level. The roadmap that QFD provides not only integrates the business functions of an organization but also assures the quality of each of the business functions (Chalmers, 1992). As a vehicle for the implementation of TQM, QFD provides a quality-driven approach for business planning and a customer-oriented methodology for product and service development.

QFD consists of two elements: “product quality deployment” and “deployment of quality function”. The former element, termed as “quality deployment” (QD), refers to the activities which are needed to convert the demanded quality into specific quality characteristics. It is defined as the conversion of the customer requirements into counterpart characteristics for determining the design quality; and, the systematic deployment of the counterpart characteristics into component quality, individual part quality and process elements and their relationships (Akao, 2002). The latter element, which may be referred to as “the narrow sense of QFD”, encompasses the activities which are needed to assure that the demanded quality is achieved. It is defined as the step-by-step deployment of jobs or business functions that are concerned with building up quality in an end-means system (Akao & Mazur, 1998; Akao, 2003). In other words, QD is the construction of a “network of quality” for the product or service whilst the narrow sense of QFD is the construction of a “network of work quality” that forms the quality. The broad sense of QFD is the interweaving of these two networks for achieving total quality (Akao, 2004). The relationship between QD and the narrow sense of QFD is provided in Appendix 2-1.
2. Characteristics

QFD adds structure to the major elements of CWQC. It contributes to CWQC, or TQM, by providing a system and a toolbox for assisting organizations in adopting the companywide approach to attain customer satisfaction. From this contribution, three key characteristics of QFD are revealed: (1) customer orientation, (2) teamwork, and, (3) application of quality management concepts and tools. In the following, each of these characteristics is reviewed, in order to achieve a clear understanding of the logic and the approach that QFD employs to achieve quality.

2.1 Customer Orientation

The goal of CWQC is to achieve customer satisfaction – the main objective of quality control. As early as in the 1950s, Drucker (1955, p. 35) maintained that the customer is the foundation of a business and keeps it in existence. What the customer thinks he/she is buying, and what he/she considers “value” is decisive, as it determines what a business is, what it produces and whether it will prosper. Contrary to taking a production orientation, CWQC suggests making quality improvement in order to satisfy customers rather than just finding ways of lowering costs to achieve business excellence. Kondo (1993) explained that quality is a concern of both the customer and the manufacturer but cost is only the concern of the manufacturer, therefore improving quality for achieving customer satisfaction should be the most appropriate and acceptable way of enhancing corporate performance. He added that quality is more aligned to the characteristics of human nature than to the reduction of cost for increasing productivity (Kondo, 1988). Shiba et al. (1993, p. 40) claimed that the focus on customer needs and quality
improvement would establish two major alignments. First, the focus on customer-defined quality not only satisfies customers but also ensures that the company is run efficiently. Second, the focus on quality unifies the goals of the customer and the goals of the staff as well. These two alignments would bring benefits to all parties concerned and assist organizations in achieving excellence.

QFD uses achieving customer satisfaction as the corporate goal to assure quality. Muffatto and Panizzlo (1995) stated that, from the process-based perspective, customer satisfaction must be seen as the critical point of reference and the culmination of all efforts made for improvement. The use of achieving customer satisfaction as the corporate goal could help in enhancing business competitiveness and strengthening the corporation in several ways. First, the internal conflicts would be reduced and problems among divisions would be easily resolved when the overall efforts are diverted to attaining the common goal of achieving customer satisfaction (Sullivan, 1987). Second, when customer satisfaction, instead of profit, is used as the business goal, the management focus will be shifted from end to means to make plans. Managers thus focus on formulating new business strategies for meeting the changing customer needs. Moreover, when customer satisfaction, instead of cost, is used as the product goal, the employees will be motivated to exert efforts on improving the quality and find ways to lower the costs for products and services (Sullivan, 1988). Lastly, when everybody is working towards the goal of achieving customer satisfaction, breakthroughs would be made more easily and innovation would also be greatly enhanced.

QFD adopts the design approach to assure quality (Mizuno, 1994a). To achieve the goal of customer satisfaction of quality assurance, the consumer demands have to be
assimilated into the quality plan and design quality, and, systematically deployed from upstream to downstream to derive the manufacturing specifics. Unlike the analytical approach, such as studying consumer complaints, that starts at the downstream end searching for factors which contribute to problems, the design approach looks upstream to take into account the qualities which consumers demand in the finished products (Akao, 1990a). In order to bring quality control to product development, QFD employs the “market-in” concept to achieve customer satisfaction. Unlike the “product-out” concept, “market-in” focuses on attaining customer satisfaction as the purpose of work and the product produced. The aim is to place oneself in the users’ shoes and then manufacture goods and services that meet market needs (Hosotani, 1992, p. 26). Tanisawa (1994) claimed that QFD brings the “market-in” concept to the entire company’s quality assurance activities, from gathering market requirements to sales and service, by providing a system linking all these activities to one objective, that being quality. Furthermore, QFD adopts a proactive approach and aims at detecting and solving quality problems at a much earlier stage. As it seeks to get the product and process right from the outset, QFD helps in reducing manufacturing costs for it is easier and less costly to correct a defect right after it occurs than to correct it further downstream (Fortuna, 1987, 1988).

2.2 Teamwork

“Companywide” is the approach that CWQC used to achieve customer satisfaction. The Japanese corporations elaborated Feigenbuam’s (1961, p. 5) concept of “QC is everybody’s job” to a much fuller extent for carrying out total quality control (TQC) on a companywide basis (Sullivan, 1986a). CWQC consists of two main features:
(1) a wide span of coverage of quality control activities, and, (2) total employee participation in quality control activities (Kondo & Kano, 1999). The idea was based on the argument that it cannot be called companywide quality control if each division or department of the company only works on improvements in its own operation, and, the term “comprehensive quality” is not appropriate when each target of quality, cost and quantity of a company is worked on individually (Mizuno, 1994b). As Ishikawa (1972) strongly emphasized, it is people who implement quality control. Therefore, TQC has to involve everyone and all activities from corporate management to entry-level workers in everything from design to manufacturing, inspection, sales, procurement, energy management, accounting and personnel, and, even has to keep up with consumer concerns with product safety and pollution (Mizuno, 1988a, p. 17).

QFD emphasizes the use of cross-functional collaboration to implement quality assurance. The study conducted by Al-Mashari et al. (2005) shows that teamwork is the common enabler for the effective implementation of both QFD and TQM. This is largely because in order to get the best sense of the VOC and to foster quality planning, members of different functional areas have to provide their best input in coordinated team activities. More importantly, the formation of teams is not only restricted to the members of an organization, but is also extended to the customers as well, that is, the members of the supply chain.

### 2.3 Application of Quality Management Tools and Techniques

The movement from quality control to quality assurance led to the development of the design approach and a new set of quality control (QC) tools. As the
conventional quality control tools, which were designed for analyzing numerical data, were not suitable for analyzing verbal data, the seven new QC tools, including affinity diagram, relation diagram, tree diagram, matrix diagram, matrix data analysis, arrow diagram, and process decision programme chart, were developed to assist in the operation of the design approach. Nayatani et al. (1994a) claimed that the major purposes of the seven new QC tools are to analyze customer requirements, which, in most cases, cannot be expressed numerically, and to organize verbal data diagrammatically. They aim to add value over and above customer needs and to prevent, rather than to rectify, failures in meeting the customer needs (He et al., 1996). Moreover, many of these tools make a unique contribution to consensus, which is important to the implementation of CWQC, or TQM (Anjard, 1995). As Mizuno (1988b, p. 20) emphasized, the seven new QC tools could be used most efficiently when they are combined in an interrelated manner. Although each of the tools has its own advantages, QFD provides a synergistic combination of them and produces a result which is far more than the sum of the tools. By skillfully combining the tools into a cycle of activities in which the output of one becomes an input of the next, the result of this seamless combination produced by QFD concisely structures communication and links together the information for achieving customer satisfaction.

QFD has evolved from merely a combination of the seven new QC tools to a platform for connecting the applications of various tools and techniques. Examples are the quality and management tools of consumer encounters, New Lanchester strategy, *kansei* engineering, theory of constraints (TOC), TRIZ (a Russian acronym for Theory of Inventive Problem Solving), VOC analysis, failure mode effective analysis (FMEA) and statistical process control (SPC) which could be incorporated
into the new product development process using QFD (Mazur, 2000). Furthermore, some useful techniques from other fields, such as fuzzy logic, artificial neural networks (ANNs), Taguchi methods and design of experiments, have been suggested to enhance the robustness of QFD in various applications (Ross, 1988; Bouchereau & Rowlands, 1999; Shen et al., 2001).

3. **Historical Development**

In general, quality movement involves two dimensions, one being the change of quality concepts and the other the change of methodology. QFD was originally intended to address the second dimension. Akao (1997) revealed that there were two main motives that drove the development of QFD. The first motive was how to determine design quality. In the 1960s, the Japanese automobile industry was in a stage of rapid growth, with incessant model changes and numerous new product developments. Although the need for quality control in the product design stage was recognized, there was no concrete idea on how design quality could be assured. The second motive was how to produce a QC process chart prior to production start-up. In the mid-1960s, the manufacturing process of the Japanese industries was still heavily controlled by the QC process chart – a chart which listed the control points within the manufacturing process that had to be checked in order to ensure quality. However, it was prepared when the new product had reached the work floor for production. This practice led to the question of why the control points of the QC process chart were not determined before the production start-up so that quality could be assured. These two queries initiated the research on how to bring the control points upstream so as to derive a methodology for managing design quality.
Two charts were important to the development of QD (Akao, 1990b). The first chart was the production process assurance items chart of Bridgestone Tire, which was presented by Oshiumi of the Kurume Plant in 1966. It was in the form of a two-dimensional matrix, which was used to prepare a quality assurance system for the production of a product. On the chart, the product items to be assured, that is, the quality characteristics of the product, were converted from and listed against the items that were to be assured to the market, that is, the true quality demanded by users, assisted by a cause-and-effect diagram. Akao thought that this method could be used in the process of new product development to form a chain of qualities so that control points could be provided for assuring quality prior to production start-up. Upon adding a field called “design viewpoint” onto the chart, he put this method into trial runs in a few companies. In 1972, he published the results of these attempts; and, in the paper, he called this method “hinshitsu tenkai”, meaning “quality deployment”. The second important chart was the quality chart of the Kobe Shipyard of Mitsubishi Heavy Industries, which was established under the guidance of Mizuno and Furukawa. According to Takayanagi (1994), a quality chart is a chart in which true quality (demanded by customers) is systematized according to functions and the relationship between these functions and quality characteristics (substitute characteristics) is indicated. This chart provided the technique for extracting a set of points to be emphasized and transmitting these points to the preparation of the QC process chart in order to ensure the design quality was incorporated into the final product. The quality chart, together with “hinshitsu tenkai”, thus enabled Akao to formulate a procedure to cover the entire process from converting the customer requirements from the design stage to the manufacturing operations (Akao, 1994b). This is “hinshitsu kino tenkai” (quality function
In 1967, Ishihara and his associates of the Parts and Components Division of Matsushita Electronic started a study on using the functional analysis of value engineering to deploy product functions. The idea was similar to Akao’s quality chain system, except for the fact that it did not begin with user-demanded quality. Ishihara extended this method to business operation functions. Akao (1994a) stated that Ishihara’s “function deployment of business” clarifies the content of quality control operations and highlights omissions in the operation, which is the concept of QFD in its narrow sense. Combining the business function deployment with QD, the holistic quality assurance system of QFD, managing quality from the stage of design down to those of production, inspection, sales and services, was eventually formulated.

4. **Major Areas of Application**

With the increasing understanding of the need for customer-driven management and systems to continuously improve an organization’s competitive position, QFD has been extensively applied to hoshin kanri, or policy management, product development and managing organizational processes. The applications show that many of them aimed at using QFD to achieve customer satisfaction and/or increase organizational competitiveness. In the following, some QFD studies and cases in these major application areas are reviewed, in order to achieve a deeper understanding of the variety of the underlying purposes.
4.1 Policy Management (Hoshin Kanri)

_Hoshin kanri_, or policy management, is a strategic quality management system. It carries two alignment purposes: (1) to align all people throughout the organization with the key corporate goals, and, (2) to align all jobs and tasks with the key corporate goals in order to create breakthroughs. _Hoshin kanri_ operates at two levels to manage continuous improvement: first at the strategic planning level, aiming at seeking for breakthroughs, and, second at the daily management level, focusing on the more routine and fundamental aspects of business operation (Watson, 1991). María and Calingo (1996) claimed that _hoshin kanri_ is more than simply a process linking strategic management and continuous process improvement. It is a quality-strategy integration system. The effectiveness of _hoshin kanri_ is that it points the organization in a single direction, leading to results that all the organizational members could share (Duarte, 1993).

4.1.1 Policy planning

QFD has been widely applied in formulating corporate and even national strategies for meeting certain specific goals. At the New England Memorial Hospital, QFD was integrated into the PDCA cycle to identify the critical processes and necessary tasks for the implementation of the organizational vision (Terninko, 1993). At Philips EBEI-IC, an assembly factory of integrated circuits in Taiwan, the HOQ was used to identify performance indicators in respect to customer requirements to formulate annual policy (Philips et al., 1994). Lu and Kuei (1995) proposed applying the QFD concept to the strategic marketing planning process to aid companies in achieving the goal of customer satisfaction. At the Warwick
Manufacturing Group, QFD was incorporated into the operation of hoshin kanri with the primary aim of creating a deeper understanding of customer requirements, a team vision and strategic goals (Roberts & Tennant, 2003). The Meat and Livestock Australia adopted the CD-MAP® QFD process for planning future beef industry research, development and information extension (Walker, 2002). Furthermore, González et al. (2006) proposed an analytic model, which used QFD and benchmarking as the tools, to design and develop an e-health strategy for the Spanish public health care system.

### 4.1.2 Policy deployment

QFD has also been applied in planning activities for supporting the derived strategies. For example, Ferguson (2001) shared a case of a technical service company on using QFD to align the customer needs with the company’s core values so as to formulate policies and plan technical resources for improving its services, and, Gonzalez et al. (2004) proposed a “QFD strategy house” for linking marketing and manufacturing strategies in which the former was input into the house for developing the latter.

In some cases, QFD was used for policy management in a more holistic way in which both policy planning and policy deployment were addressed. At the Department of Industrial Engineering at Mississippi State University, QFD was used to establish a research strategy, including the identification of the key customers and their needs, developing a strategic plan for departmental research activities, assigning the research functions and responsibilities to faculty members or groups, and, tracking research performance relative to the defined goals (Chen & Bullington, 1993). At North Press Metals, a Pennsylvania-based powered metal product
manufacturer, QFD was used to make a manufacturing strategic planning, which started from defining the business environment, formulation of functional strategies, identifying manufacturing priorities, preparing action plans to detailing tasks (Crowe & Cheng, 1996). At the Manufacturing Engineering Laboratory of City University of Hong Kong, QFD and the hoshin kanri techniques were used to identify customers’ needs, formulate quality strategies and devise tactics and plans for making service improvement (Pun et al., 2000). For Guangzhou United Printing Company, a QFD-based e-business planning framework was established to link strategic management with operations management (Tan et al., 2004).

From the operational point of view, there are two advantages of applying QFD to operate hoshin kanri, or policy management. First, QFD provides the visibility link that captures the VOC in the hoshin generation process and the tools to identify and develop the key product and service breakthroughs that are required for the successful achievement of the hoshin objectives (Colletti, 1995). Second, QFD promotes collaboration and enhances communication between departments so as to mobilize and empower the organizational workforce to cope with changes (Hummel, 1996). Killen et al. (2005) indicated that the systematic translation of QFD not only provides the logical steps for assisting in generating innovative strategies for achieving the organizational vision but also leads directly to policy deployment for implementation and performance management.

4.2 Product and Service Development

Since the introduction of QFD to the western countries in late 1980s and early 1990s, product development has been one of the major areas of application. For example,
Hewlett-Packard greatly promoted using QFD to develop new products and AT&T actively used QFD to help in upfront product planning (Daetz, 1989; Thompson & Fallah, 1989). The popularity of QFD in product and service development is largely because of the three main operational advantages. First, it provides the mechanism for translating the customer needs into product attributes. Second, it is effective in finding out the most important product attributes based on customer needs. Third, it offers the methodology for taking the voice of the consumer (or user) all the way through product development to the factory floor and out into the marketplace. These three advantages have been applied in a variety of ways for improving the product and service designs as well as the development process for products and services.

4.2.1 Improving product and service design

QFD has been extensively applied to the quality planning of product and service design. The quality planning could be simply to understand the customer needs. For example, QFD was used as a tool to gather the requirements and analyze the diverse needs of the internal customers for the design of a sequence subsystem programme of the Advanced Multi Mission Operations System of Jet Propulsion Laboratory of NASA (ELBoushi et al., 1994). Nevertheless, the most common applications of QFD for quality planning are to identify quality characteristics, or design parameters, and/or to define technical requirements. Numerous studies were reported. Tottie and Lager (1995) shared the case of LKAB, an iron ore product supplier in Sweden, on using QFD to identify the required properties and supplier services for the development of blast furnace pellet. Mohr-Jackson (1996) applied QFD to identify the key quality characteristics for the design of advertising copy for
film. Parkin et al. (2000) used QFD to make a plan for improving the existing design of the belt/buckle assembly that was used on firemen’s safety harnesses. Garcia et al. (2007) applied the HOQ to translate the consumer demands into the design features of beef products. Kumar and Labib (2004) employed QFD to identify the key engineering characteristics of a simulation game, which was to be used as an experiential learning tool for engineering students to encounter the methods and concepts that would be of importance for next-generation manufacturing. Huang and Tan (2007) conducted a study on utilizing QFD to identify the factors that affect the quality of apparel design and those that affect consumers in choosing apparel. Oke et al. (2008) made use of QFD and Pareto analysis to identify the “vital few” items so as to optimize resources for improving the services of a hotel in Ibadan of Africa. Moreover, QFD was used to identify the key viewer requirements and to deploy those requirements to define the technical requirements for redesigning the website for TV3, a private television station in Malaysia (Islam et al., 2007).

QFD has also been widely used to design various products and services. Some projects focused on defining the product and services features. For example, Knowles (2002) used the HOQ to design a mountain bike, and, Haapalainen et al. (1999/2000) reported on their use of QFD to improve the ergonomic quality of pruning shears. Some projects focused on the design of the actual products. For Puritan-Bennett, a medical equipment manufacturer, the HOQ was used to relate the market research information to the development of the Renaissance™ Spirometry system (Hauser, 1993). Woolley et al. (2000) reported a study on using QFD, together with other design methods, to develop “SuPort”, a self retaining suprapubic port for providing permanent access to the bladder for intermittent/continuous
drainage. Similarly, Booysen et al. (2006) adopted a QFD approach, which through customer interaction and a series of functional prototypes, to develop a device for holding an endo-tracheal tube of the patient in a more secure manner during anaesthesia.

### 4.2.2 Improving development process

With the increasing emphasis on customer orientation, QFD has been extensively used by expert teams to improve the product and service development process. Some focused on the technique of understanding customer requirements whilst some focused on the promotion of cross-functional collaboration. For the former, Rudolph (1995) suggested using QFD to operate product definition, the first phase of the total milestone-driven food product development process. May-Plumlee and Little (2006) presented a QFD-based model that links the consumer purchase decision and multiple consumer research strategies to the development of apparel products through various avenues of consumer input. Ip and Jacobs (2006) derived an approach, in which QFD was used to link the gamers’ preferences to game-play elements, for developing interactive video games. For the latter, Benner et al. (2003a) employed QFD to manage structured information in their proposed chain information model for food product development and Shen et al. (2000) presented an integrated approach to innovative product development using Kano’s model and QFD.

Besides effectiveness, QFD was also used to improve the efficiency of the product development process. For example, Pia (1993) used QFD as the platform to develop a process to define and integrate strategic focus with tactical development of
new products so as to save time and resources for developing the best possible products. Similarly, the specialty polymers business team of Chevron Chemical completed a series of QFD matrices to help in planning and making the complex decisions in product development (Lyman et al., 1992). Furthermore, Shillito (1992) incorporated QFD into one matrix called “Customer Oriented Product Concepting” for assisting a team in getting to technology and design faster.

4.3 Organizational Improvement

QFD is a process for continuous improvement and the methodology for planning the goals of a stream of processes to align them to the final requirements of the stream (Conti, 1989; Daetz et al., 1990). It has been applied to improve various aspects of organizations. One of the areas where many companies have employed QFD to improve the organization is to promote teamwork and enhance collaboration (Özgener, 2003; Piszczalski, 2003). For example, SENCO Fasteners made use of QFD and customer integrated decision making (CIDM) to build cross-functional and cross-cultural teams in its international projects (Holtzlieter et al., 1995), and, a Brazilian engineering company applied QFD to establish different types of partnership with its clients and suppliers (Prates, 1997). QFD has also been applied to improve various organizational processes. As Gopalakrishnan et al. (1992) suggested, QFD could help organizations in improving any internal process. Numerous cases were reported on using QFD for such a purpose. Mellina (1992) shared a case on using QFD to reengineer an order realization process. Tam and Lee (1999) adapted QFD in the planning and development of a product design system. Chang and Mohan (1999) used the HOQ to identify and prioritize employee needs so as to propose system changes in human resources management.
for retaining employees. LePrevost and Mazur (2003, 2005) applied QFD in project management for helping National City Corporation, a large financial holding company headquartered in Cleveland, Ohio, to identify and prioritize the needs of its customers and used the identified needs to evaluate each project for its benefit contribution and for its degree of complexity so as to assign resources. With the increasing emphasis on diversity, QFD has been further applied to facilitate innovation. Mazur (2004) claimed that QFD has the systems for helping innovative organizations focus on those projects and activities that are valuable to stakeholders and potential customers. At Blue Cross Blue Shield of Florida, QFD was used to capture creative ideas from its members for making various improvements, such as those for increasing membership, reducing administrative costs, differentiating products and services from those of the competitors and expanding distribution channels (Hines & Mazur, 2007). Moreover, Sankaran et al. (2008) proposed a technique called “Innovative Quality Function Deployment”, which blended QFD with innovation management principles, to enhance the innovativeness of the modern organizations for attaining quality.

5. **Industrial Applications**

Since its introduction into North America in the early 1980s, interest in QFD has spread around the world (Mazur, 1994). Many leading companies of different industries have applied QFD to bring about quality improvement (Kathawala & Motwani, 1994). For example, QFD was an integral part of the Deming Prize challenge at Florida Power and Light and it was also employed as one of the proactive/planning techniques and tools in the Total Quality Excellence programme of Colgate-Palmolive (Bodziony, 1995; Gavoor, 1990). However, due to the fact
that each industry has its own unique nature and kinds of competition, purposes and areas of application tend to vary from one industry to another. In the next section, the QFD applications made by the major industries of both manufacturing and service sectors are reviewed, in order to achieve an understanding the evolutionary change of its applicability in respect to industrial development.

5.1 Manufacturing Sector

To date, product development has been the major application of QFD in manufacturing industries. There are two key advantages that QFD offers to the companies of various manufacturing industries for the development of new products. First, the technique of capturing and integrating the VOC into the process could help the companies to focus on all functional areas, such as design, engineering and manufacturing processes, on developing a product definition which would satisfy the requirements of all of the important customers (Robert, 1993/1994). Second, the deployment of the VOC could help the companies integrate all internal expertise to select or to create the best opportunities for developing products (Hjort et al., 1992). As will be seen, these two advantages of QFD have offered much assistance to the development of many manufacturing industries.

Faced with fierce competition for customer loyalty and market placement of product, automotive was one of the first industries to apply QFD. The “Big Three” automotive companies, General Motors, Ford Motor and Chrysler, were the major early QFD pioneers in the United States. Initially, the automotive industry largely relied on achieving reliability and using technology to gain competitiveness. QFD was therefore used extensively to design engineering specifications for various
vehicle components and subsystems. Quite a number of such applications were reported. Eaton used QFD to design a blend door actuator, which was an automatic air conditioning control device for maintaining a selected temperature of passenger compartments (De Vera et al., 1988). Visteon adapted QFD to design a fuel rail (Vinarcik, 1998); and, AC Rochester utilized QFD to develop a catalytic converter (Vannoy, 1989). Ford Motor’s QFD applications to the design of auto parts were numerous, including a front-end accessory drive, a heater/AC blower motor and a vehicle wiring in a joint project with Electro-Wire (Ahoor, 1989; Wadke & Palumbo, 1990; Carter et al, 1989). AFL conducted a three-phased concurrent QFD to support the development of a junction box for a light trunk programme of Ford (Fluharty, 1994). Milliken and Northern Rubber employed QFD to review the design of an air brake chamber diaphragm for heavy goods vehicles (Wootton & Newbold, 1994). Similarly, Kelsey-Hayes and ABC Motors used QFD to design a brake system (Bodell & Russell, 1989). Volvo improved the transmission system for its “850” through an integration of QFD with customer satisfaction modeling (Gustafsson et al., 2000). In the early 1990s, the automotive manufacturers started to apply QFD to the design of entire vehicles to address customer needs and consumer preferences. There were a number of successful cases shared. For functional vehicles, General Motors utilized QFD and some other quality management tools to produce a trunk system to meet the needs of the trunk drivers (Biondo, 1991). Chrysler made use of QFD to design the LH powertrain (Czupinski & Kerska, 1992). Nissan Motors used Reverse QFD to improve its taxi car, Crew, to satisfy the needs of drivers, owners of taxi companies and passengers (Kaneko, 2000). For family cars, Ford Motor employed QFD in the design of an environmental concept car and Chrysler applied QFD to design its famous small car, Neon (Voegele, 1993; Myers, 1993; Fernandez et al., 1994). Furthermore, Ford
Motor applied QFD to improve car painting and to optimize customer comfort when opening and closing the side doors of its family cars (Miller, 1994; Miller et al., 2005).

Electronics is another major industry to have widely applied QFD. In this technology-driven industry, QFD was primarily applied in product design as well as research and development, particularly for software. Product definition and deciding product features are the two main areas of application. Hewlett-Packard used QFD, in accompaniment with activity-based costing (ABC) and design for manufacture and assembly (DFMA), to develop a digital multi-meter (Williams, 1994). It also employed QFD in the development of “Product Improvement Management System (PRIMA)”, a corporate framework for information architecture, and an interface development tool called “Interactive Visual Interface (IVI)” for systems integrators (Shaikh, 1989; Betts, 1990; Thompson & Chao, 1990). Toshiba employed QFD in the development of “Super Design Technology” for defining the user interface functions of a plain paper copier machine (Noguchi et al., 1998). Samsung employed QFD to improve the efficiency of the development process of a memory semiconductor (Lee, 1996). AT&T used QFD as a product-realization approach for planning software-development environments, specifying the characteristics of transmission systems, and guiding product definition (Brown, 1991). IBM adopted QFD as the generalized approach for the development of software whilst Philips used it as the starting point for the product-technology roadmap process to integrate the business and technology strategies and to improve the front end of the product creation process (Sharkey, 1991; Groenveld, 1997). Furthermore, Sensio applied QFD to develop the first stereoscopic home theatre system, which won many awards and achieved positive reviews, and, it used the
knowledge learnt from this product development experience to develop other markets (Routhier, 2002, 2003).

Aerospace and defense as well as space are two advanced industries that have extensively applied QFD. Understanding customer needs and concept selection were the major QFD applications of these two industries. As each project involved a huge investment, QFD was used to define design requirements and plan technology development so as to ensure effective investment. For the aerospace and defense industry, GM Hughes Electronics used QFD to develop the production line for the Microwave Modules (Hybrids), which were going to replace the current ones in the radar system of the Air Force’s aircrafts (Bersbach & Wahl, 1990). Rosemount Aerospace used QFD to make a recommendation for the replacement of a CAD system (Buell, 1992). McDonnell Douglas Aerospace employed QFD to develop a process for the conversion of national goals into military objectives, strategy concepts and response options in order to study their impact on future tactical aircraft development and to determine the ways for improving the mobility of NATO tactical aircraft as well (Bergman, 1993; Bergman, 1994). It also developed a QFD-based process for concept selection to meet the needs of a wide variety of projects and customers for developing designs (Hamilton, 1993). McDonnell Douglas Technologies applied QFD to determine the design requirements of a scenario generator for a system that electronically generated test targets for radars (Molnar, 1993). Rockwell and LME utilized QFD to develop the requirements and technology programmes for producing an advanced ejection seat for fighter pilots (Fiske et al., 1993). Sandia National Laboratories used a modified version of QFD to investigate the feasibility of installing a post-launch destruct mechanism in the intercontinental and submarine-launch ballistic missiles (Mann, 1993). Air
Academy Associates used QFD to identify operational needs, evaluate different design options, highlight trade-offs, and analyze the effects of failure modes on operational, design and functional requirements in the Command, Control, Communication and Intelligence Systems (Hofmann, 1994). ILC Dover developed a QFD matrix for the Advanced Integrated Helmet System so as to establish the customer requirements to facilitate the study of advanced technologies for the manufacture of the helmet (Cadogan et al., 1994). The Technical Support Working Group of the Combating Terrorism Technical Support Office utilized QFD to prioritize technical characteristics based on the user and operator inputs for the next generation of the explosive ordnance disposal remote-controlled vehicle (Eddy et al., 2003). Mazur (2001) used QFD to make suggestions on how to develop and implement effective homeland security activities in support of the President’s initiatives after the “9/11” terrorist attack. For the space industry, NASA Langley Research Center formulated a pre-QFD matrix for costing large, complex systems so as to prioritize project activities (Dean, 1993). For the Advanced Launch System, Pratt & Whitney used QFD to improve the understanding of complex customer requirements to define the design requirements for the main liquid propulsion engine whilst Rockwell used QFD to select the power cycle for the engine (Lecuyer, 1990; Weiss & Butler, 1992).

The building and construction industry is one in which the applications of QFD have become increasingly popular. Rapid and quality completion of buildings tailored to clients’ needs is the main drive for applying QFD in this industry (Meredith & O’Bierne, 1995). Abdul-Rahman et al. (1999) reported their use of QFD to incorporate consumers’ wants into the design process of four low-cost housing projects in Selangor of West Malaysia. Kamara et al. (1997, 1999) applied their
proposed CRPM (Client Requirements Processing Model) to the project of building the Teesside Innovation Centre. Laurikka et al. (1996) and Huovila et al. (1997) shared their QFD application in three construction projects, including the building of an apartment block on a residential area at the waterfront in the south of Helsinki, layout design of a restaurant of an office building in Espoo and structural design of an industrial building in Tempere, as a team decision-making tool to listen to the VOC to achieve common understanding, consensus and commitment in design objectives and solutions. Serpell & Wagner (1997) used QFD to identify and analyze the client requirements to determine the design characteristics of the internal layout of building apartments in Santiago of Chile. Ahmed and Kangari (1996) transformed clients’ expectations, needs and requirements through the various intermediate phases of QFD to plan an air-conditioning system. There was also a study of applying QFD to identify the key customer requirements and the critical demanded quality for planning the architecture of a supermarket building in Taiwan (Sher, 2006).

5.2 Service Sector

The quick adoption of QFD by the service sector was not only because companies wanted to add more value for their customers in the face of the increasing market competition but also because many public organizations had to be privatized. In general, QFD was applied to improve two broad categories of services: (1) customer services applied across different industries, and, (2) services specific to respective industries. Besides being used to define quality attributes, task deployment was another major purpose of applying QFD in the service sector.
QFD was initially applied in the services by some large organizations to improve their customer services, such as to improve their responses to customers and the operation of some auxiliary services. The Miami phone centre of Florida Power and Light used QFD to translate customer requirements into operational issues so as to improve the way in which the operators responded to customer requests (Hayes & Webb, 1990). Another QFD study of Florida Power and Light was to understand customer expectations when their telephone calls were answered. The results of the study led to the development of the system “Smartqueue” for providing callers with an estimate of wait time and how many callers were ahead of them in the queue (Graessel & Zeidler, 1993). Pacific Gas & Electric employed QFD to improve the operation of its 32 telephone service centres and the overall residential customer satisfaction (Tessler et al., 1993). At the University of Michigan Medical Center, the Medical Procedures Unit employed QFD to design a single portal of entry to help alleviate the anxiety and frustration patients and referral sources might feel when attempting to gain access to the medical centre (Ehrlich & Kratochwill, 1994).

Since the 1990s, some companies of the rapidly developed service industries have started to apply QFD to improve their service deliveries. For example, in the airline services, Ghobadian and Terry (1995) shared the case of Alitalia on using a modified QFD to understand the customer needs with respect to flight attendants, in-flight products and cabin environment in order to design a new service for its intercontinental business class. Wang (2007) also reported the case of China Airlines on improving its freight service quality by employing QFD to understand the demands of air cargo forwarders and to identify the aspects of cargo-shipping departments for meeting the demands. For logistic services, Baki et al. (2009) integrated SERVQUAL and Kano’s model into QFD to present a guide for cargo
companies to improve service quality. For hospital and healthcare services, Koura et al. (1997) used QFD to analyze the hospital service functions for accomplishing the mission of “providing customer satisfaction” and “contributing to improving the health of the community” of the Asahi University Hospital. Takahara and Iida (2000) of Nerima General Hospital reported the application of QFD to their Medical Quality Improvement (MQI) activities for enhancing both customer satisfaction and employee satisfaction. For the case of improving the diagnostic image for enhancing patient and physician satisfaction of Genesis, a not-for-profit community-based integrated healthcare facility located in Zanesville, QFD was used as a team approach for equipment selection (Yanci, 2006). Similarly, at a nursing home institute in Yunlin of Taiwan, QFD and fuzzy analytic hierarchy process were used to improve the rehabilitation as well as the professional care and medical services that were provided for its residents (Chang, 2006) whilst an Iranian social security hospital used QFD to improve the maternity care services (Aghlmand et al., 2008). For integrated radiological services, QFD was applied in the analysis of the framework for safety management contained in the Ionising Radiation (Medical Exposure) Regulations of 2000 (Moores, 2006). For travel and tourism industry, QFD was used to identify the strengths and weaknesses of the services provided by tourist places and to evaluate the image of Singapore from the perspective of tourists from Indonesia (Pawitra et al., 1997; Pawitra & Tan, 2003). For hotel and lodging industry, several applications were reported. Au (1997) used the HOQ to identify the gaps between the customer requirements and the attributes of an information technology operated system for making hotel room reservations. Jeong and Oh (1998) proposed an extended QFD framework for improving the service quality and customer satisfaction of the hospitality industry. Dubé et al. (1999) applied their proposal of adapting the QFD approach to extended service transactions for
conducting a comprehensive assessment of customer needs when staying at luxury business hotels. For retail services, Gustafsson and Johnson (1997) reported a study of IKEA on using customer satisfaction modeling and QFD for bridging the quality-satisfaction gap. For housekeeping services, QFD was used by CBM to improve the cleaning and disinfection techniques, calculate the standard operation time, define the evaluation criteria and plan human resources development (Kaneko, 1996). For the fast food industry, Barlow (1999) applied QFD to improve the quality of a burger and the operational processes for producing the burger. For consultancy services, Zultner (1997, 1998) suggested using QFD to manage the planning and scheduling of software development projects. For marketing services, Hamilton and Selen (2002) utilized QFD to design a web site for promoting a mobile phone to three different customer groups.

In the face of liberalization, some monopolistic companies made use of QFD to improve their services so as to gain a competitive advantage in the open market. For example, faced with the liberalization of the electrical sector in Spain, Endesa, the largest and most important electricity company, used QFD to identify internal quality indicators in respect to the expectations of the final customers for improving its services (Royo et al., 2005). Similarly, in order to compete with the new entrants because of deregulation, Chunghwa Telecom, a state-owned company in Taiwan, used QFD as the framework to develop a strategic planning system for supporting the decision on service development in order to maximize the performance improvement given the limited resources available (Wang & Hong, 2007).
In recent years, more and more governmental departments and public organizations have started to apply QFD for planning and improving their services. Among others, there are two major reasons that drive the increase of applications. The first reason is the increasing pressure on reducing spending, while increasing emphasis on quality and accountability for public services. In the USA, the Princeton Foot Clinic of the Baptist Health System used QFD to repackage its service in order to face the increasing competition and the growing pressure arising from the shrinking bottom lines and the health reform measures (Gibson, 1994). In Taiwan, QFD was used as one of the quality management tools to improve the library and information services so as to meet the increasing expectations of users (Hsieh et al., 2000). In Belgium, QFD was employed by the Tongeren police station in exploring the relevant consumer need attributes so as to better match the demands and needs of the general public and authorities to the activities deployed by the police services (Selen & Schepers, 2001). In Calgary, QFD was applied in redesigning the social system for providing services to the deaf and hard of hearing in order to improve quality and fund allocation (Gerst, 2003; Gerst 2004). Similarly, in the case of the redesign of rehabilitation services in the USA, QFD was employed to meet the challenge of satisfying the patients’ needs at reasonable cost (Einspruch et al., 1996). In Sapporo, QFD was used to evaluate the winter road maintenance services from the perspective of customers (Yamamoto et al., 2005). The second reason is the pressing need to accommodate public opinion in social developments. For example, in the Netherlands, QFD was employed in estimating the non-market net benefits for planning the development of a dairy-farming based agricultural landscape in the Northern Friesian Woodlands (Parra-López et al., 2008).
Literature showed that QFD has been increasingly applied to understand the customer requirements of some professional services. At Kennewick General Hospital, QFD was used to determine the requirements of three customer groups, namely, patients and their families, physicians, and physician office staff, to design the surgery process for a new surgery centre (Macfarlane & Eager, 1994). Pentz et al. (1996) shared their case of applying QFD, together with the technique of CIDM, to understand the strategic issues when developing a treatment system for adults with attention deficit disorder (ADD). However, for the case of employing QFD in orienting the Department of Clinical Social Medicine at Linköping University, a tertiary clinic that only received patients by referrals from other institutions, to a quasi-marketing situation, Hallberg and Timpka (1997) advised that the service provider had to carefully consider and professionally manipulate the derived outcomes before implementation.

6. Recent Developments

Besides creating exciting products, determining appropriate selling price and reducing production costs, applications to safety and environmental issues and improving QFD efficiency would be two new development areas of QFD (Akao, 2000). The former is the new customer concerns whilst the latter is due to the need of meeting the increasingly severe market competition.

With the growing diversity and complexity of customer needs and concerns, attention has been increasingly paid to the matter of reformulating QFD or integrating QFD with other techniques and tools so as to enhance the efficiency and effectiveness of product and service development. In sharing the experience of
SKF Group, a multinational manufacturing company based in the Netherlands, Bles (1997) claimed that QFD had to be integrated with other methods in the design process to achieve optimization. For the first purpose of enhancing the efficiency of product and service development, Shiu et al. (2007) renewed QFD in a comprehensive manner and developed a new process for implementation so as to support the corporate new product development cycle and achieve more systematic innovation. Yamashina et al. (2002) described a new method that systematically integrates QFD and TRIZ to enable effective creation of technical innovation for new products. For the second purpose of enhancing the effectiveness of product and service development, one of the well-known models is the Enhanced QFD proposed by Clausing and Pugh (1991). It incorporated five enhancements, including contextual analysis, structured requirements, static/dynamic status evaluation, Pugh concept selection process, and, deployment through levels of complex products, to increase the probability of developing the right products and make QFD explicitly applicable to complex products with multiple levels in the system. Carpinetti and Peixoto (2002) merged the Enhanced QFD model and Akao’s model into one to speed up the learning and decision making processes as it could help the QFD team to consider a whole range of relationships in a structured way. Furthermore, Herrmann et al. (2000) proposed an extended QFD approach to address the behaviour-forming utility dimensions and values of the consumer, in addition to purchase-decision-relevant product attributes.

In addition to customers’ needs and functional demands, QFD applications have been extended to address environmental issues and ecological concerns. For example, at UGA, the QFD approach was adopted for producing a stepwise procedure for incorporating environmental consideration into engineering solutions. The
procedure was used to create a development plan for a forest site (Esteghlalian et al., 1998). Masui et al. (2003) presented a methodology for applying QFD to environmentally conscious design in the early stage of product development, which was used to develop a BGA-type IC package of Shinko Electric Industries. Madu et al. (2002) employed QFD to evaluate not only the product features but also the environmental burden for the development of recycled paper. Raggi and Petti (2006) adopted an environmentally integrated QFD approach to improve the level of customer satisfaction and compliance with environmental requirements of the lodging services of the Hotel Duca d’Aosta. Cagno and Trucco (2007) developed the “integrated green and quality function development” methodology for the design of products or product systems that would best meet the customers’ needs as well as the company’s product and environmental policy. Yim and Herrmann (2003) shared the case of Braun on using QFD to develop a hair dryer in which eco-VOC was extracted from the conventional VOC for addressing both the consumer needs and environmental concerns. Furthermore, QFD was also used in selecting the key process for further analysis of sinter production so as to maximize environmental performance improvement within a budget constraint (Halog et al., 2001; Halog, 2002) and in selecting the activities which were crucial for fulfilling the ecological requirements of Bedzin in Poland (Wolniak & Sędek, 2009).

7. **Key Benefits**

Results of industrial applications showed that QFD is effective in achieving customer satisfaction. A benchmarking survey of QFD usage patterns, which involved 164 QFD practitioners within Ford Motor and 27 selected companies, revealed that “understanding the customer” was the top first benefit of using QFD
(Ginn & Zairi, 2005). O’Neal and LaFief (1992) claimed that the usefulness of QFD is the methodology that it provides for achieving customer satisfaction, which is vitally important for companies to attain and sustain competitiveness. Aiming at achieving customer satisfaction, the application of QFD not only strengthens the company but also brings an all-win situation to the involved parties of the supply chain. On the one hand, customers could enjoy the benefits of improved designs and lowered prices. On the other, suppliers could also reap a number of tangible and intangible benefits from the applications.

7.1 Increased Product Effectiveness

A study showed that product design and customer satisfaction were the two significant benefits that companies had attained upon the implementation of QFD (Vonderembse et al., 1997; Vonderembse & Raghunathan, 1997). QFD was found to be extremely useful for product definition. In the case of AT&T, Thompson (1989) informed that QFD helped the company to focus on customer needs. Compared to other product planning methods, Cohen (1988) of Digital Equipment Corporation claimed that QFD was efficient at developing a more detailed statement of customer needs and how product features related to customer needs. Sandelands (1994) of Volvo added that besides providing the methodological approach for developing products that would meet functional and performance expectations, QFD also provides innovative or unexpected items which present extra attraction for customers. With the growing emphasis on design for quality, Booker (2003) claimed that QFD is one of the few techniques that could potentially have a quality impact throughout a company’s product development process.
Improved designs that resulted from successful product definitions led to an increase in sales and market share. In the bagel project of Host Marriott, the application of QFD led to a sales growth of two to three times in only a month’s time (Mazur, 1996a). Mazur (1996b) also reported that the TQM course of the University of Michigan College of Engineering increased the student enrollment from one section to three upon being redesigned by using QFD. Moreover, the QFD project on the development of rods and bars for car suspension springs of Belgo-Mineira, a steel company in Brazil, reported a reduction of 23% in production cost as well as an increase of 120% in market share in two years’ time (Oliveira et al., 1996).

7.2 Increased Process Efficiency

Sorli et al. (1993) of Labein, a technological research centre in Spain, claimed that accuracy in meeting customer demands and shortened time-to-market are very important issues that research and development has to care about in order to increase competitiveness. QFD facilitates consistent flow-through and shortens the cycle time of product development by eliminating ad hoc midcourse changes. It allows key decisions to be made early in the development process, at a time when the cost of a decision is relatively low (Cohen, 1995, p. 26). QFD helps to insure that “it is done right the first time” (Denton, 1990). As Ferguson (1990) described, QFD not only provides the marketing advantage through increased marketing acceptability and identifies critical items for parameter designs but also assists companies in reducing development time and costs, changing designs early and reducing start-up problems. Ermer and Kniper (1998) informed that the first and foremost benefit of using QFD in service design is that it enables one to focus proactively on customer requirements early on in the design stage. The designer, therefore, has more
leverage early on and can receive a 10:1 payback for time taken upfront, as opposed to “fire fighting” at a 1:1 payback for improvements made after the service design has been implemented. O’Brien (1992) explained that QFD alters the manpower versus time relationship. Although more time was spent in the planning and design phase, features which were required by customers and possible issues with the manufacture of the product could be identified. Field applications showed that QFD did contribute to shorten the time-to-market and lower development costs. An agricultural manufacturer having applied concurrent engineering with QFD to product development achieved a reduction of the period required to prepare its products for production from 18 to 12 months (Farrell, 1994). Swoboda (1997) shared that the transparency and interdisciplinary teamwork of QFD enabled 30% to 50% cost savings of some large construction projects in Switzerland. A software development showed that the application of QFD reduced requirement changes by 62%, architectural design changes by 33%, module design changes by 58%, coding changes by 45% and test problems by 53%. The result was lower development costs and greater software stability at an earlier stage in the process (Nichols & Flanagan, 1994). Wiremold, a wire product manufacturer, reduced the new product development time by 75%, from 24-30 months to 6-9 months, and increased the number of new products from 2-3 items to 16-18 items per year upon utilizing QFD for three years (Blondin et al., 1994). Furthermore, the integrated solar upper stage project, which was to develop a ground demonstration test of a system to provide transfer orbit propulsion for a payload, such as a satellite, of Rocketdyne showed that QFD was able to produce a valuable product in a relatively short time, and, no time or money was spent on re-planning, negotiating and panicking (Marzec, 1998). QFD speeds up the product development process because it promotes a cross-functional working team. Waisarayutt and Siritaweetchai (2006) claimed that
QFD promoted cross-functional working teams and facilitated the communication and information transferred between marketing, research and development, and the raw material unit, which was particularly important for improving the efficiency of developing high-involvement products, such as sport bras.

QFD also improves the efficiency of production and service delivery. In a pilot study that made use of QFD and robust design to optimize the servicing process of a hospital emergency room, the results showed that the average length of stay of patients was reduced by 25% without making a major capital investment in facilities (Macfarlane & Eager, 1995). The QFD study of the Ritz-Carlton Hotel also improved the reliability and efficiency of its room housekeeping services. Upon making a change from a single housekeeper to a three-person team, defects per room were reduced by 42%, room cleaning cycle time reduced to 65%, standard guest room interruptions reduced by 33%, distance travel of an individual within a guest room reduced by 64%, and the productivity increased from 13 to 15 rooms per person (Kirk & Galanty, 1994).

Improved product development and delivery processes not only save costs but also utilize human resources. Kim and Ooi (1991) added that the QFD approach is useful in integrating the human expertise of marketing, design, production, and service personnel to address all relevant issues and to achieve the single goal of customer satisfaction. Deve Hydraulic Lifts of Australia reported that they did 40% more business with the same number of staff in the first two years upon implementing the corporate strategy plan which was designed with QFD (Hunt & Xavier, 1996).
7.3 Improved TQM Culture

QFD is a method of continuous product and service development, emphasizing the impact of organizational learning and innovation (Govers, 2001). It brings a number of intangible benefits that would promote the members of an organization to change, to learn and to contribute. These intangible benefits are critical to the building of TQM culture for attaining organizational long-term success.

The vertical and horizontal integration of QFD produced by the companywide approach enhances the ability of an organization to respond to change. Ealey (1987) claimed that QFD webs together disparate departments of an organization in much the same way that the central nervous system controls the actions and reactions of the human body so that the organization can quickly react, and, with a single purpose, it can develop products and services that could meet the ever changing needs of the market. Bosserman and Stoner (1994) of Motorola informed that, in the absence of a planned strategy, the QFD projects conducted since 1990 had assisted the company in overcoming some cultural barriers to change and improved its opportunity for success. At Emerson Process Management, the worldwide supply chain project, which used QFD to drive a series of group discussions to determine the organization’s objectives, processes, strategies and priorities, increased its capability of turning round any business challenge and resulted in a management team that was eager to do so (Clargo, 2004).

An important intangible benefit that QFD provides organizations is an increase in customer focus. Zairi and Youssef (1995) remarked that QFD is an ideal opportunity for moving away from “we know best what the customer wants” to a
new culture of “let’s hear the voice of the customer”. Ehrlich and Hertz (1993) of University Michigan Centre found that the QFD process significantly strengthened the paradigm shift of the institution from conducting business the way it was most suited to the medical centre to listening to the customer and conducting business to meet customer needs. Gibson (1995) reported that the use of QFD at the Princeton Foot Clinic of the Baptist Health System not only had increased the customer awareness of the parties involved with the clinic but also had strengthened the customer focus in the larger rehabilitation services and the entire outpatient scheduling system. Ackerman and Buckland (1993) of Digital Equipment Corporation claimed that the true dialogue between suppliers and customers, which resulted from customer focus, enabled companies to develop quality products and services, and, in return, enhanced their competitiveness. After years of application, Ginn (1999) of Ford Motors shared that QFD was a coherent strategy for bringing in and focusing on true needs.

Besides increasing the external communication with customers, QFD also promotes cross-functional communication and collaboration within an organization. In Sweden, the result of a survey showed that the top ranking benefits of QFD were better communication, knowledge preservation, unity in the group and rational decisions (Bergman & Gustafsson, 1997). Meritor, an automotive parts company in Brazil, claimed that communication and cooperation between departments were improved and teamwork was strengthened after using QFD as the tool for continuous improvement of product development (Miguel et al., 1998). Dika (1995) of Chrysler shared that after seven years of implementation, QFD helped in improving the company’s fortunes and the development of a more customer-oriented, team-based culture.
8. Voice of the Customer

Customer satisfaction is a moving target, always with opportunity for improvement. However, customer satisfaction can be improved only when we hear and act on the VOC (King, 1995, p. 5). As the process for improving those areas most important to the customers, QFD helps companies initiate quality improvement efforts by providing a simple operational rule – listening to the VOC (Reid & Hermann, 1989; Vasilash, 1989). To QFD, VOC drives everything an organization does throughout the research and development, engineering and manufacturing stages of product development (Griffin & Hauser, 1993). The focus on VOC helps to reinforce the quality linkage between departments, set the priorities for achieving marketplace advantage, and reduce the time from concept to product delivery (Perry, 1987).

8.1 Collection Methods

VOC is the raw data verbatim collected from customers. Nevertheless, due to its elusive nature, VOC is often referred to as the fuzzy front end. As VOC exists almost everywhere but is seldom explicit and never complete, Mazur (1991a) suggested that it might be acquired through different sources and appropriate methods used to capture it. Various ways of collecting VOC were revealed in the literature. In-depth discussion and on-site visits were conducted to obtain the voices of external customers for the case of using QFD to design a new manufacturing plant of Clorox (Crossley, 1992). Interviews with a target group of parents were conducted to understand their needs in the QFD project of planning an early childhood educational centre (González-Bosch et al., 2008). Besides
interviews, a questionnaire survey on backlogs was conducted in order to understand the customer requirements for software development (Kawane, 1997). In the design of an electric wheelchair with QFD, besides conducting focus groups with the current users, an activity analysis was also made to provide a detailed understanding of the situations in which the electric wheelchair was used (Friman, 1999). Stauss (1993) pointed out that problem information embedded in their voices could be transformed into problem prevention activities. As in the case of using QFD to formulate strategy for a housing project of a construction company, besides data collected from customer surveys, face-to-face interviews with potential buyers, complaints received from previous projects were also used as the entries for extracting customer expectations of high-rise building complexes (Dikmen et al., 2005). Multiple sources and collection methods were often used in order to capture the VOC as completely as possible. In the case of service development of Telia Mobitell, a large GSM operator in Finland, diary method, group interviews, critical incident and problem detection studies were used to collect the “Whats” for QFD (Ekdahl et al., 1997). The ways to collect the customer needs to design a power diode using QFD and FMEA were even more diversified. Besides questionnaires, face-to-face interviews and focus groups, information was also solicited from customer complaints, warranty data and service reports, failure analysis reports and through trade journals, data manuals and consumer magazines (Tan, 2003). Furthermore, Klein (1990) recommended using VOCALST™, a four-step process to systematically collect and structure the VOC and Mazur (1995) suggested using a few software engineering tools, such as state-transition diagrams (STD), data flow diagram (DFD), event table, and event tree to elicit the customer service needs.
Although the methods vary from one project to another, customer focus group and *gemba*, that is, site visit, are the common ones that are used to collect VOC. In the following, these methods are discussed in greater detail.

### 8.1.1 Focus group

Focus groups are created for well-defined purposes and used as special occasions to gather data on specific topics. Besides being a simple, inexpensive method to capture what the customers need (Becker, 2005), the focus group could create conversations that might never occur in the “real world” (Morgan, 1998, p. 31).

In the project of redesigning the member handbook of a managed care organization in the United States, the input for the QFD process was obtained through a series of customer focus group meetings (Omachonu & Barach, 2005). Focus group studies with subscribers were also conducted to define the quality attributes of eight mobile data services with QFD (Yun et al., 2005). In using QFD to improve the layout and features of a middle-class apartment unit, the focus group was used as one of the techniques to obtain information on the likes, dislikes, trends and opinions of different people, including real estate agents, architects, engineers, potential buyers and owners of similar apartments (Gargione, 1999). Similarly, in the design of a large-size college classroom using QFD, focus groups with teachers, students, facilities services staff who maintained the classroom, campus media centre staff who provided and maintained teaching equipment, and school administrators who approved funding for the project were held to understand their needs (Eldin & Hikle, 2003).
Two approaches have been commonly used to ask customers about their needs. For the first approach, customers were asked to make comments for the existing product or service. For example, in an improvement project of Capper, a distributor of convenience food to retail outlets, a number of key players involved in and responsible for order fulfillment and several customers were asked to identify what they considered to be the main problems within the process (Samuel & Hines, 1999). The VOC collected from this approach is useful for understanding customers’ expected and normal requirements. For the second approach, customers are asked to state their expectations of the product or service. For instance, in a service planning project of a regional acute-care hospital in Singapore, the patients were asked about their expectations of a healthcare provider (Lim & Tang, 2000). A study on service guarantee design in Stockholm used a similar approach. The discussion of the focus groups began with a question directed to the participants, who were frequent users of public transport, about what they considered to be a good service guarantee (Lidén & Edvardsson, 2003). The VOC collected from this approach is useful for understanding customers’ normal and exciting requirements. Each approach has its own advantages, and customers find it easier to talk about their needs if asked in different ways. They are complementary and often used together with the aim of obtaining a more comprehensive picture from the customers.

8.1.2 *Gemba*

In QFD, *gemba* is another method which is commonly used to understand the stated and unstated customer needs. *Gemba* is a Japanese word meaning “real place”, the place where the real action takes place. Imai (1996), the founder and chairman of
the KAIZEN® Institute, contended that *gemba* is the site of all improvements and the source of all information for adding customer-satisfying value. Since many customer needs are in the areas of expectation and excitement but often unvoiced, “going to the *gemba*” therefore could help a supplier to understand how and under what circumstances its product or service was being used (Mazur, 1997a). Furthermore, a *gemba* visit could capture VOC more comprehensively because contextual inquiry, video-taping, audio-taping and direct interview could be used in combination with direct observation to gather information (Mazur, 1997b). In general, a *gemba* visit provides two major kinds of information for improving product and service design. First, *gemba* analysis could help in identifying the potential failure modes and root causes, which are often missed in conventional problem analysis, for the design of products and services (Terninko, 2000). Second, a *gemba* visit could assist suppliers in acquiring a better understanding of customers’ latent and unspoken demands so that the product or service to be developed could surpass their basic requirements (Nelson, 1992). In a truck hood project of Rockwell, Gavoor and Marcel (1989) stated that their knowledge of how the truck hood opened and closed was greatly enhanced by having the product team visit a truck stop and interview the truck drivers and maintenance personnel. GCC Rio Grande, a cement manufacturer in New Mexico, improved its technical support services by paying visits to their key customers to document their cement use and concrete production processes (Hearon & Mazur, 2002). Rubbermaid adopted the *gemba* technique to encounter consumers in different situations in order to help develop more innovative concepts (Rings et al., 1998). When designing a dinosaur robot as a theme park attraction, the engineers visited a petting zoo in Toronto to observe how children interacted with live animals to simulate a triceratops encounter (Bolt & Mazur, 1999). Nokia conducted a *gemba* visit in the public places in the
Tokyo metropolitan area in order to capture the basic and latent needs of cellular phone users (Ronney et al., 2000). In the study of improving customer satisfaction with bagel sales at the US airports of Host Marriott, the project team discovered from *gemba* that customers wanted to have toasted bagels, which their shops had never offered before (Lampa & Mazur, 1996).

### 8.2 Extracting Customer Requirements

Upon collecting the VOC, customer requirements in terms of explicit needs and implicit meanings have to be extracted and interpreted into demanded qualities. Shillito (1994, p. 141) emphasized that the team needs to process and achieve an understanding of the raw data verbatim collected from the customers. Once structured and interpreted, the processed understanding of the VOC is deployed through the QFD process into the design community and the company’s commercialization process. Ulwick (1995) claimed that customers seldom give their requirements but solutions, so interpretation is definitely required. This interpretation process, however, is important to spur innovation. The essence of innovation lies in the creation of solutions for solving customers’ problems upon focusing on the outcomes that are derived from the captured input (Ulwick, 2002).

Scene deployment is the method which has been commonly used to extract latent customer requirements from the collected VOC. For example, in the design of Gifu Prefecture, different scenes were set up in order to extract the demanded qualities from the VOC on “dream contents” (Akao & Inayoshi, 2003). Similarly, in a satisfaction survey of surgery patients, the scene depicting post-surgery state was used to extract the patient requirements of “good appearance” and “small wound”
from the voices of “want unnoticeable scar” and “want to wear bikini” (Akao & Kozawa, 2005). The scene deployment method was also used in the development of a finger vein authentication device at Hitachi Omron Terminal Solutions. By examining the scene of “during the first visit of a patient”, the requirements of “pleasant to touch” and “appropriate size for a hand” were extracted from the patient’s voice of “pleasant to use” (Akao & Kazuhiko, 2007). For the design of innovative products, Nakamura (2008) proposed to add in the interactive 3D virtual model to the method of scene deployment in order to imagine and design a future “user experience”.

Besides scene deployment, there are also some other methods for extracting customer requirements, depending on the nature of the product or the service under study. For example, due to the difficulty associated with collecting the VOC for the manufacture of glass bottles for cosmetics, Iwama et al. (2008) indicated that clarifying the bottles’ essential functions was used as the method to extract the customer requirements. Hillmer and Kocabasoglu (2008) used the coding method to interpret the interview transcripts for understanding the requirements of the recruiters when designing an MBA programme.

Upon extraction, the demanded qualities, on the one hand, are prioritized in order to identify the important ones, and, on the other hand, are deployed to quality elements. The quality elements are then assessed against the important demanded qualities so as to identify the effective ones. This is the quality planning process which is fundamental to all QFD applications. There are two points that Akao (1990a) highly emphasized. First, the conversion process of translating demanded qualities into quality elements is important, as it is the entry from the world of the consumer
to the world of the engineer. Second, prioritization of the demanded qualities is also very important. He stressed that only high-priority items should be further deployed so as to avoid excessiveness.

8.3 Voice of Customer Table

In the early 1990s, the VOC table was developed to facilitate focusing on the vital few and to speed up the product development process as well. The VOC table provides two important advantages for enhancing QFD in meeting the growing competition of the market. First, it is formulated to reduce the design and development time for delivering newer and more exciting products and services to the market (Mazur, 1992). Second, it helps analyze customers’ stated and unstated wants and needs, and helps communicate this analysis to all required functional organizations (Nakui, 1992). Nakui stressed that some demands may be expanded by combining the VOC and different usage situations and Mazur emphasized that the analyses make later prioritization more effective.

The VOC table consists of two parts. In the first part, it is to gather data about how the product or service is being used or could be used by the customer. It is to look for who is using the product or the service, what they are using it for, when, where, why and how they are using it. The use of 5W1H is similar to that of the scene deployment method. In the second part, the collected VOC was reworded into demanded items, such as demands for performance, demands for low price, taking into account all uses described in the first part. The demanded items are then analyzed into demanded quality items, which grouped by using an affinity diagram for further deployment (Mazur, 1991b; White, 2006).
Some cases were shared on using the VOC table to process and deploy the VOC. For the case of service repackaging of Princeton Foot Clinic, the VOC table was used to analyze the customer needs with foot treatment and to deploy those needs into quality attributes (Mazur et al., 1995). Likewise, at Blue Cross Blue Shield of Florida, the VOC table was used to understand the unspoken customer needs in order to explore new health insurance services. For example, the voice of “health plans are easy to understand” was translated back to the underlying needs of “I can hire the best new college graduate”, “I can attract best employees from competitors” and “my employees know exactly what they are entitled to”. These customer needs were then deployed to functional requirements and solutions (Hepler & Mazur, 2006).

9. **Deployment**

Customers are driven by value. The value of a product or service is delivered through design and the basis for any design is function. Function, therefore, is the foundation of all products, services and systems (Shillito, 1997, 1999). The work of QFD is to map the requirements which are valued by customers into functions.

In QFD, “deployment” is a term that means either a breakdown of abstract demands of customers or technology, or, use of a matrix to convert demanded qualities to quality elements. Although how quality to be planned highly depends on the nature of the subject to be studied, there are three major deployments for the design of product or service quality. The first deployment is the elements that made up the quality of the subject. For example, Tang and Lim (1999) carried out the basic steps of the HOQ to identify the important quality dimensions for hospitals in
Singapore to improve their services, and, Bech et al. (1997) applied the HOQ to translate consumer needs for good sensory quality of food into sensory attributes measurable by conventional sensory descriptive analysis. The second deployment is the tasks and activities that needed to be performed or processed in order to create the quality of the subject. In the case of planning the design for a pultrusion machine, the customer requirements were translated into technical, operator and maintenance requirements (Rahim & Baksh, 2003). In another case of improving a ready-to-eat meal, the abstract customer demands were interpreted into a set of operative requirements for improving the processing of the used ingredients (Benner et al., 2003b). The third deployment is the options and parts that contribute to achieving the quality of the subject. In the case of designing an advanced assembly station, QFD was used to evaluate the potential concepts against the process characteristics for selecting the most promising one(s) for further development (Mrad, 1997). For automotive manufacture, QFD was applied to examine seventeen fuel rails against six engine families to choose the most suitable one (Vinarcik, 1999). In a design space model, QFD was utilized to select the best configuration concept for satisfying the design requirements (Park et al., 2006). Almannaï et al. (2008) constructed a joint QFD and FMEA model to choose the most suitable manufacturing automation technology by evaluating the alternatives against the system criteria, which were derived from the needs of the management. As how quality to be deployed varies from one project to another, Hofmeister (1990) advised that when planning a QFD project, a roadmap should be developed to explore the required deployments in order to avoid wasting time and resources.
9.1 QFD Chart and House of Quality

The QFD chart is a two-way matrix which is used to conduct deployments. The charts help the team to set targets for issues that are important to the customers and indicate how these could be achieved, also to carry out technical and customer benchmarking so as to rank the company’s product against those of the competitors (Bouchereau & Rowlands, 2000). More than simply an easy template, the QFD charts visually display the involved connections to help the team to focus on the needs of the customers throughout the total development cycle. They form an effective bridge between the concepts and the final products (Gustafsson, 1997). In addition, they serve as a kind of conceptual map that provides the means for inter-functional planning and communication as people with different problems and responsibilities can thoroughly discuss design priorities while referring to patterns of evidence on the house’s grid (Hauser & Clausing, 1988). The charts help to show people which factors to weigh most heavily and uncover interdependence among multiple goals and engineering attributes whilst the process encourages engineers, marketing executives and general managers working together to understand one another’s priorities and goals.

Taught by Fukahara of the Central Japan Quality Control Association, the HOQ, the first chart which was used to do quality planning, was commonly used in QFD applications. For QFD, one chart is used for one deployment and several linked charts are used for multiple or consecutive deployments. A typical HOQ is provided in Appendix 2-2.
9.2 Single Deployment

Many cases did single deployment and they only used the HOQ, that is, the first QFD chart, for their studies. Cohen (1997) claimed that the first HOQ could be considered as the master HOQ. It has the advantages of creating a shared view of important aspects of product development, reduces the work of creating a HOQ for each new development project and reuses previously determined customer needs, required characteristics and the relationships between them. Numerous cases were reported on using the first HOQ to do quality planning. Jacques et al. (1994) used the first HOQ to modify the design of child-sized myoelectric prosthetic hands whilst Marsot (2005) applied it to improve the ergonomic quality of a boning knife. Stocker (1991) supplied a case of completing a HOQ to improve the design of a tennis racket, with the aim of directing the team to consider breakthroughs in technology and racket design. Ferrell and Ferrell (1994) used a HOQ to identify the key possible responses to customer requirements so as to improve the service quality of a small appraisal firm. For Military Aircraft and Missile Systems – Southern California of Boeing, a HOQ was completed to facilitate an analysis of how well the various strategic thrusts and initiatives addressed the 19 items within the Criteria for Performance Excellence, including the activities of analyzing relationships for synergy/trade-offs, identifying gaps and redundancies, and benchmarking progress against other organizations through competitive comparisons (Walden, 2001, 2003). At Family Courts, a HOQ was constructed to establish the stakeholders’ needs and the importance of these needs, to design strategies to meet these needs and to make trade-offs between different design solutions for planning how to implement the New Beginnings Program (Daniels & Sandler, 2008). Fatimah et al. (2009) even adapted the HOQ for improving marriage loyalty.
However, instead of identifying the high-valued variables, they used their developed Quality_Marriage Deployment matrix to identify those variables with lowest performance values as priority needs for proposing actions.

### 9.3 Multiple Deployments

Customer requirements are deployed both vertically and horizontally in order to acquire a comprehensive quality plan. In the case of vertical deployment, customer requirements are deployed to different functions across levels and QFD is used in a sequential mode where the important “Hows” of the first matrix that have been identified become the “Whats” of the second matrix and so on. For the case of using QFD, balanced scorecard and value chain analysis for the implementation of e-manufacturing planning of Atlas Paper Products in Singapore, the vision of the company was used to identify the critical business processes, and, the identified critical business processes were then used to identify the critical e-manufacturing applications (Tan & Bennett, 2007). In the study of using QFD to improve the reference services provided by a library, the service requirements, which were derived from the customer needs, were used to identify the major process parameters, and, the major process parameters were used to plan the quality management activities (Chang & Hsieh, 1996). To design and manufacture a can opener, the functional requirements were first used to establish the design and technical requirements, the design and technical requirements were used to establish the product features, the product features were used to establish the process features, and, the process features were used to establish the process variables (Chiang et al., 2001). In the case of horizontal deployment, customer requirements are deployed across different functions at the same level. Nevertheless, determining to which
dimensions the quality is going to be deployed depends upon the kinds of information the project team aims to acquire for quality planning. For example, in improving Norwegian fishing fleets with Eco-QFD, the stakeholder requirements for a sustainable fishing fleet were deployed to identify the key management responses and technical responses respectively (Utne, 2009).

The number of deployments to be conducted depends on the degree of detail the project team aims to acquire for quality planning. In some cases, only two deployments were conducted. For example, for the case of designing a power rectifier, the VOC was deployed to identify the quality functional requirements as well as the reliability requirements (Tan & Neo, 2002). However, in other cases, numerous deployments were conducted. For the QFD phased progression for the Future Combat Systems programme, the national military strategy was consecutively deployed one after one, and, until the tenth matrix the design team used it to determine levels of work and selection of technologies (Jones et al., 2001).

The following is a review of a few models commonly used for multiple deployments.

9.3.1 Akao’s quality deployment model

Akao’s QD model initiated the applications of QFD in Japan. It provides the method for transforming user demands into design quality, deploying the functions forming quality, deploying methods for achieving the design quality into subsystems and component parts, and ultimately specifying the elements of the manufacturing process (Akao, 1994a, 1994b). The early version of the model mainly focused on
vertical deployment with the purpose of assuring production quality for products. For example, Toyoda Gosei employed the model to deploy quality characteristics into subsystems and parts, and, to prepare quality assurance charts for the manufacture of machine-assembled products (Aoki et al., 1990). With the increasing use of QD for product design, the model was further extended to include technology, reliability and cost characteristics deployments. This horizontal deployment could allow the extraction of bottleneck technologies, prevention of potential failures and planning for achieving target costs at the product design stage (Akao et al., 1987; Akao, 1994c). The development of valves for the H-IIA rocket by Mitsubishi Heavy Industries was a recent application of the comprehensive version of the model (Kojima et al., 2007). The extended version of Akao’s QD model is provided in Appendix 2-3.

9.3.2 Four-phase model

The four-phase model, which was put forward by Macabe, a Japanese reliability engineer who taught QFD, provides a simplified version for understanding the basic operation of QFD. The typical four phases are: (1) product planning, (2) product design, (3) process planning, and, (4) process control. A template of the four-phase model is provided in Appendix 2-4. This model has been commonly used in the western countries for the applications of QFD. The Big 3 U.S. automotive companies, General Motors, Ford and Chrysler, used it to develop subsystems, parts and vehicles (Ross & Paryani, 1995; Lockamy III & Khurana, 1995). For example, in designing an air bag for the passenger and the third person in the front seat of General Motors’ Cadillac “D” Car, the design requirements were cascaded to the second phase of parts deployment, third phase of process planning and fourth phase
of production planning (Pavia, 1993). These four phases of deployment were also conducted to ensure the reliability of the opening of an engine lid (Papic, 2007). Kriewall and Widin (1991) reported their application of the model to develop a cochlear implant by deploying the VOC to define the design requirements, parts, process planning and production operations. The same deployment phases were also applied in the case of using the model to develop school furniture (González et al., 2003). In the design of a lithium battery, the four-phase model was applied to specify the product measures, parts characteristics, manufacturing process steps, and, to develop the manufacturing process control plan as well (Halbleib et al., 1993). Moreover, Thackeray and Treeck (1990) used the four-phase model as the basis to derive the embedded systems QFD model, which included the phases of requirements analysis, architectural design, technology assessment and implementation planning, for software development.

Cases show that the conventional four-phase model was modified into various versions according to specified purposes. Mazur (1993) developed his Japanese translation business by mapping the QFD steps into customer deployment, voice of customer deployment, quality deployment, function deployment, reliability deployment, process deployment, new concept deployment and task deployment. In the development of the F-8 facsimile machine of Kinpo Electronics using QFD, design quality was fed into technology, cost and process, together with the respective techniques of functional analysis, value analysis and process management (Lee & Yang, 1996). There are several cases in which the four-phase model was modified into a three-phase model for QFD applications. Hwarng and Teo (2000, 2001) adapted the four-phase model to a three-phase model and applied it to three educational processes of the Business School at the National University of Singapore.
The customer requirements were used as the start for specifying the service elements, process operations and operations requirements. For the case of defining a strategy for introducing e-banking of the National Bank of Spain, the four-phase model was transformed into a three-phase action-based model, including the planning matrix for identifying the service elements, critical part matrix for linking the service elements to service operations, and action plan matrix for developing an action plan based on the information in the previous two matrices (González et al., 2004). Furthermore, three-phase models, derived from the four-phase model, were also used for planning hotel service quality and improving enterprise agility (Stuart & Tax, 1996; Baramichai et al., 2007).

10. Common Operational Tools

Besides skillfully selecting and combining appropriate new QC tools for operation, QFD also accommodates new technologies and techniques for improving its reliability. Among others, the two most common tools used in various QFD applications are affinity diagramming and analytic hierarchy process (AHP). The following paragraphs supply a brief review of the characteristics of these two tools and the ways in which they were applied in operating QFD.

10.1 Affinity Diagram

The affinity diagram is one of the seven management and planning QC tools. It has its origin in the KJ Method® developed by Jiro Kawakita, a Japanese anthropologist, for establishing an orderly system from chaotic information. The affinity diagram is a bottom-up clustering technique that has been popularly used to identify major
themes from a large number of ideas, opinions or issues. It provides an easy-to-understand, easy-to-use approach in grouping those items that are naturally related, and then identifies the one concept generic enough that it ties each grouping together (ReVelle, 2004, pp. 3-4). The affinity diagram is highly effective for cutting through confusion and bringing a problem clearly into view. It is particularly useful for locating and structuring the problem when the situation is fuzzy, indeterminate and ill-defined (Nayatani et al., 1994b, pp. 15-16). The affinity diagram helps people to think more effectively about problems in three ways: (1) define the nature of the problem and bring out hidden problems, (2) help organize and order fuzzy ideas, and, (3) show the proper direction to take in solving problems (Asaka & Ozeki, 1990, p. 246). Smith (1998, p. 77) claimed that the affinity diagram is pertinent to problem definition as it requires aspects of a complex situation to be organized in a coherent representation. Furthermore, the process of affinity diagramming helps group members better understand and teach each other, thus it promotes teamwork and enthusiasm about carrying out the group’s mission. It requires an open mind of each participant and avoids criticism of “strange” ideas. As opposed to being a logical process, affinity diagramming is a creative process that could break through preconceived notions about the situation.

The major function that the affinity diagram commonly served in QFD was to analyze the VOC and organize it into a hierarchy of customer demands. An example could be found in the application of QFD to developing an on-line travel agency website in which the affinity diagram was used to group the VOC collected from interviewing the participants of web design courses into customer requirements (Malarranha et al., 2008). Another example was the use of an affinity diagram by the sales managers and production managers for structuring the retailer wants in the
case of applying QFD to formulate an interactive product development process of a Danish supplier (Holmen & Kristensen, 1998).

10.2 Analytic Hierarchy Process

AHP has been widely utilized in the prioritization work of QFD. The initial development of QFD adopted the assignment of 4-2-1 or some other similar symbols to weight the effectiveness of the “Hows” for achieving the “Whats” of the matrix of the quality table. It is an easy method and has the advantage of encouraging people to accept and apply QFD. However, in the face of increasing competition in the market and limited available resources, this weighting step becomes critical to successful policy management and product development. In regard to this limitation, AHP, a decision support system developed by Thomas Saaty, was employed for improving the accuracy of priorities of QFD (Zultner, 1993). As pointed out in a comparative study on the methods of prioritization matrix and AHP for QFD industrial applications, if time, cost and difficulty are the major concerns in product development, the former is preferred; however, if accuracy is the major requirement, the latter would be a better choice (Wang et al., 1998).

AHP supports decision making by facilitating decision makers to model a complex problem in a hierarchical structure showing the relationships of the goal, objectives (criteria), sub-objectives and alternatives. It adopts a problem-solving approach for making complex multi-criteria decisions based on variables that do not have exact numerical consequences. AHP accommodates subjective judgments and allows for the application of data, experience, insight and intuition to make decisions in a logical and thorough way. It enables decision makers to derive ratio scale priorities
or weights instead of arbitrary assignments (Forman, 1983; Saaty, 1994, 1996, 2007; Forman & Selly, 2001; Saaty & Niemira, 2006). In doing so, AHP provides a mathematically valid mechanism to operate QFD. Not only is it easy to use, but it also greatly enhances the powerfulness of QFD for policy management and product development.

There are several benefits of using AHP in QFD applications. First, AHP allows tracking back any decision to the judgments made by the participants. Second, the certainty of importance of AHP allows focusing efforts on the critical few rather than the trivial many of customer needs. Third, the efficiency of AHP enables making hard decisions and completing difficult discussions in a timely manner while giving every participant a voice in the result. Furthermore, it creates better “buy-in” of the decision to be implemented as AHP allows giving everyone a voice (Jagrowski & Pike, 1996; Hepler & Mazur, 2007).

The first purpose of using AHP in QFD applications was to assign relative weights of importance to the customer requirements so as to make sure that the customers’ priorities are integrated in the product and service design (Madu, 2000, p. 27). To achieve this planning purpose, the function of identifying the relative importance of the sub-goals in respect to the goal of AHP was utilized. Quite a number of QFD studies were reported on using AHP for the purpose of prioritizing the customer requirements. In the prototype development of Smalltalk-80, Fukuda and Matsuura (1993) reported using AHP to prioritize the customer requirements for the selection of an appropriate joining method. Ahmed et al. (2006) employed AHP to prioritize the user requirements in the project of applying QFD to develop a healthcare software system for Sultan Qaboos University Hospital. Similarly, AHP was used
to prioritize the tourist needs in the QFD project of investigating the possibility of developing Varanasi of India into a tourist destination (Das & Mukherjee, 2008). Raharjo et al. (2007) adopted the same approach for improving the quality of higher education. They first used AHP to generate the priorities of the VOC for each customer group and then employed QFD to formulate strategies for meeting the customer requirements. Likewise, in constructing a key model for knowledge management system for the semiconductor industry in Taiwan, Chen et al. (2007) used AHP to obtain the importance weight of each model in the knowledge management system whilst QFD was utilized to locate the correlations between models and key objectives for the key models in the knowledge management system. It was the same for the case of designing a motorbike. AHP was first used to identify the relative importance of the customer need attributes and QFD was then used to assess the correlation between the customer needs and the engineering attributes (Soota et al., 2008). However, in the design planning of an exterior structural wall panel, QFD was first used to identify and the customer requirements and AHP was then used for prioritization (Armacost et al., 1994). Similarly, for the formulation of marketing strategies for the central library services of Dokuz Eylul University in Izmir of Turkey, QFD was used to identify the customer requirements and AHP was employed to assess their relative importance (Bayraktaroğlu & Özgen, 2008).

The second purpose of using AHP in QFD applications was to assign the relative weights of effectiveness to the alternates for meeting the customer requirements. Wasserman (1993) claimed that it is important to prioritize the engineering requirements in the QFD planning process as tradeoffs of design features are necessary for achieving customer satisfaction and meeting cost constraints. To
achieve this selection purpose, AHP was employed to quantify the strength of relationship between rows and columns of QFD matrices so that the weightings of the alternates could be obtained. There are many QFD studies of using AHP to evaluate the effectiveness of alternate features and processes in meeting the customer requirements. In the QFD-AHP methodology for selecting an appropriate rapid tooling process, AHP was used to prioritize the tooling requirements against a set of die/mold development attributes (Hanumaiah et al., 2006). For the robot selection of a pharmaceutical company, QFD was used to identify the technical requirement criteria whereas AHP was used to measure the priority for each technical requirement in meeting the criteria and assess the priorities of the robot alternatives for each technical requirement (Bhattacharya et al. 2005). For the development of a musical toy for children aged under seven, the qualitative design parameters and design criteria were first deployed with QFD and FMEA and then quantified with AHP to get the best design targets with which the detailed design was completed (Hsiao, 2002). In selecting capital budget projects of a tyre and wheel company in Pennsylvania, AHP was used to: (1) link customers and their wants, (2) relate customers’ wants to design specifications, (3) relate design specifications to manufacturing processes, and, (4) relate manufacturing processes to capital budgeting projects of the four QFD matrices involved (Partovi, 1999). In the cases of using QFD to design rule changes for the game of soccer and to evaluate and select facility location, AHP was used to determine the intensity between the relationship between the row and column variables of the QFD matrices, and, analytic network process (ANP) was used to determine the intensity of synergistic effects among the column variables of each matrix (Partovi & Corredoira, 2002; Partovi, 2006). Furthermore, Zultner (2007) claimed that AHP is useful in enhancing Stuart Pugh’s matrices into an even more powerful approach to
technology concept selection, which has been one of the common applications of QFD.

Some QFD applications employed AHP for both purposes of identifying the important requirements and the effective alternates for meeting the requirements as well. In the QFD study for improving the education quality of the Department of Industrial Engineering at the Middle East Technical University, AHP was adopted first to evaluate the relative importance weightings of the stakeholder requirements and then to prioritize the alternate education requirements in meeting the stakeholder requirements (Köksal & Eğitman, 1998). For the strategic marketing planning framework integrating the techniques of QFD, AHP and benchmarking, AHP was suggested to prioritize the customer requirements and to link the customer requirements with the marketing policies (Lu et al., 1994). Similarly, the QFD model for deciding facility location employed AHP to measure the relative importance weightings for each location requirement and assess the evaluating score of each candidate location for each particular location criterion (Chuang, 2001). In determining the composition of the United States peacekeeping force deployed in Bosnia, AHP was not only used to evaluate the relative importance weightings of various stakeholders, but also used to determine the intensity of the relationship between the variables of the three QFD matrices involved: (1) linking stakeholders and their interests, (2) linking stakeholder interests and peacekeeping activities, and, (3) linking peacekeeping activities and force deployment (Partovi & Epperly, 1999).
11. Applications in Education

The above sections primarily reviewed the QFD applications in various industries. In the following, there is a review of how QFD was applied, in particular, in education, with the focus on the levels and purposes of application.

11.1 Levels of Application

Since the education quality movement started in the late 1980s, QFD has been applied in various quality improvement projects at the government, institution and classroom levels. The projects ranged from formulation of educational systems to planning of courses and services.

At the government and institution levels, QFD was mainly used to make plans for improving the overall educational quality. The Education Ministry of the State of Guanajuato in México used “Comprehensive QFD Matrixes” to formulate a strategic plan for improving the educational system (Okamoto & Riobóo, 2002). In the institution-wide quality audit of a vocational secondary school in Slovenia, the HOQ was used to identify the areas for improvement (Starbek et al., 2000). Moreover, in a measuring instrument for evaluating the quality of technical education, QFD was used to provide guidelines for institutions to prioritize improvement policies (Mahapatra & Khan, 2007).

At the institution and department levels, QFD was commonly employed to improve the curriculum quality of various programmes and courses. At Portsmouth Business School, the VOC table, together with the cause-and-effect diagram, was
used to formulate the basic structure and curriculum for its vocational courses (Seow & Moody, 1996). Likewise, at the Hong Kong Institute of Vocational Education, QFD was integrated with SWOT analysis, balanced scorecard and the educational criteria of the Malcolm Baldrige National Quality Award to propose the curriculum structure for the programme of e-Enterprise and management (Lee et al., 2000; Lee & Lo, 2003).

At the classroom level, QFD was primarily applied to improve the quality of instructions and teaching materials. Koura et al. (1998) of the Asahi University employed the basic steps of QFD to turn the students’ desires into an action plan for improving the lecture quality. Abdollahi-Negar and Yaqoobi (2008) used QFD to design and manage the delivery of an English writing course. At ASQC’s Greater Detroit Section, the HOQ was used to plan actions for improving the instructional process of a certified quality auditor refresher course (Zaciewski, 1994). Furthermore, Chen and Chen (2001) developed a two-phase HOQ model for the purpose of selecting technical course textbooks.

11.2 Purposes of Application

The original purposes of QFD are to provide the guiding principles for building quality assurance systems and a technique for policy management and product development. However, it is an elaborate and detailed subject that could be used to its fullest extent or in part. Although the manner by which QFD may be applied highly depends on the particular problem to be solved, the purpose of making quality improvement across different projects is unique. Similar to many other industries, the QFD applications in education are primarily aimed to achieve one or some of
these five quality improvement purposes: (1) facilitating organizational change, (2) identifying areas for improvement, (3) quality planning, (4) selecting best alternatives, and, (5) designing products and services. These five purposes, to a certain extent, could be viewed as an evolutionary process for the implementation of TQM. In the following, each of these five purposes is reviewed one by one in greater detail.

11.2.1 Facilitating organizational change

Resistance to change was a major problem that many educational institutions had to overcome before they could successfully implement TQM (Winter, 1991; Froiland, 1993; Weller & Hartley, 1994). Some educational institutions thus made use of the objective approach and the teamwork setting of QFD to seek cooperation and support from the faculty members. For example, QFD was used to team up the faculty members for improving the contents of a production/operations management course (Burgar, 1994). At the Mechanical Engineering Department of the University of Wisconsin-Madison, three QFD studies were conducted with the purpose of facilitating the departmental change. The first study, which was conducted with the faculty members, informed the chairman of the necessity of providing more support and recognition to faculty members. The other two studies which were conducted with the students and a major employer respectively made the faculty members realize the need of redesigning the undergraduate curriculum (Ermer, 1993, 1995). In the case of using QFD to develop a manufacturing engineering curriculum at the California State Polytechnic University, Pomona, Rosenkrantz (1996) found that the faculty members took ownership and felt pride in the curriculum which they had developed. He added that due to the non-threatening
and empowering approach of QFD, not only had the junior faculty members expressed their ideas without fear of reprisal but the tendency of preserving and defending one’s teaching area was also nullified. Similarly, for the project on redesigning the operations management course of the MBA programme at the Middle Tennessee State University, Peters et al. (2005) reported that the major benefits of the QFD application were the development of a fact-based foundation and the provision of informed areas that facilitated the discussion between the faculty members.

Recently, QFD has been applied to change some other traditional practices with education. In the study on achieving customer satisfaction of the Higher Hotel Institute in Cyprus, Varnavas and Sotiropoulos (2002) employed QFD matrices to identify actionable characteristics so as to assist the school in establishing a customer-driven management culture. Moura e Sá and Saraiva (2001) used a combination of concept engineering and QFD to encourage the involvement of the whole community and family generations in the design of a customer-oriented kindergarten.

11.2.2 Identifying areas for improvement

Some educational institutions adopted an evaluative approach to assess whether their existing products and services could meet certain designated requirements or customer expectations as a start of quality improvement. In these cases, a two-way matrix was commonly used and QFD was primarily utilized as an assessment tool. One of the studies of using QFD for quality assessment was the review of the Masters in Business Administration programme of the Grand Valley State University.
With the aim of assisting the business school to obtain accreditation of the American Assembly of Collegiate School of Business, three consecutive HOQs were used to elicit the programme strengths and to identify areas for improvement upon considering the requirements of the students, employers and academic staff members (Pitman et al., 1995; Motwani et al., 1996). For the Product Management and Engineering Specialization Program offered by the Continued Education Centre of the Polytechnic School of the University of São Paulo, QFD was adopted to evaluate the course processes against the student requirements for making quality improvement (Kaminski et al., 2004). Similar quality evaluation was found in the case of improving the quality of undergraduate nursing education in Taiwan. Survey data collected from the nursing students of four Taiwanese universities were subject to QFD analysis to identify the quality characteristics most valued by students, the elements of educational services they considered most important and least important, and relationships and discrepancies between student quality requirements and institutional service elements (Chou, 2004). Maki et al. (1996) shared their study on using QFD to provide an insight for improving students’ satisfaction with university education. By deploying the weights assigned to different categories and types of students for the objective of entering university, they identified the important quality elements that universities could consider for respective improvements.

Some other educational institutions adopted a proactive approach to identify which areas were important to customers when starting their quality improvement efforts. In these cases, QFD was used as an exploratory tool to find out which areas were to be improved. At the University of Missouri-Rolla, QFD was used a tool to estimate the priority of objectives of the Computer Integrated Manufacturing Laboratory of
the Engineering Management Department for meeting the needs of the students so as to plan the appropriate actions (Benjamin & Pattanapanchai, 1993). At Lakeshore Technical College, QFD matrices were used to conduct a comprehensive study of its two learning centres with the purpose of improving the educational services that were provided to help minority groups, women, the handicapped and disadvantaged. Upon analyzing and ranking the voices of different customer groups, the steering committee identified the kinds of basic skills training and learning support which could offer greater assistance to the students when seeking employment (Grimes et al., 1994). At El Camino College, QFD was used to match the needs of three customer groups: (1) students, (2) faculty and staff, and, (3) community and business leaders, and leaders from feeder schools and institutions, to the college functions to identify which processes and systems should be first improved (Schauerman et al., 1994a, 1994b). Likewise, Hillmer et al. (1995) reported an application of QFD to improve an MBA programme in which the requirements of various groups of customers of the programme were sought and to formulate how to improve the delivery.

11.2.3 Quality planning

There are some studies which reported the use of QFD in the quality planning process for education. The QFD application in these studies was to ensure that the quality elements had been fully explored and would be designed into the programmes and services. At Athabasca University, Murgatroyd (1993) used a preliminary study with the students of a 400-level course in organizational change to illustrate how the HOQ could be used to identify the components that could create successful learning experiences for students, which are critical for the instructional
design of distance education. At the Technology and Vocational Education of Aeronautical Department in Taiwan, QFD was employed to identify the key school characteristics from the airline companies’ requirements with aircraft maintenance technicians, which were going to be used for planning the future training curriculum and teaching plans (Cheng et al., 2005). At Southeast Missouri State University, Downing and Downing (2004) employed a HOQ to derive the instructional and technological requirements from the needs of the students with online learning for the design of a web-based course. Furthermore, Alptekin and Isiklar (2005) used QFD to understand customer needs and use them to explore the key product technical requirements for improving various e-MBA programmes in Turkey. Besides programmes, QFD was also employed in planning how to improve various educational services. For example, in association with process mapping, QFD was used by the Glasgow Community Education Service to identify the critical elements of the service package so as to determine the respective levels of customer satisfaction (Herbert & Conroy, 1997; Curry & Herbert, 1998). A six-stage QFD approach was developed for improving the provision of technical library and information services (Chin et al., 2001), and a HOQ was constructed for improving the services offered by the research centre of the College of Business Administration of Tennessee Technological University (Natarajan et al., 1999).

Recently, the applications of QFD in education have been extended to assist management in planning long-term improvement projects. At Tamagawa University, QFD was employed in deploying the societal demands, the competencies required for being a functional member of the society, to plan the future curriculum for teaching its students (Obara, 2006). In the study of evaluating the potential of the self-financed technical institutions to implement TQM Thakkar et al. (2006)
developed a HOQ to understand the students’ requirements and suggested that the institutions might use the four-phased QFD process to explore further improvement opportunities. Furthermore, Hattingh (2004) used QFD to identify and quantify the user requirements for tertiary engineering education in South Africa.

11.2.4 Selecting best alternatives

Some cases were reported on using QFD to select the best from a given set of alternatives. At the course level, the parts deployment chart of QFD was commonly used to choose the most appropriate teaching methods and learning aids that would facilitate the process of knowledge transfer. At the Schools of Business and Engineering of University College of Falun Borlange, QFD matrices were used to identify the effective means for assisting the students in relating their learning to actual industrial practices (Nilsson et al., 1995). To identify appropriate pedagogical methods, Lam and Zhao (1998) conducted a study at the Department of Applied Statistics and Operational Research of the City University of Hong Kong on using QFD to identify appropriate teaching techniques for achieving the educational objectives of two undergraduate programmes. At the programme level, QFD was employed to select the courses and content areas that best support the programme goals and desired outcomes. For example, in the case of restructuring an engineering management master degree programme of Old Dominion University, Kauffmann et al. (2002) developed a decision model to quantify curricular decisions. In the model, QFD was used to select courses and topics that had the highest impact on the programme goals.
11.2.5 Developing products and services

QFD was also found to be utilized to improve the existing and to develop new products and services for education. For the former, Eringa and Boer (1998) reported the case of the Christelijke Hogeschool Noord-Nederland, a small professional university in the Netherlands, on integrating QFD and service blueprinting for restructuring the learning process and learning supports to facilitate student learning. Ogot and Okudan (2007) applied a QFD-based methodology to redesign an engineering course for increasing student satisfaction with their educational experience. For the latter, QFD was applied by Large Midwestern High School to design a guidance programme for improving the communication with students and parents (Stamm, 1992). It was also applied by Meat and Livestock Australia to develop education packages on beef cattle nutrition and grazing land management for producers (Blakeley et al., 2000), and, to develop training materials for the continuing education of nurses (Shaffer & Pfieffer, 1995).

12. Applications for Curriculum Planning

Literature shows that QFD has often been used in curriculum planning. However, the majority of the applications were for curriculum evaluation rather than curriculum development. In the evaluative applications, QFD was seen as an inspection tool which was used to check whether the existing curriculum met the educational or training goals or matched with certain professional standards or requirements. For example, the Rose-Hulman Institute of Technology used the steps of QFD to develop an educational assessment plan for evaluating the components of its engineering education to determine whether they were effective...
enough for achieving the desired graduate qualities (Brackin, 2002). At the Department of Vision Sciences of Aston University, a “QFD Systems Flow Model” was constructed for assessing the course provision, delivery and resources for the undergraduate programme of optometry to assess whether they were relevant to and sufficient for students to obtain the accredited qualification (Clayton, 1993, 1995). A similar type of application was recorded at RainStar University. QFD was used to ensure the curriculum of the acupuncture and oriental medicine master-degree programme had provided sufficient learning experience to students for mastering the professional competencies, which were proposed by the accrediting body and the expert panel (Bier & Cornesky, 2001). At Central Connecticut State University, QFD was utilized to assess the learning activities of the manufacturing engineering technology programme for their contribution towards fulfillment of the expected learning outcomes (Prusak, 2007). Richter and Lyman (1994) used QFD to understand the relationships between jobs, skills and courses so as to establish a curriculum that could support the objectives and at the same time meet the management needs. The team members first identified the significance of a skill to each of the jobs and then evaluated to what extent the available courses covered that skill. With this process, the company could maintain a manageable training activity by purging obsolete or ineffective courses and modifying other courses to improve their effectiveness. At the University of Glamorgan, QFD was used as a tool for monitoring the quality of a mechanical engineering course. Student feedback was put into the HOQ in order to assess whether the taught subjects had effectively achieved the course objectives (Smith et al., 1993; Higgins et al., 1994). Lastly, Suliman (2006) presented a methodology for curriculum development and review. QFD was first used as a tool for determining and assessing the relationships between industry requirements, curriculum areas of study and specialization, contents and
teaching methods. The curriculum review process then employed these relationships to adjust the relative importance of the attributes of the curriculum components by inserting or deleting them.

Although Brackin and Rogers (1999) claimed that “QFD parallels to the requirements for developing an educational assessment program”, the primary purpose of QFD is for quality assurance. Only when QFD is used for product and service development can its powerful function of quality deployment be fully performed. Curriculum and course evaluation is the basis of controlling the quality of education. However, in today’s rapidly changing environment, the development of timely curricula and courses is essential for supporting the manpower development of the industries and human resources development of the society. The two-way matrix is useful for checking whether the product and service attributes can meet the customer needs, but the powerfulness of QFD lies in its ability to create the product and service attributes for meeting the ever-changing customer needs. Hence, research into the feasibility of applying QFD to curriculum and course development is of paramount importance to the implementation of TQM for education.
Chapter 3
Model Building
1. Scope

Curriculum has its root in the Latin word “currere”, meaning “to run” or “to run the course”. However, concepts of curricula have changed over the years. Besides the fact that increasingly more study topics are expected to be covered, the areas of emphasis have also been shifting in response to social expectations and economic demands. To define the scope for the model, the difference between curriculum development and instructional design is briefly reviewed and then a definition follows of the nature of curricula to be produced, that is, the output of the model.

1.1 Differentiating Curriculum from Instruction

The concept of a curriculum is increasingly broad, partly because it has to address the growing complexity of education. For example, the definition offered by Oliver consists of four elements, and that of Tanner and Tanner covers a number of schooling issues:

“The educational program consists of four basic elements: (1) the program of studies, (2) the program of experiences, (3) the program of services, and (4) the hidden curriculum.”

Oliver (1977, p. 8)
“... the planned and guided learning experiences and intended learning outcomes, formulated through the systematic reconstruction of knowledge and experience, under the auspices of the school, for the learner’s continuous and willful growth in personal-social competence”

(Tanner & Tanner, 1975, pp. 48-49)

However, at a fundamental level, there are two main issues of relevance to a curriculum which concern educators the most: (1) what constitutes the essential knowledge, and, (2) how to teach the knowledge or how to ensure that the knowledge is learnt.

The issue of what constitutes essential knowledge involves both the learning content and the learning experience. For the former, it is the knowledge of a discipline, the syllabus. The curriculum is thought of as a course of study or plan of what is to be taught in an educational institution. An example of referring curriculum as a learning content is the suggestion which Phenix offered to schools:

“The curriculum should consist entirely of knowledge which comes from the disciplines, for the reason that the disciplines reveal knowledge in its teachable forms. ... Education should be conceived as a guided recapitulation of the processes of inquiry which gave rise to the fruitful bodies of organized knowledge comprising the established disciplines.”

(Phenix, 1962, p. 64)

For the latter, it is the knowledge the learner learnt from experiencing the learning process. As Saylor et al. (1981, p. 8) proposed, the curriculum is a plan for
providing sets of learning opportunities for persons to be educated. They added that the provision of sets of learning opportunities can constitute a learning environment where learners can grasp a range of meanings. The following are two examples of referring curriculum as a learning experience for the students:

“The school curriculum is held to be composed of all of the experiences children have under the guidance of teachers.”

(Caswell & Campbell, 1935, p. 69)

“A sequence of potential experiences is set up in the school for the purpose of disciplining children and youth in group ways of thinking and acting. This set of experiences is referred to as the curriculum.”

Smith et al. (1957, p. 3)

The issue on how to teach the knowledge or how to get the knowledge to be learnt is about the intended learning outcomes and the process for achieving the intended learning outcomes. The former focuses on the ends of learning and the latter to the means of learning. In order to avoid any possible confusion which may arise, it is common to classify the ends as curriculum and the means as instruction. As Popham and Baker (1970, p. 48) stated, curriculum is “all the planned learning outcomes for which the school is responsible”. Beauchamp (1972) asserted that what ought to be taught in schools is the primary curriculum question and responses to this primary curriculum question would define the subject matter of a school. He further clarified that how the subject matter of a school ought to be taught is a question for the domain of instruction, not curriculum. Macdonald (1965) concluded that curriculum and instruction are at two different levels. He argued
that the instructional system is the teaching-learning system which usually confined
to a classroom with a teacher, a group of students, materials, social norms, etc.
However, the curriculum system is one level higher since plans for action are being
made. Johnson (1967) agreed with Macdonald that curriculum precedes instruction.
He viewed curriculum as the output of a “curriculum-development system” and as an
input into an “instructional system”. He added that curriculum is concerned with
ends and it does not prescribe the means, that is, the activities, materials, or even the
instructional content, to be used in achieving the ends. Oliva (2005, p. 7) believed
that curricula could be thought of as a programme, a plan, content, and learning
experiences, whereas instruction is characterized as methods, the teaching act,
implementation, and presentation. Although curriculum and instruction are of two
different levels and the former precedes the latter, both are subsystems of a larger
system called education. They are two interdependent entities, and one may not
function without the other.

1.2 Nature of the Curriculum Produced

The purpose of the model was to identify the kinds of industry-specific knowledge
which are important to the job incumbents of the service-oriented manufacturing
industries for curriculum development. On the one hand, it aimed to produce
course outlines which could be used for subsequent instructional design. On the
other hand, the model aimed to address the subject matter aspect rather than the
learning experience aspect of curriculum, in regard to the vocational nature of
industrial training. Conclusively, the curricula which would be produced by the
model would be subject-centred in nature, suggesting that the training contents and
corresponding training hours would be the main issues.
2. **Job of Curriculum Development**

Irrespective of whether a curriculum refers simply to the subjects on the timetable or the whole range of educational studies, the importance of planning is highly emphasized for curriculum development. Inlow (1973, p. 40) contended that school curricula should evolve not whimsically but purposefully, not aimlessly but according to a carefully designed plan. Wiles and Bondi (2002, p. 50) also viewed the curriculum as a plan for learning. They stated that all such plans contain a vision of what should be, as well as a structure that translates those visions into experiences for learning. The seminal work of Ralph Tyler, the “Tyler’s Four Questions”, which has come to be called the “Tyler Rationale”, clearly depicted the planning cycle for curriculum development and instructional design:

1. What educational purposes should the school seek to attain?
2. What educational experiences can be provided that are likely to attain these purposes?
3. How can these educational experiences be effectively organized?
4. How can we determine whether these purposes are being attained?

(Tyler, 1949, pp. 1-2)

Taba elaborated the “Tyler’s Rationale” and outlined the operational procedures for curriculum development:
Taba’s operational procedures revealed four major bases of curriculum development: (1) analysis, (2) design, (3) implementation, and (4) evaluation. Whilst the work of the latter two would be shared with instruction designers, the work of the former two, that is, comprehensive, in-depth, systematic analysis and professional design, is the responsibility of curriculum developers.

3. Conceptualization

It has been the tradition to use the employer-centred and teaching-oriented approach to develop industrial training curricula. This approach was useful to develop skill-based programmes for training production workers. However, these methods may not be effective enough for the development of industrial training programmes which best match the increasingly complex job duties, more educated job incumbents and fast changing job environment of today’s service-oriented manufacturing industries. Rather, the learning-oriented and job-incumbent-centred approach would be more appropriate and effective for developing knowledge-based
industrial training programmes to cope with the new industrial needs. In the following, the reasons why the latter approach was adopted for the curriculum development model are explained. In addition, the parties who take part in the process as well as their respective roles and responsibilities within the given QFD settings are addressed.

3.1 Customers of Industrial Training

The vocational nature of industrial training indicates that companies and individuals of the industry are its two major customers. However, the central question is “Who are the primary customers?” The answer to this question predominantly determines the strategic planning of the industrial training institutions (Conway et al., 1994). On the surface, it would seem that those whom the institutions primarily serve supply the major source of finance. In the case of subsidization, the primary customers are the companies but when the institutions rely on tuition fees for their income, then individual students are of greater account. Nevertheless, it is not simply a financial matter. Rather, it is a matter of quality, which concerns about the ways for meeting the needs of the changed primary customers. The real change is so profound that it requires the industrial training institutions to respond in a totally customer-oriented manner.

3.1.1 Problems with student consumerism

The shift of the major income source from training levy to tuition fees can easily drive the industrial training institutions to only focus on solving their financial problems instead of understanding the real change in the environment. On the one
hand, the institutions may misunderstand that the change is merely a matter of a different source of income if they still consider themselves as operational units. From a financial point of view, their training income could be received from industrial subsidies or the tuition fees paid by students. Therefore, it is financially sensible that the reduction in subsidies could be compensated by a rise in tuition fees. However, this is a temporary but not an adequate solution. The problem could not be solved in a purely financial way. On the other hand, the institutions may misinterpret the change of the primary customers as a change of order source if they still use production capacity to operate their business. It is again financially sensible that the enrollments could be increased by switching to entertain students’ non-vocational needs. The point is the consequences of such myopic act would be unfavourable to all parties involved.

For higher education in western countries, the switch of tuition fees from being subsidized by government to being paid by individuals has given rise to the problem of student consumerism. As their share of the tuition fees rises, so the tendency among students to refer to themselves as customers grows. A study conducted with sociology undergraduates showed that the idea that “we’re the customers – we pay the tuition” prevailed in the campus (Delucchi & Korgen, 2002). Many students believe that they have consumer rights exactly equivalent to those they experience in the marketplace, so they also assume they should be cheerfully served by the institutions because they are paying the bills. As a result, they increasingly expect to be amused (Edmundson, 1997), and, some even act like disgruntled consumers regarding their grades (Wiesenfeld, 1996).
Many educators have observed that adopting the student-as-customer notion from the commercial settings for the sake of implementing TQM is a major cause of student consumerism. Baldwin (1994) stated that a direct import of commercial practices and TQM language to education would jeopardize many educational purposes and values. Furedi (2003) supported Baldwin’s criticism and stated that the ethos that shapes the transmission of academic pedagogy is inconsistent with the values and practices of commerce. Schwartzman (1995) claimed that the student-customer metaphor would compromise the goals of education. The result of a study conducted in six universities showed that there was very limited support to the student-as-customer notion among academic staff (Lomas, 2007). Scott (1999) explained that the bottom line for academics regarding students as customers is the impression that from a marketing view of “the customer is always right”. Many educators found that consumer sovereignty not only conflicts with the goals of effective pedagogy but the undue emphasis on customer services also inverts the teacher-student relationship by vesting authority in students as customers. Smith (2000) argued that the rise of student consumerism would erode the intellectual authority of classroom instructors. Long and Lake (1996) emphasized that casting students as customers may give rise to inappropriate intimacies, undermine professional authority, encourage students’ passivity, and foster a misconception of degrees as products to be purchased. Kohn (1993) warned that intellectual development would be put at risk if this led to turning the classroom into a workplace. Jones (1997) indicated that if efforts to please students and their parents went too far this would undercut standards. Likewise, Trout (2000) warned that undergraduate education will be downgraded if universities relied on students’ evaluation to assess faculty members. Driscoll and Wicks (1999) claimed that regarding students as customers would subordinate the values and objectives of
academics and other stakeholders to the perceived needs and wants of students.

3.1.2 Learners as primary customers

Institutions are advised not to view students as their only customers as there are many education stakeholders that they need to serve. By taking a holistic view of the education process, Reaville (1997) identified eleven stakeholders of universities whilst Brennan and Bennington (1999) summarized that universities have six different markets of potential customers. Hewitt and Clayton (1999) pointed out that educational institutions have to recognize the divergent opinions of the stakeholders and they have to find ways to reconcile them for improving the quality of higher education. Ho and Wearn (1996) emphasized that higher educational institutions have to acknowledge the diversity of customers before they can successfully implement TQM. Eagle and Brennan (2007) contended that as students are neither the sole consumers nor the sole customers in the higher education system, institutions must not seek to serve only the interests of students to the exclusion of other stakeholder groups. Nonetheless, Winn and Green (1998) argued that although institutions have different customers in different situations, students are always amongst them.

For the implementation of TQM, educational institutions were advised not to directly equate students with customers because students play multiple roles in the educational process. Sirvanci (1996, 2004) proposed four different roles that students play within educational institutions, namely, product-in-process, internal customers for facilities, labourers in the learning process, and, internal customers for the delivery of course materials. From another point of view, Ewell (1993) claimed
that students are “raw materials” in most instructional settings, but they are also a part of the “workforce” in the cooperative learning settings, “constructors” of their own knowledge and “managers” of their own learning.

Wallace (1999) stressed that students have to be aware of their responsibilities before they can be considered as customers in the classroom. As education is not a commodity, it is not simply a give-and-take kind of transaction. Quality outcomes in the classroom do not depend solely on what instructors do, and student contributions are equally important (Beaver, 1994). Sharrock (2000) contended that students should not passively consume their education but actively “co-produce” it. Co-production is a concept that is based on the notion that the person providing the service and the next-in-line customer receiving the service share the responsibility for the quality and outcome of that service (Chappell, 1994). Supporting the co-production concept, Halbesleben et al. (2003) viewed students as labour contributors because this metaphor suggests that the accountability for student education does not solely lie with the service providers. Albanese (1999) and George (2007) used the term “learning worker” to describe the students’ role in education as they asserted that students should actively participate in their learning. Hoffman and Kretovics (2004) described students as “partial employees” because students have to perform employee-like tasks to facilitate the co-production of the educational process.

To encourage students to actively participate in their learning, the roles of educators have gradually shifted from concentrating on teaching to facilitation of learning. In making recommendations to universities on how to reduce student costs and enhance student learning, Guskin (1994a, 1994b) emphasized that the faculty needs to
restructure its role to maximize essential faculty-student interaction, integrate new technologies into the student learning process and enhance student learning through peer interaction. Others have indicated that administrators need to restructure the system, and that the teaching practitioners also have to manage students’ learning and improve the learning environment (Tribus, 1993; Parsell, 2000). In the traditional teaching mode, teaching practitioners primarily performed the roles of knowledge provider and activity organizer. However, in the new learning mode, teaching practitioners have to assume some further roles of assisting student’s learning, such as facilitator, mentor, classroom manager and counsellor (Tudor, 1993; Null, 1996). To perform the new roles, teaching practitioners need to find more ways to motivate students to learn (Helms & Key, 1994). They need to adopt new approaches, such as coaching, to increase students’ self-awareness and capacity for self-discovery and to motivate them to begin a process of continuous learning and development (O’Neil & Hopkins, 2002). They also need to implement measures, such as reduction of uncertainty in students’ grades and provision of a reasonable amount of feedback, to strengthen the knowledge-seeking motivation of students (Meirovich & Romar, 2006). Furthermore, teaching practitioners need to render various kinds of assistance to facilitate students to learn. Shelley (2005) claimed that professors need to take up additional responsibilities for supporting students to learn, such as discussing academic progress with students, sharing their assessments of student performance with colleagues, and, if necessary, referring students to support services – similar to the ways in which doctors take care of their patients. In the new learning era, educators have to relearn the learning process and change their approach in order to provide quality education (Cleary, 1996).
The above could lead us to the conclusion that the central process of education is learning and the primary customers of education are learners. This is equally true for industrial training. The primary purpose of the institutions is to provide the important kinds of industry-specific knowledge to the job incumbents whilst that of the training practitioners is to teach and to facilitate the job incumbents to learn the knowledge. To genuinely improve quality, it is necessary to adopt both a learning-oriented and job-incumbent-centred approach for planning and delivering industrial training. Similar to the case of education, it is only the position of learners as primary customers which could give industrial training its unique character (Muller & Funnell, 1991, 1992); and, it is the way to serve the long-term interests of the students and the institutions (Bailey & Dangerfield, 2000).

3.2 Job-incumbent-centred Approach

Many higher education curricula were developed with the aim of meeting the employers’ needs as this could bring positive benefits to both the economy and the society as a whole. On the one hand, the supply of appropriate manpower would support industrial growth and development. Brewer et al. (2002) highlighted the importance of bridging the industry-education gap in order to support the commercial organizations in their endeavours to combat market competitors. Emery et al. (2001) suggested business schools shift their focus to enhance student capabilities and hold their programmes responsible for producing knowledgeable, effective students who possess skills and talents valued by corporations. On the other hand, students’ employability would be improved if they could be prepared for employers’ workforce requirements. Bailey and Bennett (1996) said, “If a student is attending college primarily to obtain a good job, then it is clear that businesses and
other employers of students are the university’s customers.”

Literature shows that a number of higher educational institutions have used meeting the employers’ needs as the primary objective of curriculum development. At the University of Cincinnati, Krishnan and Houshmand (1993) used improving the quality of products (students) as the means for satisfying the needs of the customers (employers) as the basis for designing engineering curricula. In the design of a management information systems course, Denton et al. (2005) stated that employers are considered to be the customers in the course design because they are the downstream consumers of the graduates. Similarly, the design of an integrated manufacturing curriculum for industrial engineering students of a higher technical school also used meeting the employers’ needs as the goal. Balderrama Duran et al. (2007) explained that it was because the industry would be more interested in employing the school’s graduates if they were better prepared.

The employer-centred approach is suitable for developing pre-vocational curricula since the students generally do not have any knowledge of the industry. However, it might not be appropriate for developing in-service vocational curricula as the students, to a certain degree, know their knowledge needs for meeting the performance requirements. The growing importance of learning and the changed nature of the manufacturing industries indicate that the job-incumbent-centred approach would be more appropriate than the employer-centred approach for the development of industrial training curricula. The job-incumbent-centred approach does not mean the job incumbents are allowed to freely determine the knowledge areas or study subjects for the course. With this approach, employers are still responsible for informing what kind of performance is required whilst the teaching
practitioners are still responsible for advising the students what should be learnt. It is only to place the focus on the kinds of knowledge and skills which the job incumbents found to be important. Rather than the employers or the teaching practitioners, it is the incumbents who determine what to be included into the course contents from a given set of knowledge areas or study subjects, according to the importance found for meeting their job performance requirements.

3.3 Collaboration with Job Incumbents

It is unarguable that the student-as-customer analogy has caused many problems. However, the institutions would easily become bureaucratic ivory towers and unresponsive to the real needs of students if they totally rejected it (Laskey, 1998). Furthermore, it would be dangerous if students were identified as products because this would make them vulnerable to objectification and manipulation (Zollers & Fort, 1996). In recognizing these drawbacks, more and more educators have advocated considering students as collaborative partners for improving educational quality (Brower, 1994; Playle, 1996; Delucchi & Smith, 1997; Franz, 1998; Clayson & Haley, 2005). The advantage of establishing partnership between teaching and learning is two-fold. Not only can the educational goals be achieved, but also both the teaching and the learning parties will benefit from the partnership (Bay & Daniel, 2001).

Some educators have suggested that although students and teaching practitioners are partners, they are not of equal position in the partnership. Svensson and Wood (2007) described the university-student relationship as that of the community and citizens whilst Bailey (2000) used professionals and clients to describe the
teacher-student relationship. The former revealed the institutional authority and the latter stressed the teaching practitioners’ professionalism. Ferris (2002) referred to students as “junior partners” and professors as “senior partners”. This analogy indicates the need for collaboration between the two parties but, at the same time, it displays the order of power within the collaboration. However, the focus should be placed on the respective roles and responsibilities of the two parties rather than the uneven distribution of power between the two parties before a successful partnership for improving educational quality can be built.

The growing importance of learning as well as the advocacy of a teaching-learning partnership has led to an increase in student participation in various educational planning activities. In the classroom, a number of universities reported their cases of involving students in instructional design. At the University Teknologi Malaysia, students were invited to express their concerns in evaluating the effectiveness of the problem-based learning system (Rohani et al., 2005). At West Virginia University, students’ opinions were used as the basis for improving the advising and teaching of engineering (Jaraiedi & Ritz, 1994). Franceschini and Terzago (1998) conducted research in which the participants in a SPC training course were asked to indicate what they needed from the course so that this information could be used to improve the instructional quality. Another study, used to evaluate the instructional design of a two-semester graduate course in quality technology, involved student opinion in the identification of the key instructional attributes for the course (Wiklund & Wiklund, 1998, 1999). The literature also provides a case in which students were empowered to determine assignment areas, evaluation criteria and were given options for the selection of delivery methods (Durlabhji & Fusilier, 1999). Besides instructional design, involving students in curriculum evaluation is growing popular.
In a curriculum development project in Australia, over 800 students of Years 11 and 12 were invited to evaluate the syllabus of a physical education subject for senior secondary schools (Brooker & Macdonald, 1999). At the institution level, students of Sam Houston State University were requested to evaluate theoretical course weights with respect to course grades and career needs (Leavell, 2006), and, students of business education in Romania were invited to assess the importance level of various business competencies and their perceived level of preparedness in meeting the competencies (Glaser-Segura et al., 2007).

In addition to curriculum evaluation, those responsible for industrial training might usefully collaborate with the potential students in curriculum development. The knowledge and experience of the job incumbents of the service-oriented manufacturing industries make them ideal partners in the co-development of industrial training curricula.

3.4 Role Appropriation

Although multiple parties were commonly involved in using QFD to operate the curriculum development process, the purposes of involving multiple parties varied. In some cases, the purpose was to collect more ideas on the requisite qualities. For example, in the framework proposed for engineering curriculum design, employers and alumni were surveyed to obtain their ideas on the programme objectives and outcomes (Duffuaa & Al-Turki, 2003). In other cases, the purpose was to cater for a wide spectrum of interests of the stakeholders. Customers were asked about their expectations of the graduates, and they also took part in determining the curriculum features. In improving the educational quality of industrial engineering at the
Middle East Technical University, students, employers and faculty members were invited to prioritize the competencies required of the graduates (Köksal & Eğitman, 1998). Likewise, the three stakeholder groups, these being students, faculty members and employers, were asked to prioritize seven given educational processes to identify the areas of improvement for an engineering department. Unlike the case of the Middle East Technical University, the ratings given by the three stakeholder groups were allocated with different weights so as to reconcile their respective degrees of importance in the final decision (Owlia & Aspinwall, 1998).

In the design of an industrial engineering curriculum at Prince of Songkla University, besides employers, faculty and students, students’ parents were also invited to express their expectations and identify the important qualities which the graduates were expected to possess (Boonyanuwat et al., 2008). A weighing method was once again used to reconcile the importance ratings of the stakeholder groups. Instead of balancing the stakeholders’ needs by weights, the design of an introductory course in Engineering Graphics at Georgia Southern University used obtaining consensus as the method for resolving the difference in opinions between the employers, professional societies and accreditation boards on the quality requirements of the graduates (Desai & Thomassian, 2008). The problem with these cases was the needs of the involved parties were assumed to be of the same level and similar in nature. The only area of difference between the stakeholders was the magnitude of the importance of the needs. However, as the study conducted by Sahney et al. (2003, 2004a, 2004b) found, the needs and views of various stakeholder groups may not always coincide, especially those of employers and students. Educators have to look for the issues which unite them to resolve their different interests and needs.
To improve higher educational quality, the importance of meeting the needs of the employers and students was highly emphasized (Bemowski, 1991; Foggins, 1992). In order to properly address the needs of employers and students, we have to realize that these two parties have different needs and their needs are of two different levels. The concept of internal-external customers displays the difference between the needs of employers and students (Siegel & Byrne, 1994, pp. 19-23). In this concept, employers were referred to as the external customers whilst students were considered to be the internal customers of educational quality. The former are the customers of educational institutions and the latter are the customers of the educational services provided by the institutions. When this concept is applied to industrial training curriculum development, employers are the customers of the job incumbents and students are the customers of the training contents. As employers and students are customers of two different levels, besides their needs, their roles and the activities in which they participate are also different. As contended by Akao et al. (1996), educational quality could only be properly designed when the evaluations done by students (internal evaluators) are based on the premise of satisfying the demands of companies (external evaluators). Following this logic, employers are responsible for defining the demanded qualities of the curriculum, for example, the graduates’ competency; and, students are responsible for identifying the alternatives, such as the knowledge areas or study subjects, so that the developed curriculum can supply the qualities which the employers require.

The central purpose of involving multiple parties in QFD is to implement partnership in product and service development. Through partnership, the product or service which is developed can meet the respective needs of the parties. Quality curricula can hardly be the result if the purpose of involving multiple parties is simply to
collect ideas or to cater for the needs of different parties. Rather, it should be the collaborative arrangement which could effectively facilitate the involved parties to contribute their expertise to building the curriculum. In view of this importance, the rationale of the model was to design a QFD process in which the members of the industrial training supply chain take up different but complimentary roles and responsibilities so that they could make use of their respective best knowledge to develop the curriculum collectively. In the following, the respective roles and responsibilities of the involved parties in the development of learning-oriented industrial training curricula and the activities of each party participating in the process are discussed.

3.4.1 Employers

Employers are the external customers as they are the users of the job incumbents’ competency. They have been playing an informative role in curriculum development. In the design of an engineering curriculum of Greenfield, a funded education coalition, industrial partners were invited to describe their expectations of graduates’ competencies (Hillman & Plonka, 1995). Similarly, in the development of a supply chain management curriculum, employers were asked about their expectations of the degree of knowledge and experience of the future professional practitioners in this field (Gonzalez et al., 2008). In former times, employers found it relatively easy to cite the kinds of skills required of workers on the shop floors. However, changes in job nature have meant that industry-specific knowledge is no longer the core knowledge required by the incumbents. Employers are finding it increasingly difficult to define industry-specific knowledge precisely and comprehensively for the job incumbents of the service-oriented manufacturing
industries. Instead of directly asking the employers what should be taught, or, to prioritize the course topics, as in the case of designing a basic statistics course at the Department of Systems Engineering of the King Fahd University of Petroleum and Minerals (Duffuaa et al., 2003), it would be more appropriate to invite them to define the performance requirements or to explore the technical capabilities which they expect the incumbents to perform for a particular job or task.

Within the QFD context, the parties who took part in prioritizing the customer requirements varied. In the development of a computer numerical control course, employer and graduate representatives were invited to attend a meeting to first suggest the objectives and then prioritize the suggested objectives for the course (Chao, 1997). At the Kocaeli University Köseköy Vocational School of Higher Education, besides the managers of the tyre companies, the faculty members were also invited to suggest and prioritize the skills and qualifications to be acquired by the graduates in the case of revising the curriculum of the Tyre Technology Department (Aytaç & Deniz, 2005). Although faculty members and alumni undoubtedly understand the requisite qualities of graduates, it may be more appropriate for the employers themselves to do the prioritization, simply because they are the customers of the graduates.

3.4.2 Training practitioners

Training practitioners will still play an advisory role in learning-oriented curriculum development. Instead of using their subject knowledge and field experience to determine what is be taught to the students, as in the case of the teaching-oriented curriculum development, the training practitioners apply their expertise to suggest
what could be useful for the incumbents to enhance their competency or improve their job performance. It would then be up to the job incumbents to make the final decision on what would be included in the course contents. For example, as cited in the literature, in the design of an information technology programme a faculty member used his experience to supply a list of service requirements. The various degrees of importance of the listed service requirements were then prioritized by the students (Debnath et al., 2008). There are two major reasons for the change of the responsibility of the training practitioners in the curriculum development process. First, the incumbents know what they have to learn in order to match the job performance requirements. Second, the fast changing industrial environment makes it increasingly difficult for the training practitioners to identify the effective kinds of knowledge required for performing the job.

3.4.3 Job incumbents

Job incumbents are the internal customers as they are the customers of the knowledge of the course. They also play an informative role in the curriculum development process. As previously discussed, the course contents are not freely determined by the job incumbents. However, the job incumbents will be the ones who prioritize the importance of the knowledge areas or study subjects which are suggested by the teaching practitioners in order to meet the performance requirements specified by the employers. An example of such an arrangement was the design of the freshman-year experience at the University of Cincinnati. Students were asked to prioritize a given list of crucial skills and the important ones which were identified were used to plan the programme (Houshmand & Lall, 1999).
3.4.4 Curriculum developers

Curriculum developers play the role of facilitator in the curriculum development process. They not only listen to the employers’ views about the requirements for a given job but also work with the training practitioners on deriving the useful knowledge and innovating new subjects so as to assist the job incumbents in enhancing their competency for meeting the specified job performance. Their task is to design the course contents and arrange them in a logical and coherent manner. The contribution of the curriculum developers is to use their expertise in curriculum development and course design to match the expectations of the two major customers of industrial training, employers and job incumbents, and satisfy the needs of both of them.

4. The Model

Figure 3-1 shows the QFD-based curriculum development model for industrial training. It was made up of two portions. The upper portion was the process of needs analysis whilst the lower portion was the process of content design. QFD played the role of providing the mechanism for integrating the two processes so as to prescribe a specification with which courses to be derived could achieve customer satisfaction.
Figure 3-1: QFD-based industrial training curriculum development model
4.1 Two Core Processes

The model drew upon two core processes of curriculum development. One of the two core processes that the model addressed was needs analysis, which is the starting as well as the key planning effort of almost every curriculum development project. To determine training implications, the technique of hierarchical task analysis (HTA), proposed by Annett et al. (1971), was used as a general approach for conducting the needs analysis. There are two basic principles of HTA. First, a job should be decomposed into a set of tasks for analysis. Second, further breakdown has to be performed until the information needed for the training purpose is obtained (Shepherd, 1985, 2000; Stammers, 1996). Another core process of curriculum development that the model addressed was content design. Upon understanding the kinds of knowledge required for meeting the specified job requirements, the development team members use their expertise to compile and organize them into a coherent form so as to facilitate the students to learn the knowledge.

4.2 Three Main Tasks

The model was developed to execute three basic tasks of QFD. The first task was to define the demanded qualities. This task requires the development team to collect and to analyze the VOC, extract the embedded meanings from the voices and put them into an organized structure that represents the customers’ needs. Prioritizing the importance of the customer needs or identifying the important customers’ needs is also required. The second task is to derive quality elements for meeting the demanded qualities. Team efforts, professional contributions and innovation are highly emphasized for executing this task. The third task is to
review the degree of correlation between the demanded qualities and the quality elements so as to identify the few essential quality elements for further action or investigation. As Zultner (2005) explained, a small number of items have a very significant effect on the value which customers perceive. These few items, if done well, can deliver sufficient value to assure satisfaction on the part of the customers.

4.3 Operational Steps

From the QFD point of view, VOC is the basis for partnership, both within the supplier as well as between the supplier and its customers (Akao, 1995). To be a responsible and professional supplier, it is necessary to capture, rank and deploy the VOC and translate that voice into staff actions (Mazur, 2003). The operation of the model is a procedure for the industrial training institutions to manipulate the VOC, with appropriate involvements of customers at different stages to develop industrial training curricula. Upon integrating the two core processes of curriculum development and the three basic procedures of QFD, the model was operated by seven steps (Figure 3-2).

Table 3-1 shows the details of how to put the seven operational steps into action. Each step was broken down into two to three activities for execution. To achieve an efficient and effective operation, various data collection methods such as interview, questionnaire and *gemba* are used to capture the required qualitative and quantitative data. Different data processing and analyzing tools including affinity diagramming, conversion table and AHP are employed wherever appropriate.
At Job Level: Step 1
Decompose the job into its corresponding tasks

At Task Level: Step 2
Understand the technical performance requirements

At Task Level: Step 3
Prioritize the technical performance requirements

At Task Level: Step 4
Translate the technical performance requirements into subject alternatives

At Task Level: Step 5
Identify the important subjects for meeting the technical performance requirements

At Task Level: Step 6
Design the training content according to the important subjects identified

At Job Level: Step 7
Organize the designed training contents into a coherent curriculum

Figure 3-2: Steps for operating the QFD-based industrial training curriculum development model
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<tr>
<td>Industrial Training Curriculum Development</td>
<td>Needs Analysis</td>
<td>Define demanded qualities</td>
<td>Needs Analysis</td>
<td>Decompose the job into its corresponding tasks</td>
<td>Conduct a structural analysis of the job</td>
<td>Tasks performed by the job incumbents to achieve their roles and functions</td>
<td>Qualitative</td>
<td>Field experts and/or job incumbents</td>
<td>Individual, semi-structured interviews</td>
<td>Pre-set interview questions</td>
<td>Affinity diagramming</td>
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Table 3-1: Action plan for operating the QFD-based industrial training curriculum development model
5. **Benefits**

Practically speaking, there were three major benefits provided by the model. First, the function analysis of the model offered a mechanism for appropriately incorporated employers and job incumbents’ voices into the curriculum development process. Second, the team approach of the development process stimulated interaction between members and fosters innovation. Last but not least, the process provided curriculum developers with the opportunity of applying their expertise to develop quality curricula.
Chapter 4
Methodology
1. Multi-method Approach

This study adopted the multi-method approach to demonstrate the applicability of the industrial training curriculum development model which was proposed in the last chapter. The applicability of the model can be represented by the practicability in field settings and the effectiveness of the developed curricula in achieving customer satisfaction. Although laboratory experiments could be used to draw statistical inferences for establishing causality between the application of the model (the independent variable) and the achieved customer satisfaction (the dependent variable), it was neither feasible nor appropriate for this task of applied research. Firstly, an experimental group to which the model was applied and a corresponding control group to which it was not could hardly be arranged for testing. Secondly, practical significance was important for this practice-oriented study. In order to be feasible and appropriate, a combination of quasi-experiment, or natural experiment, and field applications was chosen as the method for demonstrating the applicability of the proposed model. However, the result of the quasi-experiment was not compared with others as it was thought that such comparisons might cause unnecessary conflict with the field practitioners. Rather, it was used to examine the level of customer satisfaction to be attained by the curricula which were developed using the model. To supplement any inadequacies of the quasi-experiment, field applications were also conducted in order to show other intangible benefits which would be obtained from applying the model. In other words, a quasi-experiment and multiple field applications were conducted in this study so as to collect a variety of relevant and convincing forms of evidence to support the applicability of the model.
2.  Conceptual Framework

The unit of analysis of both quasi-experiment and field application was a case. For each case, the model was used to design an industrial training course. Besides evaluating the results against the defined objectives, other information which would contribute to supporting the applicability and effectiveness of the model was also collected. Figure 4-1 exhibits the conceptual framework for the empirical test of the proposed model.

![Conceptual framework for the empirical test of the model](image.png)

Figure 4-1: Conceptual framework for the empirical test of the model

It was predicted that the curricula developed using the model could attain a high degree of customer satisfaction and the courses designed using the model could achieve the purposes of industrial training satisfactorily. According to the logic of replication, if such results were repeatedly obtained from different cases, then the model could be generalized.
3. Quasi-experiment

Quite a number of QFD practitioners conducted experiments in natural settings for testing the effectiveness of their proposed models. For example, Viaene and Januszewska (1999) conducted sensory analyses for testing the HOQ model they proposed for food development. Both consumer and training panels were invited to taste and numerically describe their satisfaction with the chocolate of which the product specification was developed by the model. In the development of web design guidelines, Park and Hoh (2002) used simulation tests to quantify the effects of the design elements identified using QFD on the search performance and subjective sensibility of users. In order to validate the hypothesis of the dual perspective of medical service quality, Akao and Fujimoto (2000) used the differences between the expected quality of patients and those of the medical services provided, which were obtained from the QFD study at Nerima General Hospital, as the evidence. Ziemer et al. (2005) conducted a two-group test, one using and one not using QFD in conducting trade-off analysis, to show QFD was effective in improving communication for web development teams. For the development of virtual items in massive multiplayer online role playing games, Li and Kuo (2007) validated the use of genetic chaotic neural network in their proposed enhanced QFD by evaluating the performance with other methods for identifying customers’ needs. Matook and Indulska (2009) calculated the reference model quality measure of their proposed QFD-based approach for improving the process reference models and compared it to that of the users’ perceptions in order to justify the usefulness of their proposal.
A quasi-experiment was conducted at the industry level to examine the level of customer satisfaction attained by the curriculum which was developed using the model. The details of the experimental design are supplied in the following paragraphs.

3.1 Case Selection

The order follow-up and provision of product development services, two common tasks performed by garment merchandisers in the Hong Kong clothing industry, were selected as the case for experimentation.

3.1.1 Major manpower group of the service-oriented clothing industry

Garment merchandisers were chosen as the study target since they represent the largest manpower group of the clothing industry in Hong Kong. Since the relocation of production in the late 1980s, the manufacturing sector has shrunk dramatically but the trading sector has been steadily growing. The number of persons engaged in clothing manufacturing dropped from 243,540 in 1989 to 18,836 in 2007. With the marked shift from production to services, merchandisers have become the largest manpower group of the current clothing industry in Hong Kong. Since the late 1990s, over half of the persons employed by the import/export firms of wearing apparel have been merchandisers. In 2007, there were 29,491 persons employed as merchandisers, accounting for 66.8% of the total employment of import/export of wearing apparel. Table 4-1 shows the employment of garment merchandisers in the past ten years.
<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Persons Employed as Merchandisers</th>
<th>Total Number of Employed Persons of I/E of Wearing Apparel</th>
<th>Percentage of Merchandiser in Total Employment of I/E of Wearing Apparel</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>21,945</td>
<td>38,952</td>
<td>56.3%</td>
</tr>
<tr>
<td>2001</td>
<td>23,528</td>
<td>40,310</td>
<td>58.4%</td>
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<tr>
<td>2003</td>
<td>23,072</td>
<td>38,056</td>
<td>60.6%</td>
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<tr>
<td>2005</td>
<td>26,786</td>
<td>46,146</td>
<td>58.0%</td>
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<tr>
<td>2007</td>
<td>29,491</td>
<td>44,179</td>
<td>66.8%</td>
</tr>
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Source: Manpower Survey Report: Textile, Clothing, Footwear and Handbag Industries, Textile and Clothing Trading Board, Vocational Training Council

Table 4-1: Employment of garment merchandisers in the clothing industry in Hong Kong: 1999-2007

3.1.2 Major tasks performed by garment merchandisers

According to the job description supplied in the 2007 Manpower Survey Report, the following are three major components of a garment merchandiser’s job:

1) Assist in the negotiation with buyers and preparation of quotations,

2) Handle buyers’ production orders and samples, and,

3) Follow up buyers’ orders including liaising with other departments on the quality requirements of buyers and tracing the progress of production to ensure prompt shipment.

In order to find out the major tasks of the garment merchandiser’s job, an exploratory study was conducted in 2008. During the period 1\textsuperscript{st} to 31\textsuperscript{st} of July, six garment merchandisers, who had 2-5 years’ working experience, were interviewed by phone to ascertain their job duties. Besides the kinds of merchandising services they offered to their customers, they were also asked to describe what they had to do in their daily work. With reference to the job description given by the Manpower Survey Report, the collected information was organized into the activities performed
by the garment merchandisers. Using the technique of affinity diagram and working together with two merchandising managers, the activities were grouped into two tasks: (1) order follow-up, and, (2) provision of product development services. They were categorized according to the general business operation of garment trading firms. The purpose of the first task is to accomplish the received orders whilst that of the second task is to seek new orders. They work in a cycle and are complementary to each other. These two tasks, which are commonly performed by garment merchandisers, were used as the cases for experimentation. An industrial training curriculum was developed for each of them using the curriculum development model.

It is necessary to clarify that six was not the planned number of interviews; rather, it was the number of merchandisers that had been interviewed when the information given started to repeat. Besides, this task categorization process was the first step of the proposed model, which is indicated in Figure 4-2. The resultant affinity diagram representing the garment merchandiser’s job is displayed in Figure 4-3.
Figure 4-2: Applied portion of the model for identifying the major tasks of garment merchandiser's job
Garment Merchandisers’ Job

Order Follow-up
- Follow up approvals
- Confirm order details
- Liaise shipping department for delivery
- Liaise QC department for inspection
- Confirm size specifications
- Prepare contracts
- Solve order problems

Provision of Product Development Services
- Follow up prototypes and other samples
- Source fabrics and accessories
- Liaise with factories for sample making
- Prepare quotations
- Relate technical problems to customers
- Suggest ways to lower costs
- Prevent quality problems

Figure 4-3: Affinity diagram for structuralizing the garment merchandisers’ job
3.2 Arrangements

Interviews and *gemba* were conducted with a group of merchandising managers in order to understand their views on the performance requirements for the tasks of order follow-up and provision of product development services. The collected information, on the one hand, was analyzed into task performance requirements. On the other hand, it was translated into subject alternatives for the training. Upon organization, the interviewed and visited managers were invited to weight the importance of the defined performance requirements for the task whilst their subordinates were invited to weight the importance of the suggested subject alternatives for meeting the defined performance requirements. The important subject alternatives, which were identified from the surveys, were used to develop a curriculum for the training of the two tasks.

A curriculum development team was formed for the study. The jobs of the team included: (1) to analyze the managers’ voices for defining task performance requirements, (2) to translate performance needs into subject alternatives for the training, and, (3) to develop a curriculum for the training of the two tasks based on the survey results.

3.3 Measurements

A survey was conducted with the participating merchandising managers and merchandisers to determine their level of satisfaction with the developed curriculum. The collected opinions were summarized into satisfaction scores to show the level of customer satisfaction which could be attained using the curriculum. The details and
results of the quasi-experiment are supplied in the next chapter.

4. **Field Application**

Many QFD practitioners conducted field applications for their proposed models. On the one hand, they made use of the actual environments to illustrate how to put their proposed models into work. On the other hand, they aimed to reveal the benefits which could be obtained from applying their models. For example, Adiano and Roth (1994) used the application at an IBM assembly plant in Austin to illustrate the potential usage of their proposed dynamic QFD approach for translating customer wants and needs into relevant product and process parameters. Okongwu (2006) used the application at an aerospace company to demonstrate how his proposed model, “SCM Function Deployment”, could enable managers to design supply chain systems more effectively. Clegg and Tan (2007) presented the case of itCMP Limited to show how their proposed framework could be used as part of structured planning and analysis for micro-sized enterprises to use QFD to build up their e-business capabilities. Panizzolo (2008) reported the application at an Italian manufacturer of heating units to illustrate how his modified QFD methodology could be used to measure the value of the services offered by a company. An et al. (2008) used the application at one of the largest mobile phone manufacturers and the major mobile service provider in Korea to illustrate the potential advantages of using QFD to prepare product-service roadmaps for helping companies to make organizational development plans. Chien and Su (2003) demonstrated the feasibility of their proposal of adding an “ability index” to the QFD methodology to supplement the lack of customer satisfaction in traditional strategic analysis via an application of an industrial manufacturer in Taiwan. In order to support the proposal of integrating
Kano’s model and SERVQUAL into QFD for helping organizations to evaluate customer satisfaction, to guide improvement efforts in strengthening their weak attributes and to expedite the development of innovative services through the identification of attractive attributes and embedding them into future services, Tan and Pawitra (2001) first developed a framework and then applied it to evaluate the image of Singapore from the Indonesian tourist’s perspective for illustrating the effectiveness of the framework. For the establishment of a QFD-enabled product conceptualization system, a case study on wood golf club design was used to demonstrate the performance of the proposed approach (Yan et al., 2005). Furthermore, Hamilton and Selen (2004) showed the usefulness of their proposed QFD methodology in enabling personalized Web interface by reporting a successful application to the development of a regional real estate portal in Australia. In some studies, two or more cases or applications were reported in order to support the applicability of the proposed frameworks or models. For example, Dijkstra and Bij (2002) presented two applications in Dutch healthcare organizations to illustrate the usefulness of their refined and extended QFD method in meeting customer requirements in redesign and renewal of healthcare services. Moreover, Kobayashi et al. (2005) used the cases of vacuum cleaners and refrigerators to show the effectiveness of their presented method of using QFD and life-cycle impact assessment for quantifying eco-efficiency.

Two field applications were carried out to collect evidence to support the practicability of the proposed model. The first one involved the improvement of an in-house training course on teaching newly recruited merchandising trainees how to perform a sample measurement check for garments. The second one was the development of a training programme for providing the junior merchandisers of a
garment buying office with the essential kinds of industry-specific knowledge to perform material sourcing and vendor sourcing. Both applications were conducted at the company level but the objectives and areas of emphasis were different. The results and details of these two field applications are provided in the next chapter.

5. **Tools for Operating the Model**

There were two major tools used to assist in the operation of the model: (1) the VOC table, and (2) AHP. The former provided a visual guideline for processing the customers’ voices whilst the latter was used to produce more accurate prioritizations.

The VOC table facilitated the operation of the model in serving the purposes of facilitating and documenting the process of acquiring, processing and deploying the collected customers’ voices. Moving across the columns from left to right, the collected VOC not only was translated into performance requirements but subject alternatives were also derived. The original statements which were recorded in the course of the field study were reworded into positive statements and meanings were extracted from the statements. Based on the extracted meanings, performance needs were identified. On the one hand, the identified performance needs were organized into performance requirements using affinity diagrams. On the other hand, with reference to the identified performance needs, knowledge areas were suggested. The suggested knowledge areas were organized into subject alternatives, again using affinity diagrams. According to the resultant affinity diagrams, the performance requirements and subject alternatives were entered into the corresponding columns of the VOC table for record purposes. Upon completion, the VOC table displayed the flow as well as the results of the whole conversion
AHP facilitated the generation of mathematically valid data in two aspects. First, AHP was used to weight the importance of the performance requirements in respect to the task. The numerical weights which were generated by means of AHP could be used to accurately measure the importance of each of the performance requirements. Second, AHP was used to prioritize the subject alternatives in meeting the performance requirements. Although the simple 1-5 scale, where “1” is for the least important item and “5” is for the most important item, could be used to do the prioritization, the ordinal-scale priority obtained was limited to the ranking of the subject alternatives. However, the ratio-scale priority generated using AHP could not only produce more accurate priorities of the subjects but also serve to identify the magnitudes of the difference between the alternatives.
Chapter 5
Empirical Studies
1. Quasi-experiment: Order Follow-up and Provision of Product Development Services

1.1 Objective

To measure the level of customer satisfaction attained by an industrial training curriculum that was developed using the model.

1.2 Coverage of the Curriculum and Target Trainees

The training was aimed at providing the basic kinds of industry-specific knowledge which were important for the entry-level garment merchandisers to execute the following two tasks:

1) Order follow-up
2) Provision of product development services

The target trainees were the new merchandising entrants of the garment import/export trading firms and the buying offices of overseas importers in Hong Kong. They were assumed to have less than two years’ experience in the field.

1.3 Method

The curriculum was developed using the steps indicated by the model and it was sent to the customers for satisfaction assessment after development. The customers were the merchandising managers and merchandisers who had voiced their needs in the curriculum development process. Each of them was asked to comment on
his/her satisfaction with the curriculum. The collected individual scores were synthesized into aggregate scores for representing the level of customer satisfaction attained by the curriculum that was developed using the model.

1.4 Procedure

A total of 14 merchandising managers and 60 subordinates of these managers participated in the study. They worked at different trading firms and buying offices in Hong Kong of which the numbers of local employees ranged from 60 to several hundreds. The managers each had more than five years’ experience in merchandising management and the merchandisers each had two to four years’ working experience in the garment industry. A curriculum development team, which consisted of the author and two industrial training instructors, was formed for the study. The two instructors had over ten years’ experience in teaching garment merchandising.

Before the study began, the author called each of the 14 merchandising managers. The purpose of this initial contact was to explain the aim and the details of the arrangement as well as the activities in which they and their subordinates would participate in the study.

1.4.1 Defining performance requirements and generating subject alternatives

Two different methods were used to collect the VOC for the two tasks. For order follow-up, individual interviews were conducted with the merchandising managers to collect their opinions on the technical performance required for each task. For
provision of product development services, company visits were conducted to

capture the technical performance requirements by reviewing the files and

interviewing the involved persons. The use of two different VOC collection

methods not only addressed the different task natures but also served to triangulate

the data on the technical performance required for the two tasks.

Order Follow-up

In October and November of 2008, the author interviewed eight of the 14

participating merchandising managers over the phone. The managers were asked to

express their opinions on the technical performance required for the task of order

follow-up. He/she was requested to elaborate, clarify or illustrate with examples

when the given expression was found to be unclear or too broad.

The author and the two instructors worked together to process the collected VOC.

Using a VOC table (Table 5-1), the collected data from the interviews were

processed into the technical performance requirements for the task and to generate

the industry-specific subject alternatives for the training. Each collected opinion

was reworded into a positive statement and performance needs were extracted from

the statement. The interpretation process stopped when the needs appeared to

repeat. By eliminating the overlapping ones, the needs were organized into

performance requirements. The affinity diagram for the technical performance

requirements for order follow-up is shown in Figure 5-1.

Four technical performance requirements were identified and they were arranged in a

hierarchical order. The hierarchy was then sent to two of the interviewed
merchandising managers for review. The two managers were asked to comment on whether the performance requirements could accurately and comprehensively describe the technical performance to be required for the task of order follow-up. With reference to the comments received from the two managers, the performance requirement of “Know how to communicate” was adjusted to “Know how to technically communicate” and the performance need of “Know how to provide timely information” was reworded to “Know how to supply timely information”. The final version of the technical performance requirement hierarchy for order follow-up is displayed in Figure 5-2.

Besides interpreting into the performance requirements for the task, the needs which were extracted from the collected VOC were also translated into the subject alternatives for the training. With reference to the technical performance to be required, the two instructors used their knowledge and experience to suggest the kinds of industry-specific knowledge which were useful for the entry-level merchandisers to achieve. Again, the translation process stopped when most of the items appeared to repeat. By eliminating the overlapping ones, the extracted items were grouped into knowledge areas and further into subjects. Figure 5-3 shows the affinity diagram for the subject alternatives for the industrial training of order follow-up. The subject alternatives together with the respective knowledge areas to be covered are shown in Table 5-2.
<table>
<thead>
<tr>
<th>Ref</th>
<th>Merchandising Manager’s Voice</th>
<th>Reworded into Positive</th>
<th>Extracted Meaning</th>
<th>Performance Need</th>
<th>Performance Requirement</th>
<th>What To Be Known</th>
<th>Knowledge Area</th>
<th>Subject Alternative</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>C01</td>
<td>To follow-up an order, the first thing he/she has to do is to make a time-and-action plan.</td>
<td>He/she knows how to set timelines for an order.</td>
<td>Know how to set timelines for orders</td>
<td>Know How to Plan</td>
<td>Know How to Execute Order Follow-up</td>
<td>Items to be followed up</td>
<td>Order Elements</td>
<td>Order Knowledge</td>
<td>Basic items of an order</td>
</tr>
<tr>
<td></td>
<td>From time to time, he/she has to check whether the order is proceeded according to the time-and-action plan.</td>
<td>He/she knows how to monitor order progress.</td>
<td>Know how to check order status with vendors</td>
<td>Know How to Plan Schedule and Monitor Progress</td>
<td>Know How to Execute Order Follow-up</td>
<td>Items to be submitted by vendors for approval</td>
<td>Basics of Order Follow-up</td>
<td>Order Follow-up Practices</td>
<td>Seek confirmation on details and approvals, keep track on fabric and L/C status</td>
</tr>
<tr>
<td></td>
<td>He/she needs to deal with problems.</td>
<td>He/she understands problems.</td>
<td>Able to understand the nature of a problem</td>
<td>Able to understand the Nature of a Problem</td>
<td>Able to Deal with Problems</td>
<td>Common order problems</td>
<td>Common Order Problems</td>
<td>Order Knowledge</td>
<td>Delivery problems, quality problems, payment problems, etc.</td>
</tr>
<tr>
<td></td>
<td>He/she should know lab dip approvals and order quantities are the first things to be required by vendors to start orders.</td>
<td>He/she knows the priorities of information to be required for processing an order.</td>
<td>Know the priority of order information</td>
<td>Know How to Provide Timely Information</td>
<td>Vendor operation</td>
<td>Common production problems</td>
<td>Common Production Problems</td>
<td>Production Knowledge</td>
<td>Capacity problems, material problems, skill problems, etc.</td>
</tr>
<tr>
<td></td>
<td>He/she could clearly relate clients’ requests to vendors.</td>
<td>He/she could relate clients’ requirements to vendors.</td>
<td>Able to interpret clients’ requirements to vendors</td>
<td>Know How to Give Instructions to Vendors</td>
<td>Garment specification</td>
<td>Different aspects of an order</td>
<td>Different Aspects of an Order</td>
<td>Order Knowledge</td>
<td>Quality issues, L/C and logistics arrangement</td>
</tr>
<tr>
<td></td>
<td>Some just follow up without being aware of the problems with the orders.</td>
<td>He/she knows if there are any problems with the orders.</td>
<td>Aware of problems</td>
<td>Aware of Problems</td>
<td>Able to Deal with Problems</td>
<td>Merchandising Operation Workflow</td>
<td>Festivals and selling events</td>
<td>Selling Schedule</td>
<td>Merchandising Operation Workflow</td>
</tr>
</tbody>
</table>

(To Be Continued)
<table>
<thead>
<tr>
<th>Ref.</th>
<th>Merchandising Manager's Voice</th>
<th>Reworded into Positive Statement</th>
<th>Extracted Meaning from Reworded Statement</th>
<th>Performance Need</th>
<th>Performance Requirement</th>
<th>What To Be Known</th>
<th>Knowledge Area</th>
<th>Subject Alternative</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>C03</td>
<td>He/she has to make proper arrangement for shipping the goods during the peak seasons.</td>
<td>He/she knows how to coordinate with QC and shipping departments for arranging shipment matters.</td>
<td>Able to coordinate with QC department for arranging inspections</td>
<td>Able to Work with Quality Control Department</td>
<td>Know How to Coordinate with Different Departments to Process Orders</td>
<td>Arrangement for inspection of goods</td>
<td>Administration for Inspection</td>
<td>Quality Control Knowledge</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Understand quality control practices</td>
<td>Able to Work with Quality Control Department</td>
<td>Know How to Coordinate with Different Departments to Process Orders</td>
<td>Quality control practices</td>
<td>Quality Control Practices</td>
<td>Quality Control Knowledge</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Able to coordinate with shipping department for arranging shipments</td>
<td>Able to Work with Shipping Department</td>
<td>Know How to Coordinate with Different Departments to Process Orders</td>
<td>Arrangement for shipments of goods</td>
<td>Administration for Shipment</td>
<td>Shipping Knowledge</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Understand shipping practices</td>
<td>Able to Work with Shipping Department</td>
<td>Know How to Coordinate with Different Departments to Process Orders</td>
<td>Shipping practices</td>
<td>Shipping Practices</td>
<td>Shipping Knowledge</td>
<td></td>
</tr>
<tr>
<td>C03</td>
<td>He/she has to update and recap order status.</td>
<td>He/she needs to be clear about the order status.</td>
<td>Able to identify the outstanding matters of an order</td>
<td>Know How to Plan Schedule and Monitor Progress</td>
<td>Know How to Execute Order Follow-up</td>
<td>Things to be done to follow up an order</td>
<td>Items to be submitted by vendors for approval</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C04</td>
<td>He/she needs to fully understand the buyers' actual wants.</td>
<td>He/she knows how to check if the items submitted by vendors could meet the clients' standards or not.</td>
<td>Know how to check if a lab dip meets the given colour standard</td>
<td>Know How to Check Samples and Colours</td>
<td>Know How to Execute Order Follow-up</td>
<td>Light box operation</td>
<td>Light Box Operation</td>
<td>Order Follow-up Practices</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Know how to check if a sample meets the required quality standards</td>
<td>Know How to Check Samples and Colours</td>
<td>Know How to Execute Order Follow-up</td>
<td>Sample inspection</td>
<td>Sample Inspection</td>
<td>Order Follow-up Practices</td>
<td></td>
</tr>
<tr>
<td>C04</td>
<td>He/she has to find ways to make clients' design feasible for production.</td>
<td>He/she knows how to find ways to solve technical problems.</td>
<td>Able to work with technicians to solve problems</td>
<td>Able to Work with Technical Department</td>
<td>Know How to Coordinate with Different Departments to Process Orders</td>
<td>Pattern making</td>
<td>Pattern Making</td>
<td>Product Making Knowledge</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Garment making</td>
<td>Garment making</td>
<td>Garment Making</td>
<td>Product Making Knowledge</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C05</td>
<td>He/she knows how to explain to clients why their requirements could not be met.</td>
<td>He/she knows how to explain to clients why their requirements could not be met.</td>
<td>Able to explain technical problems to clients</td>
<td>Able to Explain Technical Issues to Clients</td>
<td>Know How to Communicate</td>
<td>Common product making problems</td>
<td>Fitting</td>
<td>Fitting</td>
<td>Product Making Knowledge</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Able to explain production constraints to clients</td>
<td>Able to Explain Technical Issues to Clients</td>
<td>Know How to Communicate</td>
<td>Common production problems</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C05</td>
<td>The larger the company, the more the gaps in following up orders.</td>
<td>He/she knows how to coordinate with other departments of the company.</td>
<td>Know the information required for conducting inspections</td>
<td>Able to Work with Quality Control Department</td>
<td>Know How to Coordinate with Different Departments to Process Orders</td>
<td>Information required by QC department for conducting inspections</td>
<td>Administration for Inspection</td>
<td>Quality Control Knowledge</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Know the information required for arranging shipments</td>
<td>Able to Work with Shipping Department</td>
<td>Know How to Coordinate with Different Departments to Process Orders</td>
<td>Information required by shipping department for arranging shipments</td>
<td>Administration for Shipment</td>
<td>Shipping Knowledge</td>
<td></td>
</tr>
<tr>
<td>C06</td>
<td>He/she could effectively communicate with vendors.</td>
<td>He/she could effectively communicate with vendors.</td>
<td>Know how to give clear and adequate instructions to vendors</td>
<td>Know How to Give Instructions to Vendors</td>
<td>Know How to Communicate</td>
<td>Garment specification</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C06</td>
<td>He/she would not miss something important.</td>
<td>He/she knows what have to be done for an order.</td>
<td>Able to identify the activities to be performed for an order</td>
<td>Know How to Plan Schedule and Monitor Progress</td>
<td>Know How to Execute Order Follow-up</td>
<td>Things to be done to follow up an order</td>
<td>Items to be submitted by vendors for approval</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(To Be Continued)
<table>
<thead>
<tr>
<th>Ref</th>
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<th>Reworded into Positive Statement</th>
<th>Extracted Meaning from Reworded Statement</th>
<th>Performance Need</th>
<th>Performance Requirement</th>
<th>What To Be Known</th>
<th>Knowledge Area</th>
<th>Subject Alternative</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>C06</td>
<td>Order follow-up is just like forming a chain. He/she should be able to link up the rings by himself/herself.</td>
<td>He/she knows what is to be done next.</td>
<td>Know how to act upon receiving requests/responses</td>
<td>Know How to Process Collected Information</td>
<td>Know How to Execute Order Follow-up</td>
<td>Workflow of order follow-up</td>
<td>Workflow of Order Follow-up</td>
<td>Order Follow-up Practices</td>
<td></td>
</tr>
<tr>
<td>C07</td>
<td>In some cases, he/she just asks the vendor to follow the given instructions.</td>
<td>He/she knows whether the client's requirements are technically feasible.</td>
<td>Able to know if there are any potential technical problems</td>
<td>Able to Detect Potential Problems</td>
<td>Able to Deal with Problems</td>
<td>Pattern making</td>
<td>Fabric making</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>C07</td>
<td>He/she should know how to prioritize his/her tasks.</td>
<td>He/she knows how to prioritize his/her tasks.</td>
<td>Know how to prioritize tasks for facilitating order progress</td>
<td>Know How to Process Collected Information</td>
<td>Know How to Execute Order Follow-up</td>
<td>Vendor operation</td>
<td>Buyer operation</td>
<td>Buyer Operation</td>
<td>Merchandising Operation Workflow</td>
</tr>
<tr>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C07</td>
<td>If certain sample should have been approved but is still under revision, then he/she should know which areas have not yet met the client's requirements.</td>
<td>He/she understands the reasons behind a disapproval.</td>
<td>Understand the reasons behind a problem</td>
<td>Able to Understand the Nature of a Problem</td>
<td>Able to Deal with Problems</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>C08</td>
<td>He/she should understand the whole garment production process.</td>
<td>He/she could oversee the production of an order.</td>
<td>Able to know if there are any potential delivery problems</td>
<td>Able to Detect Potential Problems</td>
<td>Able to Deal with Problems</td>
<td>Assembly process</td>
<td>Garment processing processes</td>
<td>Common production problems</td>
<td></td>
</tr>
</tbody>
</table>

Table 5-1: VOC table for order follow-up
Know How to Execute Order Follow-up

Know How to Process Collected Information
- Know how to act upon receiving requests/responses
- Know how to prioritize tasks for facilitating order progress

Know How to Check Samples and Colours
- Know how to check if a sample meets the required quality standards
- Know how to check if a lab dip meets the given colour standard

Know How to Plan Schedule and Monitor Progress
- Know how to set timelines for orders
- Know how to check order status with vendors
- Know how to monitor order progress for meeting clients’ selling schedules
- Able to identify the outstanding matters of an order
- Able to identify the activities needed to be performed for an order

Figure 5-1: Affinity diagram for the technical performance requirements for order follow-up
Know How to Coordinate with Different Departments to Process Orders

Able to Work with Technical Department
- Able to work with technicians to solve problems

Able to Work with Quality Control Department
- Able to coordinate with QC department for arranging inspections
- Understand quality control practices
- Know the information required for conducting inspections

Able to Work with Shipping Department
- Able to coordinate with shipping department for arranging shipments
- Understand shipping practices
- Know the information required for arranging shipments

Figure 5-1: Affinity diagram for the technical performance requirements for order follow-up
Able to Deal with Problems

Able to Detect Potential Problems

Aware of Problems

Able to know if there are any potential delivery problems

Able to Understand the Nature of a Problem

Able to know if there are any potential technical problems

Understand the reasons behind a problem

Able to know if there are any potential quality problems

Figure 5-1: Affinity diagram for the technical performance requirements for order follow-up
Know How to Technically Communicate

Know How to Supply Timely Information

Know how to get information ready for vendors to start production

Know the priority of order information

Know How to Give Instructions to Vendors

Know how to give clear and adequate instructions to vendors

Able to interpret clients’ requirements to vendors

Able to Explain Technical Issues to Clients

Able to explain technical problems to clients

Able to explain production constraints to clients

Figure 5-1: Affinity diagram for the technical performance requirements for order follow-up
Order Follow-up

Know How to Execute Order Follow-up
Including:
1. Know how to process collected information
2. Know how to check samples and colours
3. Know how to plan schedule and monitor progress

Know How to Coordinate with Different Departments to Process Orders
Including:
1. Able to work with Technical Department
2. Able to work with Quality Control Department
3. Able to work with Shipping Department

Know How to Technically Communicate
Including:
1. Know how to instruct vendors
2. Know how to give instructions to vendors
3. Able to explain technical issues to clients

Able to Deal with Problems
Including:
1. Aware of problems
2. Able to understand the nature of a problem
3. Able to detect potential problems

Figure 5-2: Technical performance requirement hierarchy for order follow-up
Order Follow-up Practices

Basics of Order Follow-up
- Things to be done to follow up an order
- Items to be submitted by vendors for approval

Workflow of Order Follow-up

Light Box Operation

Sample Inspection

Order Knowledge

Order Elements
- Items to be followed up
- How an order item should be specified

Different Aspects of an Order

Common Order Problems

Figure 5-3: Affinity diagram for the subject alternatives for the industrial training of order follow-up
Figure 5-3: Affinity diagram for the subject alternatives for the industrial training of order follow-up
Merchandising Operation Workflow

Vendor Operation

Buyer Operation

Selling Schedule

Seasons for product lines

Festivals and selling events

Arrangement for inspection of goods

Information required by QC department for conducting inspections

Quality Control Practices

Quality Control Knowledge

Figure 5-3: Affinity diagram for the subject alternatives for the industrial training of order follow-up
Figure 5-3: Affinity diagram for the subject alternatives for the industrial training of order follow-up
<table>
<thead>
<tr>
<th>Subject</th>
<th>Major Knowledge Areas To Be Covered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Order Knowledge</td>
<td>Order elements, different aspects of an order, common order problems</td>
</tr>
<tr>
<td>Quality Control Knowledge</td>
<td>Quality control practices, administration for inspection of goods</td>
</tr>
<tr>
<td>Order Follow-up Practices</td>
<td>Workflow, things to do, approval items, sample inspection, light box operation</td>
</tr>
<tr>
<td>Product Making Knowledge</td>
<td>Specification, different product making processes, common product making problems</td>
</tr>
<tr>
<td>Merchandising Operation Workflow</td>
<td>Buyer and vendor operations, seasons for product lines, festivals and selling events</td>
</tr>
<tr>
<td>Production Knowledge</td>
<td>Assembly and processing processes, common production problems</td>
</tr>
<tr>
<td>Shipping Knowledge</td>
<td>Shipping practices, administration for shipment of goods</td>
</tr>
</tbody>
</table>

Table 5-2: Subject alternatives for the industrial training of order follow-up
During December of 2008, the author visited six of the 14 participating merchandising managers. The aim of the visits was to collect information about the technical performance to be required for the task of provision of product development services. For each visit, a product development file was reviewed and the merchandising manager was invited to comment on the technical performance which the entry-level merchandisers were expected to demonstrate.

As was the case with order follow-up, the author and the two instructors worked together to process the collected information from the visits. The VOC table which was used to define the technical performance requirements for the task and to generate the industry-specific subject alternatives for the training of provision of product development services is shown in Table 5-3. Each item of collected information was interpreted into a positive statement, and, performance needs were extracted from the statements until most of the items appeared to repeat. By eliminating the overlapped ones, the extracted items were organized into performance requirements. Figure 5-4 shows the affinity diagram for the technical performance requirements for provision of product development services. Two of the merchandising managers visited reviewed the performance requirements and they were satisfied with them. Figure 5-5 shows the technical performance requirement hierarchy for provision of product development services.

Upon defining the technical performance requirements, the curriculum development team proceeded further to generate the subject alternatives for the training. The two instructors used their knowledge and experience to translate the technical
performance requirements into the kinds of industry-specific knowledge which were useful for the entry-level merchandisers to achieve them. Using the technique of affinity diagramming, the extracted items were first grouped into knowledge areas and further into subjects. Figure 5-6 shows the affinity diagram for the subject alternatives for the industrial training of provision of product development services and Table 5-4 exhibits the subject alternatives and the knowledge areas to be covered by each of them.
<table>
<thead>
<tr>
<th>Ref Item Source</th>
<th>Ref Item</th>
<th>Voice of the Customer (VOC)</th>
<th>Reworded into Positive Statement</th>
<th>Extracted Meaning from Reworded Statement</th>
<th>Performance Need</th>
<th>Performance Requirement</th>
<th>What To Be Known</th>
<th>Knowledge Area</th>
<th>Subject Alternative</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>C09 E-mails in the order file</td>
<td>C09 Ladies' bra and thong set</td>
<td>The client wanted to change the central gore height from 7/8&quot; to 2-1/4&quot;. The merchandiser told him that the vendor suggested to change to 1-3/4&quot; in order to avoid fitting problem for D-cup.</td>
<td>He/she could relate technical suggestions to clients.</td>
<td>Able to relate suggestions to clients to avoid technical problems</td>
<td>Able to Communicate with Clients and Vendors</td>
<td>Able to Follow Up Technical Issues of Sample Making</td>
<td>What is a good fit for a given type of garment</td>
<td>Fitting</td>
<td>Product Making Knowledge</td>
<td>General guidelines to determine whether a garment fits, e.g. sleeves do not twist and do not have wrinkles that run across the cap for a jacket</td>
</tr>
<tr>
<td>C09 E-mails in the order file</td>
<td>C09 Ladies' bra and thong set</td>
<td>The client wanted to change the central gore height from 7/8&quot; to 2-1/4&quot;. The merchandiser told him that the vendor suggested to change to 1-3/4&quot; in order to avoid fitting problem for D-cup.</td>
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<td>Able to Communicate with Clients and Vendors</td>
<td>Able to Follow Up Technical Issues of Sample Making</td>
<td>What is a good fit for a given type of garment</td>
<td>Fitting</td>
<td>Product Making Knowledge</td>
<td>General guidelines to determine whether a garment fits, e.g. sleeves do not twist and do not have wrinkles that run across the cap for a jacket</td>
</tr>
<tr>
<td>C09 E-mails in the order file</td>
<td>C09 Ladies' bra and thong set</td>
<td>The client commented that the cup of the 2nd fit sample was very flat and did not have enough depth.</td>
<td>He/she could feedback to clients how problems to be fixed.</td>
<td>Know how to explain to clients how problems will be corrected</td>
<td>Able to Communicate with Clients and Vendors</td>
<td>Able to Follow Up Technical Issues of Sample Making</td>
<td>Fit standards for different garment parts</td>
<td>Fitting</td>
<td>Product Making Knowledge</td>
<td>What is a well-fitted waistline supposed to be? What is a proper hip area supposed to be?</td>
</tr>
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<td>C09 E-mails in the order file</td>
<td>C09 Ladies' bra and thong set</td>
<td>The client commented that the cup of the 2nd fit sample was very flat and did not have enough depth.</td>
<td>He/she could feedback to clients how problems to be fixed.</td>
<td>Know how to explain to clients how problems will be corrected</td>
<td>Able to Communicate with Clients and Vendors</td>
<td>Able to Follow Up Technical Issues of Sample Making</td>
<td>Fit standards for different garment parts</td>
<td>Fitting</td>
<td>Product Making Knowledge</td>
<td>What is a well-fitted waistline supposed to be? What is a proper hip area supposed to be?</td>
</tr>
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<td>Know how to explain to clients how problems will be corrected</td>
<td>Able to Communicate with Clients and Vendors</td>
<td>Able to Follow Up Technical Issues of Sample Making</td>
<td>Fit standards for different garment parts</td>
<td>Fitting</td>
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<td>Able to Communicate with Clients and Vendors</td>
<td>Able to Follow Up Technical Issues of Sample Making</td>
<td>Fit standards for different garment parts</td>
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<td>Product Making Knowledge</td>
<td>What is a well-fitted waistline supposed to be? What is a proper hip area supposed to be?</td>
</tr>
<tr>
<td>C09 E-mails in the order file</td>
<td>C09 Ladies' bra and thong set</td>
<td>The client commented that the cup of the 2nd fit sample was very flat and did not have enough depth.</td>
<td>He/she could feedback to clients how problems to be fixed.</td>
<td>Know how to explain to clients how problems will be corrected</td>
<td>Able to Communicate with Clients and Vendors</td>
<td>Able to Follow Up Technical Issues of Sample Making</td>
<td>Fit standards for different garment parts</td>
<td>Fitting</td>
<td>Product Making Knowledge</td>
<td>What is a well-fitted waistline supposed to be? What is a proper hip area supposed to be?</td>
</tr>
<tr>
<td>C09 E-mails in the order file</td>
<td>C09 Ladies' bra and thong set</td>
<td>The client commented that the cup of the 2nd fit sample was very flat and did not have enough depth.</td>
<td>He/she could feedback to clients how problems to be fixed.</td>
<td>Know how to explain to clients how problems will be corrected</td>
<td>Able to Communicate with Clients and Vendors</td>
<td>Able to Follow Up Technical Issues of Sample Making</td>
<td>Fit standards for different garment parts</td>
<td>Fitting</td>
<td>Product Making Knowledge</td>
<td>What is a well-fitted waistline supposed to be? What is a proper hip area supposed to be?</td>
</tr>
</tbody>
</table>

(To Be Continued)
<table>
<thead>
<tr>
<th>Ref.</th>
<th>Item</th>
<th>Source</th>
<th>Voice of the Customer (VOC)</th>
<th>Reworded Statement</th>
<th>Extracted Meaning</th>
<th>Performance Need</th>
<th>Performance Requirement</th>
<th>What To Be Known</th>
<th>Knowledge Area</th>
<th>Subject Alternative</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>C10</td>
<td>Boys' cargo pants</td>
<td>E-mails in the order file and merchandiser</td>
<td>A sketch was drawn to illustrate the construction of the cargo pocket on the pants. Merchandiser explained that client only gave her written comments and she needed to make them clear for the vendor.</td>
<td>He/she knows how to provide additional information for vendors to make samples.</td>
<td>Able to give clear instructions to vendors for sample making</td>
<td>Able to Communicate with Clients and Vendors</td>
<td>Able to Follow Up Technical Issues of Sample Making</td>
<td>Garment part structures</td>
<td>Garment Futures</td>
<td>Product Knowledge</td>
<td>Structure of pocket, collar, sleeve, etc.</td>
</tr>
<tr>
<td>C10</td>
<td>Boys' cargo pants</td>
<td>E-mails in the order file</td>
<td>The merchandiser told the client that 24L button was too small for the waistband.</td>
<td>He/she could advise clients on button size.</td>
<td>Able to give advice on usual practice with sub-material applications</td>
<td>Able to Give Advice on Material and Sub-material Applications</td>
<td>Able to Follow Up Technical Issues of Sample Making</td>
<td>Applications of different components and trims</td>
<td>Sub-materials</td>
<td>Material and Sub-material Knowledge</td>
<td>Sewing thread, button, zipper, etc.</td>
</tr>
<tr>
<td>C10</td>
<td>Boys' cargo pants</td>
<td>E-mails in the order file</td>
<td>The merchandiser suggested that the client use Velcro tape instead of button for the cargo pocket of the pants.</td>
<td>He/she could make recommendations to clients about the use of fasteners.</td>
<td>Able to give advice on usual practice with sub-material applications</td>
<td>Able to Give Advice on Material and Sub-material Applications</td>
<td>Able to Follow Up Technical Issues of Sample Making</td>
<td>Different materials of a given type of component or trims</td>
<td>Sub-materials</td>
<td>Material and Sub-material Knowledge</td>
<td>Fasteners, supporting items, etc.</td>
</tr>
<tr>
<td>C10</td>
<td>Boys' cargo pants</td>
<td>E-mails in the order file</td>
<td>The merchandiser checked with the vendor to see if it had the latest model of needle detection machine.</td>
<td>He/she is aware of the potential machinery problems for producing the order of a given garment.</td>
<td>Aware of potential machinery problems</td>
<td>Able to Identify Potential Production Problems</td>
<td>Basic machines for the production of a given type of garment</td>
<td>Machinery</td>
<td>Production Knowledge</td>
<td>Typical cutting and sewing machines</td>
<td></td>
</tr>
<tr>
<td>C10</td>
<td>Boys' cargo pants</td>
<td>E-mails in the order file</td>
<td>The client was suggested to change cotton twill jacket and skirt set</td>
<td>He/she knows the potential machinery problems of a given garment.</td>
<td>Able to identify potential machinery problems of a given garment.</td>
<td>Able to Identify Potential Production Problems</td>
<td>Basic machines for the production of a given type of garment</td>
<td>Machinery</td>
<td>Production Knowledge</td>
<td>Machines for embroidery and special stitches, needle detection machines, etc.</td>
<td></td>
</tr>
<tr>
<td>C11</td>
<td>Girls' jacket</td>
<td>E-mails in the order file</td>
<td>The client was advised to use embroidery instead of print for the butterfly design on the jacket front to avoid the risk of toxicity.</td>
<td>He/she knows the potential machinery problems of a given garment.</td>
<td>Able to identify potential machinery problems of a given garment.</td>
<td>Able to Identify Potential Production Problems</td>
<td>Basic machines for the production of a given type of garment</td>
<td>Apparel safety issues</td>
<td>Apparel Safety Regulations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C11</td>
<td>Girls' jacket</td>
<td>E-mails in the order file</td>
<td>The client was suggested to change the collar and cuff trimmings from floral print to solid to avoid the problem of fabric minimum.</td>
<td>He/she is aware of the potential fabric order problems for producing the order of a given garment.</td>
<td>Able to identify potential fabric order problems of a given garment.</td>
<td>Able to Identify Potential Production Problems</td>
<td>Fabric order minimums</td>
<td>Materials</td>
<td>Material and Sub-material Knowledge</td>
<td>E.g. order minimums and delivery for piece-dye fabrics, yarn-dye fabrics, etc.</td>
<td></td>
</tr>
<tr>
<td>C12</td>
<td>Cadet cotton twill jacket and skirt set</td>
<td>E-mails in the order file</td>
<td>The merchandiser checked with the client to see if she would accept a 18 cm reduction in the sweep of the skirt in order to lower the material costs.</td>
<td>He/she could explain to clients why a suggested adjustment could lower the production costs of a garment.</td>
<td>Understand why a given adjustment could lower the cost of a garment.</td>
<td>Able to Explain the Cost Difference between Options</td>
<td>Supplier Planning</td>
<td>Informative Quotes</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(To Be Continued)
<table>
<thead>
<tr>
<th>Ref</th>
<th>Item</th>
<th>Source</th>
<th>Voice of the Customer (VOC)</th>
<th>Reworded into Positive Statement</th>
<th>Extracted Meaning from Reworded Statement</th>
<th>Performance Need</th>
<th>Performance Requirement</th>
<th>What To Be Known</th>
<th>Knowledge Area</th>
<th>Subject Alternative</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>C12</td>
<td>Ladies' cotton twill jacket and skirt set</td>
<td>E-mails in the order file</td>
<td>For the jacket, the merchandiser explained to the client that cotton lining would be more expensive than acetate lining but should be more comfortable to wear.</td>
<td>He/she is able to analyze the pros and cons of different materials for a garment.</td>
<td>Able to analyze the pros and cons of different materials for a given garment</td>
<td>Able to Give Advice on Material and Sub-material Applications</td>
<td>Able to Follow Up Technical Issues of Sample Making</td>
<td>Fabric characteristics</td>
<td>Materials</td>
<td>Material and Sub-material Knowledge</td>
<td>Fabrics applications</td>
</tr>
<tr>
<td>C12</td>
<td>Merchandising Manager</td>
<td>The designer expects us to update him on the latest washing technologies for his new product development.</td>
<td>He/she could update clients on new washing technologies for their product development.</td>
<td>Able to update clients on washing technology development</td>
<td>Able to Update Clients on New Technology Development</td>
<td>Able to Offer New Ideas</td>
<td>New washing methods</td>
<td>New Technology Development</td>
<td>New Ideas for Product Development</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C12</td>
<td>Merchandising Manager</td>
<td>I have a client who always asks us to source fancy materials for her teenager's line.</td>
<td>He/she could offer clients new materials for their product development.</td>
<td>Able to offer new materials to clients</td>
<td>Able to Update Clients on New Material and Sub-material Development</td>
<td>Able to Offer New Ideas</td>
<td>New materials</td>
<td>New Material and Sub-material Development</td>
<td>New Ideas for Product Development</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C13</td>
<td>Ladies chiffon blouse</td>
<td>E-mails in the order file</td>
<td>Clients' comments were directly quoted to vendors for sample revision.</td>
<td>He/she understands clients' sample comments.</td>
<td>Understand sample comments given by clients</td>
<td>Understand Why Revisions are Needed</td>
<td>Able to Follow Up Technical Issues of Sample Making</td>
<td>Common fit problems for a given type of garment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C13</td>
<td>Ladies chiffon blouse</td>
<td>E-mails in the order file</td>
<td>The client commented that there was a slippage problem with the two side seams.</td>
<td>He/she knows the potential sewing problems of a given garment.</td>
<td>Able to identify potential sewing problems of a given garment</td>
<td>Able to Identify Potential Product Problems</td>
<td>Common sewing problems</td>
<td>Garment Making</td>
<td>Product Making Knowledge</td>
<td>Applications of seams and stitches to sewing</td>
<td></td>
</tr>
<tr>
<td>C14</td>
<td>Merchandising Manager</td>
<td>The merchandisers need to provide sensible quotations to clients.</td>
<td>He/she knows how to provide sensible quotations to clients.</td>
<td>Able to know if the quotations given by vendors make sense</td>
<td>Know how to specify the key conditions for the quotations to clients</td>
<td>Able to Identify the Key Constituents of a Garment's Cost</td>
<td>Able to Prepare Logical and Informative Quotations</td>
<td>Components of Production Costs</td>
<td>Production Costs</td>
<td>Ways of reducing material costs</td>
<td>Ways of reducing Product Costs</td>
</tr>
</tbody>
</table>

Table 5-3: VOC table for provision of product development services
Able to Prepare Logical and Informative Quotations

Able to Identify the Key Constituents of a Garment’s Cost
- Able to know if the quotations given by vendors make sense
- Know how to specify the key conditions for the quotations to clients

Able to Identify the Costing Options for a Garment
- Know the adjustments for lowering the production costs of a given garment
- Able to identify the relevant versions of a given garment for quotation

Able to Explain the Cost Difference between Options
- Understand why a given adjustment could lower the cost of a garment
- Able to tell the cost difference between various versions of a garment

Figure 5-4: Affinity diagram for the technical performance requirements for provision of product development services
Figure 5-4: Affinity diagram for the technical performance requirements for provision of product development services

Able to Offer New Ideas

- Able to Update Clients on New Technology Development
  - Able to update clients on washing technology development
- Able to Update Clients on New Materials
  - Able to offer new materials to clients
Able to Identify Potential Problems

Able to Identify Potential Production Problems
- Aware of potential machinery problems
- Aware of potential fabric order problems

Able to Identify Potential Product Problems
- Able to identify potential safety problems of a given garment
- Able to identify potential sewing problems of a given garment

Figure 5-4: Affinity diagram for the technical performance requirements for provision of product development services
Able to Follow Up
Technical Issues of Sample Making

Understand Why
Revisions are Needed

Understand sample comments
given by clients

Understand why a change of
fit or measurement is needed

Able to Give Advice on Material
and Sub-material Applications

Able to give advice on usual practice
with sub-material applications

Able to analyze the pros and cons of
different materials for a given garment

Able to Communicate with
Clients and Vendors

Able to relate suggestions to clients to
avoid technical problems

Able to give clear instructions to
vendors for sample making

Know how to explain to clients
how problems will be corrected

Figure 5-4: Affinity diagram for the technical performance requirements for provision of product development services
Figure 5-6: Affinity diagram for the subject alternatives for the industrial training of provision of product development services
New Ideas for Product Development

New Material and Sub-material Development
- New materials
- New sub-materials

New Technology Development
- New washing methods
- New printing methods
- New dyeing methods

Figure 5-6: Affinity diagram for the subject alternatives for the industrial training of provision of product development services
Product Making Knowledge

Garment Making
- Application of seams and stitches to sewing
- Common sewing problems

Pattern Making
- Basic principles of pattern making
- Ways of creating fullness in pattern making

Fitting
- What is a good fit for a given type of garment
- Fit standards for different garment parts
- Common fit problems for a given type of garment

Figure 5-6: Affinity diagram for the subject alternatives for the industrial training of provision of product development services
Fit Evaluation and Pattern Alteration

Fit Evaluation
- How to conduct garment fit

Pattern Alteration
- How to correct garment fit problems

Figure 5-6: Affinity diagram for the subject alternatives for the industrial training of provision of product development services
Production Knowledge

Grading
- General increments between different sizes of a given type of garment

Marker Planning
- Interlocking of pattern pieces
- Factors affecting fabric consumption

Machinery
- Basic machines for the production of a given type of garment
- Machines for special functions

Figure 5-6: Affinity diagram for the subject alternatives for the industrial training of provision of product development services
Figure 5-6: Affinity diagram for the subject alternatives for the industrial training of provision of product development services
Material and Sub-material Knowledge

Sub-materials
- Functions of different components and trims
- Supporting items
- Different materials of a given type of component or trim
- Applications of different components and trims

Materials
- Fabric characteristics
- Fabric applications
- Fabric order minimums

Figure 5-6: Affinity diagram for the subject alternatives for the industrial training of provision of product development services
Able to give advice on production problems

1. Able to identify potential products
2. Able to update clients on new product problems

1. Able to identify potential production problems
2. Able to update clients on new materials

Able to communicate with clients and vendors

1. Able to identify the key constituents of a garment cost
2. Able to identify the costing options for a garment
3. Able to explain the cost difference between options

1. Able to identify the costing options for a garment
2. Able to identify potential production problems

Figure 5-5: Technical performance requirement hierarchy for provision of product development services
### Major Knowledge Areas To Be Covered

<table>
<thead>
<tr>
<th>Subject</th>
<th>Major Knowledge Areas To Be Covered</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Ideas for Product Development</td>
<td>New development of technologies and materials</td>
</tr>
<tr>
<td>Product Knowledge</td>
<td>Sizes &amp; measurements, garment features, product testing and safety regulations</td>
</tr>
<tr>
<td>Fit Evaluation and Pattern Alteration</td>
<td>How to conduct garment fit, how to correct garment fit problems</td>
</tr>
<tr>
<td>Product Making Knowledge</td>
<td>Knowledge of pattern making, garment making and fitting</td>
</tr>
<tr>
<td>Production Knowledge</td>
<td>Knowledge of grading and marker planning, production machinery</td>
</tr>
<tr>
<td>Material and Sub-material Knowledge</td>
<td>Characteristics and applications of various materials and sub-materials</td>
</tr>
<tr>
<td>Production Costs</td>
<td>Components of production costs, ways of reducing production costs</td>
</tr>
</tbody>
</table>

Table 5-4: Subject alternatives for the industrial training of provision of product development services
1.4.2 Weighting performance requirements and subject alternatives

Two separate surveys were conducted for the study. One was aimed at weighting the importance of the performance requirements for the task and the other one was aimed at weighting the importance of the subject alternatives for meeting the performance requirements. The technique of AHP was used for processing the collected data and the software ExpertChoice® was employed for operation.

The first survey was conducted with the 14 merchandising managers on weighting the importance of the performance requirements for the two tasks. For each task, the responding manager was asked to do a pairwise comparison on the importance of every given pair of performance requirements in respect to the task. The two questionnaires used for the survey are provided in Appendices 5-1 and 5-2.

All 14 managers responded to the survey. The questionnaire was returned to the corresponding manager to recheck his/her responses when the consistency ratio was found to be greater than 0.1. Two copies of the order follow-up questionnaire and four copies of the provision of product development services questionnaire were returned to the corresponding managers for further checking. Upon revision, the consistency ratios of all the responses were within 0.1. The individual sets of data were synthesized into aggregate results. Figures 5-7 and 5-8 exhibit the importance weights of the performance requirements for order follow-up and provision of product development services which were identified by the survey.
The second survey was conducted with the merchandisers on weighting the importance of the subject alternatives for meeting the performance requirements for the two tasks. Each merchandising manager was asked to select two merchandisers of his/her department or company to complete the order follow-up questionnaire and another two to complete the provision of product development services questionnaire. For both questionnaires, the responding merchandiser was asked to do a pairwise comparison on the importance of every given pair of subject alternatives in respect to achieving each of the performance requirements for the task. The two questionnaires used for the survey are supplied in Appendices 5-3 and 5-4.

32 completed copies of the order follow-up questionnaire and 28 completed copies of the provision of product development services questionnaire were received. Similar to the survey with the merchandising managers, the questionnaire was returned to the corresponding merchandiser to check it again when the consistency...
ratio of his/her responses was found to be greater than 0.1. In the case of order follow-up, eight copies were returned for recheck and four of them responded. Of the four revised copies, the consistency ratios of three of them were found to be greater than 0.5. These three copies were discarded as the high inconsistencies indicated that the responding merchandisers might not be clear about the relative importance of the subject alternatives for meeting the performance requirements. For provision of product development services, five copies were returned for a further check and three of them responded. One of the three revised copies was discarded for the consistency ratio was found to be greater than 0.5. After revision, there were 25 valid responses for order follow-up and also 25 valid responses for provision of product development services. By synthesizing the individual sets of data into group data, the importance weights of the subject alternatives for the training of order follow-up and provision of product development services were found. Figures 5-9 and 5-10 show the respective results.

Figure 5-9: Weights of importance of the subject alternatives for the industrial training of order follow-up
Figure 5-10: **Weights of importance of the subject alternatives for the industrial training of provision of product development services**

Figures 5-11 and 5-12 present the completed curriculum development models for order follow-up and provision of product development services respectively.
Figure 5-11: Completed industrial training curriculum development model for order follow-up
Provision of Product Development Services

Able to Follow Up Technical Issues of Sample Making

Able to Prepare Logical and Informative Quotations

Able to Identify Potential Problems

Able to Offer New Ideas

Knowledge & skills

Knowledge & skills

Knowledge & skills

Knowledge & skills

Knowledge & skills

Knowledge & skills

Knowledge & skills

Knowledge & skills

New Ideas for Product Development

Product Knowledge

Fit Evaluation and Pattern Alteration

Product Making Knowledge

Production Knowledge

Material and Sub-material Knowledge

Production Costs

Figure 5-12: Completed industrial training curriculum development model for provision of product development services
1.4.3 Curriculum development

The curriculum development team members held two meetings to discuss how to develop the curriculum. The first meeting was to draw up the guidelines, including the principle of selecting subjects for developing the curriculum, the training approach for the curriculum and the logic of the flow. The second meeting was to execute the development of the curriculum.

As a foundation course for new entrants, the team members found that, rather than only the important ones, those basic industry-specific subjects should also be included in the curriculum. The team decided to use the 80/20 principle to select subjects for curriculum development. However, instead of selecting the top 20% and eliminating the bottom 80%, the top 80% was selected and the bottom 20% was eliminated. Based on this selection principle, the encircled subjects in Figures 5-13 and 5-14 were included into the curriculum development for the industrial training of order follow-up and provision of production development services.

Figure 5-13: Subjects selected for the curriculum development of the industrial training for order follow-up
Figure 5-14: Subjects selected for the curriculum development of the industrial training for product development services

Five subjects were selected for each of the tasks of order follow-up and provision of product development services. Having eliminated the duplication of the subjects “Product making knowledge” and “Production knowledge”, which were common to both tasks, the following eight subjects were used for the curriculum development:

1) Order follow-up practices
2) Production knowledge
3) Order knowledge
4) Product making knowledge
5) Merchandising operation workflow
6) Product knowledge
7) Production costs
8) Material and sub-material knowledge

On the one hand, the curriculum development members decided to use the job-incumbent-centred approach to develop the curriculum. In other words, the training was developed to address the knowledge needs of the merchandiser for processing the orders and dealing with the products of the orders. On the other hand, the members also agreed to use the product approach to organize the content. For example, general merchandising knowledge was taught before specific product
knowledge, and, the product was introduced before introducing product making and production.

After having set out the guidelines, the course development team members spent two weeks on doing an initial plan for the curriculum and collecting information. Besides searching for what was to be included into the curriculum, the members also checked to see if any items were missing from the knowledge derivation process. At the second meeting, the members exchanged their ideas, determined the modules and collaboratively outlined a draft for the curriculum. In the following week, the draft was turned into a complete curriculum upon reviews and revision of the team members.

In order to provide the trainees with the basic industry-specific knowledge, the curriculum was divided into two parts, one for merchandising knowledge and the other for product knowledge. The first part was trade-oriented in nature. It included the modules of “Order knowledge”, “Merchandising operation workflow” and “Order follow-up practices”. These modules provided merchandisers with the essential knowledge for executing the administrative activities. The second part was product-specific in nature. It included the modules of “Product knowledge”, “Product making knowledge”, “Production knowledge”, “Material and sub-material knowledge” and “Production costs”. The knowledge provided by these modules was useful for merchandisers to manipulate the products which they were assigned to handle. Using cut-and-sewn woven items as examples, below are the modules of the curriculum and the major knowledge areas to be covered by each module:
1) Order Knowledge
   - Trade fundamentals
   - Order elements
   - Trade, delivery and payment terms

2) Merchandising Business Workflow
   - Kinds of retail operation
   - Product development and purchasing procedure
   - Production order processing procedure

3) Product Knowledge*
   - Categorizations of garment merchandise
   - Product terms
   - Sizes and measurements
   - Specification
   - Testing and safety regulations

4) Product Making Knowledge*
   - Pattern making fundamentals
   - Garment making fundamentals
   - Fitting standards and problems

5) Production Knowledge*
   - From product making to production
   - Production processes
   - Production defects

6) Materials*
   - From fibre to fabric
   - Fabric performance
7) Components and Trims*
   • Functionality
   • Applications

8) Production Costs*
   • Components
   • Ways of reducing production costs

9) Order Follow-up Practices
   • Issues to be followed up
   • Pre-production approvals
   • Sample inspection
   • Light box operation

Remarks: Those marked ‘*’ are product-specific modules.

The extended curriculum appears in Appendix 5-5.

1.5 Results

The merchandising managers and merchandisers who had participated in the study were invited to express their satisfaction with the curriculum which had subsequently been developed (Appendix 5-5). Each of them was asked to indicate a satisfaction score for each of the following three criteria on a scale of 1-10, with “1” indicating “very dissatisfied” and “10” “very satisfied”, to represent his/her satisfaction with the curriculum:

1) Extent of practicability of the content in helping entry-level merchandisers to perform the task,
2) Degree of ease of the module sequence for entry-level merchandisers in acquiring the knowledge, and,

3) Degree of appropriateness of the course structure for the training

The evaluation sheets which were used for the satisfaction surveys with the merchandising managers and the merchandisers are provided in Appendices 5-6 and 5-7.

30 merchandisers and all 14 merchandising managers responded to the survey. By taking the average of the individual scores, the overall customer satisfaction levels with the curriculum were derived and are shown as follows:

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Level of Satisfaction with the Curriculum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Merchandising Manager</td>
</tr>
<tr>
<td>Practicability of the content in helping</td>
<td>87.1%</td>
</tr>
<tr>
<td>entry-level merchandisers to perform the tasks</td>
<td></td>
</tr>
<tr>
<td>Ease of the module sequence for entry-level</td>
<td>83.6%</td>
</tr>
<tr>
<td>merchandisers in acquiring the knowledge</td>
<td></td>
</tr>
<tr>
<td>Appropriateness of the course structure for the</td>
<td>85.7%</td>
</tr>
<tr>
<td>training</td>
<td></td>
</tr>
</tbody>
</table>

Table 5-5: Overall customer satisfaction levels with the developed curriculum

The results of the survey showed that the customers were very satisfied with the developed curriculum. No individual score was below “7”, and, the levels of satisfaction with all three criteria of both the merchandising managers and merchandisers were over 82%. In particular, the levels of satisfaction with the content and the course structure were greater than 85%. Besides the scores, the
satisfaction survey received three comments and they were positive in nature. The first one was made by a merchandising manager. He claimed that the curriculum was fundamental and the training for the common techniques of order follow-up was useful for junior merchandisers mastering their jobs. The second one was made by a merchandiser. She commented that “product-specific” was the advantage of the curriculum as it could help her focus on the knowledge she needed to handle her products. The third one was also made by a merchandiser. She remarked that product-oriented training was a good idea as the arrangement allowed her to study different products by enrolling for the different modules.

Besides using the model, the high level of customer satisfaction with the developed curriculum obtained was also attributed to the professional knowledge and expertise of the two instructors and the enthusiasm of the merchandising managers and merchandisers. Although we could not conclude that the use of the model was the cause which led to the effect of attaining high level of customer satisfaction, the objectiveness, the logical flow and the appropriate use of the concerned parties’ knowledge of the process demonstrated that the model contributed to the development of a quality industrial training curriculum.

1.6 Reflections from Curriculum Development Team Members

After the study, the two instructors of the curriculum development team shared their experience on using the model. The first instructor reflected that she was mostly impressed with the process of analyzing the managers’ voices. Although the managers’ voices were not new to her, the process of interpreting their voices into performance needs and translating them into industrial knowledge was inspiring.
Instead of focusing on what ought to be taught, the process made her plan the curriculum from the perspective of the customers. She commented that such an approach to designing training could bring benefits to all parties concerned. Furthermore, she said that she would try to use this problem solving approach to design instructions. Unlike the first instructor, the second instructor claimed that the major benefit she gained from the study was the way of proposing subjects for the curriculum. She commented that although most of the subjects identified by the study should have been known to instructors, the logic of method and objective approach was useful for designing training curricula for the newly emerging jobs of the industry. Both instructors admitted that the curriculum was preliminary and there was much room for improvement. However, it was sufficient to serve as a guideline for instructional design. The first instructor added that the curriculum could be better designed if customers were involved in the drafting process. After all, they both admitted that they had had a good experience with the study and agreed that the model was useful for developing industrial training curricula.

2. **Field Application: Sample Measurement Checks**

2.1 **Aim**

The aim of this case was to illustrate the applicability of the model, with the focus being the identification of the important kinds of industrial knowledge and skills for meeting the learning needs of the job incumbents. It had the following three objectives:

1) To demonstrate how the model was applied to the development of an industrial training curriculum for meeting the performance requirements for a single task,
2) To provide evidence for supporting the effectiveness of the model in developing training curricula for meeting the industrial knowledge needs of the job incumbents, and,

3) To collect comments from the training practitioners on using the model

2.2 Background

The case was about a project of applying the model for improving an in-house training course of an internationally renowned trading company in Hong Kong. The purpose of the course was to teach the merchandising trainees how to carry out a garment sample measurement check, one of the two major tasks of sample inspection. As a provider of merchandising services, the merchandisers of the trading company had to perform dimensional and quality checks with the samples before sending them to the buyers for approval. The merchandisers had to perform proper sample checks so as to help product development and reduce quality problems. Sample inspection was a daily task of the junior merchandisers and sample measurement check was an important part of the basic training the company provided for the newly recruited merchandising trainees. The training for sample measurement checks which was provided by the company emphasized both inspection skills and knowledge of the common material and production defects. The approach was similar to that used for training the quality controllers to improve inspection efficiency. However, many merchandising trainees were fresh university graduates of various disciplines and their garment knowledge was limited. Not only was the nature of sample inspection different from that of bulk inspection, but the trainees’ backgrounds were also different from those of the quality controllers. The company realized that the former training methods were inadequate for enhancing
the merchandising trainees’ competency to perform sample measurement checks. In order to solve this problem, the aim of the project was to apply the model to design a new training content for assisting the merchandising trainees to learn how to perform sample measurement checks for garments.

2.3 Procedure

The project was implemented in October 2006. A project team was formed, and it included the training manager, the course instructor and the author as the members. The project was completed in a month’s time and the new course content was tested in a trial run in February 2007. The applied portion of the curriculum development model for this case is indicated in Figure 5-15.
Figure 5-15: Applied portion of the model for the case of sample measurement checks
2.3.1 Defining performance requirements

Three merchandising managers were invited by the training manager to attend a brainstorming session. In the brainstorming session, the managers were asked to express their performance requirements for sample measurement checks. The managers’ statements were recorded in note form as close to the original as possible. Using an affinity diagram, the statements were reworded and grouped into a meaningful structure to represent the performance requirements for sample measurement checks. After further discussion and review of the structure, the managers finally agreed that the performance goal, or the primary performance requirement, for sample measurement checks was “Measure accurately”. This performance goal consisted of two performance objectives, or secondary performance requirements: (1) “Measure with appropriate techniques”, and (2) “Measure at the right positions”. Figure 5-16 exhibits the affinity diagram which was used by the merchandising managers to organize their voices into the performance requirements for sample measurement checks.
Measure Accurately

Measure with Appropriate Techniques

- Know how to take measurements on curve
- Know how to take measurements for elastic and stretchable items
- Able to use different tools to assist in taking measurements
- Do not press too hard when taking measurements for bulky materials

Measure at the Right Position

- Know how to specify how the measurements to be taken if not supplied on the given spec
- Fully understand how each item or position to be measured
- Know where the measurements are to be taken, e.g., pocket and pocket position

Figure 5-16: Affinity diagram for the performance requirements for sample measurement checks
Having agreed upon the structure, each of the three merchandising managers was asked to assess the relative importance of the two secondary performance requirements in respect to the primary performance requirement. Using AHP, the responses of the merchandising managers were entered into the group model of ExpertChoice® to calculate the weights of importance of the two performance objectives in respect to the primary performance goal. Figure 5-17 displays the performance requirement hierarchy for sample measurement checks, with the relationship of the components and the respective weights of importance as indicated.

![Figure 5-17: Performance requirement hierarchy for sample measurement checks](image)

2.3.2 Generating subject alternatives

The author and the training manager paid a gemba visit to the second lesson of the current training course to collect information about the situation of actual learning of the trainees. During the class, the trainees were observed to see how they conducted sample measurement checks. After the class, several trainees were interviewed so as to understand the difficulties which they had experienced when learning how to perform sample measurement checks. With the aim of exploring the possible subjects to be required by the trainees to perform sample measurement checks, the author, training manager and instructor used a conversion table to reword and interpret the information collected during the gemba visit. Tables 5-6 and 5-7
exhibit the conversion tables of processing the information collected from the *gemba* for skill and knowledge extraction. Using an affinity diagram (Figure 5-18), the extracted skills and knowledge were grouped into the following five subjects, which were the alternatives for achieving the performance objectives of sample measurement checks:

1) Measuring techniques
2) Basic measurements
3) Garment and human figure
4) Clothing terminology
5) Fundamental knowledge of pattern making
<table>
<thead>
<tr>
<th>Trainee</th>
<th>Sample Being Measured</th>
<th>Scenario</th>
<th>Trainee’s Raised Question</th>
<th>Reworded into Positive Statement</th>
<th>Extracted Meaning from Reworded Statement</th>
<th>Related Knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sharon</td>
<td>Style MWV-10 Men's woven dress shirt</td>
<td>What is &quot;sleeve muscle&quot;?</td>
<td>I want to know what sleeve muscle is.</td>
<td>I need to know the definition of sleeve muscle.</td>
<td>Definitions of measurements</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>I need to know where sleeve muscle is.</td>
<td>I need to know the position of sleeve muscle.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>I need to know the measurement points for sleeve muscle.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>I need to know how to measure the sleeve muscle.</td>
<td>I need to know the technique for measuring the sleeve muscle.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Techniques for measuring various positions of sleeve</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>She was going to measure the front length of the shirt.</td>
<td>What does &quot;from HPS&quot; mean?</td>
<td>I want to know the full version for the abbreviation of &quot;HPS&quot;.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>I need to know what &quot;HPS&quot; stands for.</td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>I need to know the position of high point shoulder.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Reference points of human figures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mewan</td>
<td></td>
<td>What is &quot;shoulder slope&quot;?</td>
<td>I want to know what the shoulder slope is.</td>
<td>I need to know the definition of shoulder slope.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>I need to know where the shoulder slope is.</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>I need to know the measurement points for shoulder slope.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Measurements points for shoulder slope.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Techniques for measuring various positions of shoulder slope.</td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Geometry for lines and angles</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Shoulder construction</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>The meaning of shoulder slope was explained.</td>
<td>Is it measured along the edge of shoulder?</td>
<td>I need to know the function of shoulder slope to the shoulder construction.</td>
<td></td>
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</tr>
<tr>
<td></td>
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<td></td>
<td>I need to know where the shoulder slope is.</td>
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<td>I need to know the measurement points for shoulder slope.</td>
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<td></td>
<td>Techniques for measuring various positions of shoulder.</td>
<td></td>
<td></td>
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<tr>
<td></td>
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<td></td>
<td></td>
<td>Reference lines of human figures</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>What is “across back (5” below HPS)”?</td>
<td>I want to know what across back is.</td>
<td>I need to know the definition of across back.</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>I need to know where across back is.</td>
<td></td>
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<tr>
<td></td>
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<td></td>
<td></td>
<td>I need to know the measurement points for across back.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Measurement points for upper bodice</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Techniques for measuring various positions of shirt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chang</td>
<td>He was pointing to the width of a sleeve placket of the shirt.</td>
<td>Is this the depth of sleeve pleat?</td>
<td>I want to know which component of the sleeve is the sleeve pleat.</td>
<td>I need to know the components of a sleeve.</td>
<td></td>
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<tr>
<td></td>
<td></td>
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<td>I need to know what &quot;depth&quot; means.</td>
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<td></td>
<td>I need to know the meaning of the dimension of depth.</td>
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<td></td>
<td>Dimensions</td>
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<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>I need to know how to measure the depth of the sleeve pleat.</td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Techniques for taking measurements of different dimensions</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>How to measure the front and back neck drops?</td>
<td>I want to know what front and back neck drops are.</td>
<td>I need to know the definitions of front and back neck drops.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>I need to know the measurement points for front and back neck drops.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Measurement points for neck drops.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>It was explained to him that the neck drops had to be measured from the imaginary line.</td>
<td>How to locate the imaginary line?</td>
<td>I need to know where the imaginary line is.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>I need to know the position of imaginary line.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Reference lines of human figures</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>I need to know how to fix the imaginary line.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Techniques for taking measurements of different positions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dui</td>
<td>He had some difficulties with using the measuring tape to measure the armhole on curve.</td>
<td>I want to know how to take the curve measurement of armhole.</td>
<td>I need to know the technique for taking curve measurements.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Techniques for taking curve measurement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shawn</td>
<td>Why is the neck opening (seam to seam) measured straight across the neck instead of along the curve of the neckline?</td>
<td>I want to know what the neck opening is.</td>
<td>I need to know the definition of neck opening.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>I need to know why the measurement of neck opening is required.</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>I need to know the function of neck opening to the neckline construction.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(To Be Continued)
<table>
<thead>
<tr>
<th>Trainee</th>
<th>Sample Being Measured</th>
<th>Scenario</th>
<th>Trainee’s Raised Question</th>
<th>Reworded into Positive Statement</th>
<th>Extracted Meaning from Reworded Statement</th>
<th>Related Knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Archie</td>
<td>Style MWV-03 Men's woven casual pants</td>
<td>What is &quot;3-point seat&quot;?</td>
<td>I want to know what &quot;3-point seat&quot; is.</td>
<td>I need to know the definition of 3-point seat.</td>
<td>Definitions of measurements</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>I want to know where &quot;3-point seat&quot; is.</td>
<td>I need to know the position of 3-point seat.</td>
<td>Reference lines of human figures</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>I want to know how to take the V-measurement of &quot;3-point seat&quot;.</td>
<td>I need to know the technique for taking V-measurements.</td>
<td>Techniques for taking V-measurement</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Why we take a V-measurement instead of straight measurement for the seat?</td>
<td>I need to know the girth of the 3-point seat on the human figure.</td>
<td>Reference lines of human figures</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>What is &quot;welt pocket&quot;?</td>
<td>I need to know the components of a pocket.</td>
<td>Pocket components</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>I am confused with &quot;back welt pocket length&quot; and &quot;back pocket bag length&quot;.</td>
<td>I need to know the meaning of the dimension of length.</td>
<td>Dimensions</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>I want to know whether the dimension of length is always referred to the vertical direction.</td>
<td>I need to know the construction of a welt.</td>
<td>Welt construction</td>
<td></td>
</tr>
<tr>
<td>Andy</td>
<td></td>
<td>Where is the crotch?</td>
<td>I want to know where the crotch is.</td>
<td>I need to know the position of the crotch on the pants.</td>
<td>Terminology of pants</td>
<td></td>
</tr>
<tr>
<td>Minnie</td>
<td>Style WWK-02 Ladies' knitted pullover</td>
<td>What is &quot;rigid waist at top edge&quot;?</td>
<td>I want to know whether there are cases that the waist is not rigid.</td>
<td>I need to know the waist types.</td>
<td>Waist types</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>I want to know whether there are cases that the waist is not measured at the top edge.</td>
<td>I need to know the measurement positions of different waist types.</td>
<td>Waist construction</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>What is a dart?</td>
<td>I need to know the definition of a dart.</td>
<td>Basic garment parts</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>I want to know why dart is required.</td>
<td>I need to know the functions of a dart.</td>
<td>Mechanisms for creating shapes and fullness of garments</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Should I measure the thigh from edge to edge or from seam to seam of the front leg panel?</td>
<td>I need to know the girth of the thigh on the human figure.</td>
<td>Reference lines of human figures</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>What is &quot;fly J-stitch length&quot;?</td>
<td>I need to know the definition of &quot;fly&quot;.</td>
<td>Terminology of pants</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>I want to know what a &quot;fly&quot; is.</td>
<td>I need to know the definition of &quot;fly J-stitch&quot;.</td>
<td>Terminology of pants</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>I want to know the measurement points for &quot;fly J-stitch&quot;.</td>
<td>I need to know the measurement points for &quot;fly J-stitch&quot;.</td>
<td>Assembly methods</td>
<td></td>
</tr>
<tr>
<td>Shadow</td>
<td></td>
<td>She was going to measure the back neck height.</td>
<td>What does &quot;1x1 rib included 3/8&quot; tubular&quot; mean?</td>
<td>I need to know the components of a turtle neck.</td>
<td>Collar components</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>I want to know where the back neck is.</td>
<td>I need to know the knitting stitch types.</td>
<td>Stitch patterns of knit</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>I want to know what 1x1 rib is.</td>
<td>I need to know the assembly features of knitted garments.</td>
<td>Assembly methods</td>
<td></td>
</tr>
</tbody>
</table>

Table 5-6: Conversion table for translating information collected from class observation into subject alternatives for the training of sample measurement checks
<table>
<thead>
<tr>
<th>Trainee</th>
<th>Comment</th>
<th>Reworded into Positive Statement</th>
<th>Extracted Meaning from Reworded Statement</th>
<th>Related Knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Erica</td>
<td>I think I understand what collar point is, but I am not that sure about its exact position when I refer to the garment.</td>
<td>I need to get familiar with the measurement points for a collar.</td>
<td>I need to get familiar with the measurement points for the components of different types of garments.</td>
<td>Measuring points for components of garment parts</td>
</tr>
<tr>
<td>Yuki</td>
<td>There are many short terms that I do not understand, e.g. CF, HPS, etc.</td>
<td>I need to know the abbreviations that are commonly used on garment specifications.</td>
<td>I need to learn the abbreviations that are commonly used for garment specifications.</td>
<td>Abbreviations used for specifications</td>
</tr>
<tr>
<td>Andy</td>
<td>Take the hip measurement as an example, some specifications call it &quot;3-point seat&quot; but some call it &quot;low hip&quot;. It makes me confused.</td>
<td>I need to know the common names of hip measurement that are used for garment specifications.</td>
<td>I need to learn the common names of each measurement that is commonly used for garment specifications.</td>
<td>Different common names of measurements</td>
</tr>
<tr>
<td>Shawn</td>
<td>For those bulky and slippery garments, I do not have much confidence that the measurements being taken are accurate.</td>
<td>I need to learn the skills for measuring bulky and slippery garments.</td>
<td>I need to learn the skills for measuring garments of different textures.</td>
<td>Techniques for measuring garments of different textures</td>
</tr>
<tr>
<td>Jason</td>
<td>I know the meaning of thigh but I do not know the meaning of crotch.</td>
<td>I need to learn the terminology of a pair of pants.</td>
<td>I need to learn the terminology of different types of garments.</td>
<td>Terminology of garment types</td>
</tr>
</tbody>
</table>

Table 5-7: Conversion table for translating information collected from interviews with trainees into subject alternatives for the training of sample measurement checks
Garment and Human Figure

Reference Points and Lines of Human Figures
- Reference points of human figures
- Reference lines of human figures

Mechanism for creating shapes and fullness of garments
- Geometry for lines and angles
- Dimensions

Figure 5-18: Affinity diagram for the subject alternatives for the training of sample measurement checks
Basic Measurements

Different Common Names of Measurements

Abbreviations Used for Specifications

Definitions of Measurements

Measurement Points for Garment Parts
  - Measurement points for upper bodice
  - Measurement points for sleeve
  - Measurement points for shoulder

Measurement Points for Components of Garment Parts
  - Measurement points for neck drops
  - Measurement points for 3-point seat
  - Measurement points for “fly J-stitch”

Figure 5-18: Affinity diagram for the subject alternatives for the training of sample measurement checks
Figure 5-18: Affinity diagram for the subject alternatives for the training of sample measurement checks
Fundamental Knowledge of Pattern Making

Construction of Garment Parts

- Waist construction
- Welt construction
- Neckline construction
- Shoulder construction

Figure 5-18: Affinity diagram for the subject alternatives for the training of sample measurement checks
Figure 5-18: Affinity diagram for the subject alternatives for the training of sample measurement checks
2.3.3 Prioritizing subject alternatives for meeting performance requirements

On the third lesson of the training course, a survey was conducted with the trainees to identify which of the five subject alternatives were important for them to achieve the performance requirements for sample measurement checks. For each given pair of subject alternatives, the trainee was asked to make a comparison of the importance for him/her to achieve each of the two performance objectives for sample measurement checks. Appendix 5-8 is the questionnaire which was used to collect the merchandising trainees’ opinions. In order to assist the trainees to make the pairwise comparisons, the questionnaire was supplemented with definitions specifying the scope of each of the five subject alternatives. To ensure that the questionnaire was properly designed, the training manager invited two assistant merchandisers to complete the questionnaire and sought their comments before the survey. In the class, the author explained to the trainees how to complete the questionnaire before they started to answer it. 20 copies of the questionnaire were distributed and they were all completed and collected. The responses were put into the group model of ExpertChoice® to synthesize the priorities for the five subject alternatives. Below are the weights of importance of the subject alternatives for meeting the performance requirements for sample measurement checks:

![Figure 5-19: Weights of importance of the subject alternatives for meeting the technical performance requirements for sample measurement checks](image-url)
2.4 Curriculum Development

Figure 5-20 shows the completed curriculum development model for sample measurement checks, indicated with the weights of importance for the performance objectives and subject alternatives.

The project team held a meeting to interpret the results of the survey and discuss how to redesign the course content.
Figure 5-20: Completed industrial training curriculum development model for sample measurement checks
2.4.1 Information derived from the survey

The two highest scoring subject alternatives were “Measuring techniques”, and “Basic measurements”, with 28.5% and 25.0% respectively. This indicated that, from the merchandising trainees’ point of view, these two subjects were important for them to achieve the performance requirements for sample measurement checks. In fact, these two subjects were expected to be important to the trainees, as they needed to know what was to be measured and how to take the measurements.

There was a new insight from the results of the survey. “Garment and human figure”, an area which was not emphasized in the current training course, turned out to be in third place of importance (20.3%). Although the terms such as high point shoulder, pleat and dart were mentioned from time to time in the classes, it seemed that the trainees wanted to have a more comprehensive understanding about the reference points and lines of the human figures as well as the mechanisms for creating the shapes and fullness in order to fully understand about garment measurements. This was an important piece of information obtained from the survey for improving the training course.
Figure 5-21: Performance of the five subject alternatives for meeting the two performance objectives of sample measurement checks

The graph displayed above shows how well each of the five subject alternatives performed with respect to each of the two performance objectives of sample measurement checks. From the graph, it may be seen that the top three subject alternatives, “Measuring techniques”, “Basic measurements” and “Garment and human figure”, could satisfactorily meet the two performance objectives of “Measure with appropriate techniques” and “Measure at the right positions”.

The order of importance of the subjects did not directly influence factors such as the teaching sequence or the allocation of time for them. It only highlighted the areas on which the training course should focus.

2.4.2 Content design

The project team members agreed that the approach would be more appropriate if a theoretical background was provided before the trainees started to practice. Table
5-8 shows the changes that were made to the training course content. With the number of training hours remaining unchanged, the subjects and the teaching sequences were revised with the aim of assisting the trainees to learn the required skills and industrial knowledge more easily. Whilst the subject of “Defects of clothing items” was removed, an introduction to sample measurement checks and a new subject, “Garment and human figure”, was added to the course. “Garment and human figure” would be taught before the subject of “Basic measurements” and the practical sessions. However, clothing terminology, an essential knowledge area for the new entrants of the industry, would be covered in some other courses of the merchandising trainee programme.

<table>
<thead>
<tr>
<th>Original Course Content</th>
<th>New Course Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject</td>
<td>Method</td>
</tr>
<tr>
<td>Basic measurements</td>
<td>Lecture</td>
</tr>
<tr>
<td>Measuring techniques and practice</td>
<td>Practice</td>
</tr>
<tr>
<td>Defects of clothing items</td>
<td>Lecture</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Total:</td>
<td></td>
</tr>
</tbody>
</table>

Table 5-8: Comparison of the original and new course contents for the training of sample measurement checks

The instructor redesigned the instruction for the training course according to the agreed changes. She retained the useful topics and added some new elements to make it easier for the required knowledge and skills to be learnt by the trainees. The revised course outline for the training of sample measurement checks is exhibited in Appendix 5-9. A trial run was performed with the newly prepared
2.5 Discussion

The new training course received positive feedback from the trainees. In the last session of the trial run, the training manager and the author paid a visit to the class. It was a practical session. When compared to the original course, it was observed that the trainees had fewer problems when checking the sample measurements. Most of them demonstrated their mastery of skills for measuring samples. In the class of 30 trainees, 25 obtained over 90% correct measurements and the remaining 5 obtained over 82% correct measurements with the given samples. Furthermore, the course evaluation revealed that 85% of the trainees indicated they were confident that they could perform sample measurement checks competently. Compared to only 52% of the October class, an increase of 30% was recorded. The understanding of the task purposes, the basic principles of garment construction and the mastery of measuring skills were believed to be the major reasons that increased the trainees’ confidence. In addition to the professionalism of the instructor, the instructional design and the subject delivery, the training manager believed that the application of the model was another factor influencing the outcome, as it effectively identified the important subjects that the trainees had to learn in order to perform sample measurement checks competently.

Besides learning improvement, positive feedback was also received from the training manager and the instructor. The training manager stated that the model assisted him in acquiring a greater understanding about the performance required by the merchandising managers and the knowledge which the merchandisers wanted to
learn as well. He pointed out that the brainstorming session with the merchandising managers and the class observation of the trainees provided him with many new insights. The instructor claimed that it was a good opportunity for her to review and to rethink how she could help the trainees to learn the required skills and knowledge more easily. She added that the extraction process was a good exercise for her to discover some knowledge areas which she had overlooked. Both of them claimed that this project was beneficial for them to improve their skills and knowledge for curriculum development. Upon application, they both found that the model was effective for designing industrial training courses and so they would use it to develop a new course of sample quality checks, another task of sample inspection.

3. **Field Application: Material sourcing and Vendor Sourcing**

3.1 **Aim**

The aim of this case was to illustrate the applicability of the model, with the focus on programme planning and content organization of industrial training for meeting the knowledge needs of job incumbents. It had the following three objectives:

1) To demonstrate how the model was applied to the development of industrial training curriculum for meeting the performance requirements for multiple tasks,

2) To provide evidence for supporting the effectiveness of the model in planning programme curricula, and,

3) To collect comments from the training practitioners on using the model.
3.2 Background

The case was about a project of applying the model for planning an in-house training programme for a garment buying office in Hong Kong. For this buying office, material sourcing and vendor sourcing were two major tasks which the merchandisers had to perform competently. On the one hand, they needed to source reliable and capable vendors to produce the buyers’ orders. On the other hand, they had to be able to offer suitable and competitive materials, such as fabrics and trims, to buyers for product development. In view of the growing importance of sourcing to company’s business development, the buying office decided to offer a training programme for enhancing the competency of its merchandisers for performing these two tasks. The aim of the project was to plan this training programme. It was expected that the use of the model could assist in preparing the training outline and planning the programme structure.

3.3 Procedure

The project was conducted in June 2007 and completed in two months. A project team was formed which consisted of four members: the training manager, two senior merchandising managers, who were the advisors of the programme, and the author. The applied portion of the industrial training curriculum development model for this case is indicated in Figure 5-22.
Figure 5-22: Applied portion of the model for the case of material sourcing and vendor sourcing
3.3.1 Defining performance requirements

The training manager organized two brainstorming sessions with the purpose of understanding the merchandising managers’ technical performance requirements for the two sourcing tasks. For the first brainstorming session, five merchandising managers of the product development teams were invited to share their ideas on the technical performance requirements for material sourcing. For the second brainstorming session, four merchandising managers of the order follow-up teams were invited to express their opinions on the technical performance requirements for vendor sourcing. For each sourcing task, the managers structuralized their voiced needs into a performance requirement hierarchy using the technique of affinity diagram. Figures 5-23 and 5-24 show the respective affinity diagrams for material sourcing and vendor sourcing.
Offer Suitable Materials to Buyers

Add Value to Merchandise
- The material could meet the designer’s aesthetic needs
- The material could achieve the effects the designer wants
- The material could achieve the textures the designer desires
- The material could achieve the end uses of the garment

Meet Regulations and Standards
- Know safety regulations
- Know material standards

Avoid Production Problems
- Know the production lead-time of the offered material
- Know the characteristics of the offered material
- Know the order minimum of the offered material
- Know if the offered material could meet the target price
- Could foresee potential problems of the offered material in garment production

Figure 5-23: Affinity diagram for the technical performance requirements for material sourcing
Identify Appropriate Vendors for Merchandise Production

Know if Vendors have Required Facilities
- Know if the vendor has the machine to perform certain stitches or embroidery
- Know if the vendor has the set up to perform the required printing or washing processes

Know if Vendors have Required Technologies
- Know if the vendor has the crochet workers for sweater production
- Know if the patter maker skill could meet the buyer’s requirements
- Know the general skill level of the workers of the vendor

Know if Vendors have Required Skills
- Know if the vendor has new printing technology for T-shirt production
- Know if the vendor has new washing methods for sweater or jean production
- Know if the vendor has new method or technology for bra production

Figure 5-24: Affinity diagram for the technical performance requirements for vendor sourcing
Upon agreeing the structure of the performance requirement hierarchy, the managers prioritized the importance of the secondary-level performance criteria to the first-level performance goal, using the pairwise comparison technique of AHP. The responses of the merchandising managers were entered into the group model of ExpertChoice® to calculate the weights of importance of the performance objectives in respect to the primary performance goal. Figures 5-25 and 5-26 show the technical performance hierarchies for material sourcing and vendor sourcing respectively.

![Figure 5-25: Technical performance requirement hierarchy for material sourcing](image)

![Figure 5-26: Technical performance requirement hierarchy for vendor sourcing](image)

### 3.3.2 Suggesting relevant industrial knowledge areas

After each brainstorming session, the project team members discussed the kinds of industrial knowledge which were useful for meeting the technical performance requirements of the sourcing task. Using a conversion table, the project team members derived a list of relevant industrial knowledge areas from the collected managers’ voices for achieving the required technical performance. Tables 5-9 and
5-10 illustrate examples of this conversion process.

<table>
<thead>
<tr>
<th>Managers’ Voices</th>
<th>Reworded into Positive Verbatim</th>
<th>Extracted Meanings</th>
<th>Derived Industrial Knowledge Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>They should not offer those fabrics that contain potential production problems.</td>
<td>Merchandiser could be able to foresee potential production problems with the offered fabrics.</td>
<td>Should have the ability of predicting the potential problems with garment production from fabrics</td>
<td>Principles of fabric construction, Material Knowledge</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Common defects with materials</td>
<td>Material Defects</td>
</tr>
<tr>
<td></td>
<td>Should know the common problems with the production of fabrics</td>
<td>Common defects found on fabrics</td>
<td>Material Knowledge</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Manufacture of fabrics</td>
<td>Material Production</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Weaving methods, techniques and technology</td>
<td>Material Production</td>
</tr>
</tbody>
</table>

Table 5-9: **An example of translating managers’ voices on technical performance requirements into relevant kinds of industrial knowledge areas for material sourcing**
### Table 5-10: An example of translating managers’ voices on technical performance requirements into relevant kinds of industrial knowledge areas for vendor sourcing

Below are the industrial knowledge areas suggested for meeting the technical performance requirements for material sourcing and vendor sourcing.

<table>
<thead>
<tr>
<th>Managers’ Voices</th>
<th>Reworded into Positive Verbatim</th>
<th>Extracted Meanings</th>
<th>Derived Industrial Knowledge Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>I could give you an example on a quality problem that happened to my blouse. The vendor did not have the skilled worker to operate the embroidery machine as it had been borrowed from another vendor.</td>
<td>Merchandisers should know how to assess the vendor’s conditions to prevent quality problems.</td>
<td>Should know the common quality problems associated with their merchandise that may arise from production</td>
<td>Quality problems</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Should know the vendor conditions that contribute to the quality of their merchandise</td>
<td>Workers’ skills</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Kinds of machine</td>
</tr>
</tbody>
</table>

**Material Sourcing:**

1) Material production
2) Material knowledge
3) Material defects
4) Garment production
5) Garment costing
6) Regulations and material testing
Vendor Sourcing:  
1) Garment assembly quality  
2) Garment production quality  
3) Garment production machinery  
4) Garment processing technologies  
5) Garment production  
6) Material knowledge  
7) Garment defects

3.3.3 Prioritizing suggested industrial knowledge areas for meeting performance requirements

Two questionnaire surveys were conducted to collect opinions from the merchandisers on the importance of the suggested industrial knowledge areas for meeting the technical performance requirements for each of the two sourcing tasks. For each task, the merchandisers were asked to make pairwise comparisons on the importance of the suggested industrial knowledge areas for meeting each performance objective. Upon pilot testing, the two questionnaires were distributed to two different groups of merchandisers. A briefing session was held to explain the purpose of the survey and how to complete the questionnaires. The author contacted each of the merchandisers who had not attended the briefing session by phone to see if they had any questions concerning the survey or any problem with completing the questionnaire. Copies of the two questionnaires are provided in Appendices 5-10 and 5-11. In a week’s time, 17 completed questionnaire copies of material sourcing and 14 completed questionnaire copies of vendor sourcing were collected. The collected data were processed using the software of ExpertChoice® to calculate the weights of importance of the suggested industrial knowledge areas.
Below are the weights of importance of the suggested industrial knowledge areas for meeting the technical performance requirements for material sourcing and vendor sourcing obtained from the surveys.

**Figure 5-27:** Weights of importance of the suggested industrial knowledge areas for meeting the technical performance requirements for material sourcing

**Figure 5-28:** Weights of importance of the suggested industrial knowledge areas for meeting the technical performance requirements for vendor sourcing

### 3.4 Curriculum Development

Figures 5-29 and 5-30 show the respective completed models for material sourcing and vendor sourcing, indicated with the weights of importance for the performance objectives and suggested industrial knowledge areas.
Figure 5-29: Completed industrial training curriculum development model for material sourcing
Figure 5-30: Completed industrial training curriculum development model for vendor sourcing
3.4.1 Information derived from the surveys

After discussion, the project team members agreed that an industrial knowledge area was considered to be important when it could meet all the technical performance requirements satisfactorily.

For material sourcing, the following four industrial knowledge areas properly met the three performance objectives:

1) Garment production (20.8%)
2) Garment costing (19.4%)
3) Material knowledge (16.6%)
4) Material defects (16.5%)

For “Regulations and material testing” (15.6%) and “Material production” (11.1%), although they met the performance objective of “Meet regulations and standards”, they failed in meeting those of “Add value to merchandise” and “Avoid production problems”. Figure 5-31 displays the performance of the six suggested industrial knowledge areas for meeting the three performance objectives of material sourcing.
Figure 5-31: Performance of the six suggested industrial knowledge areas for meeting the three performance objectives of material sourcing

The results of the survey revealed that merchandisers considered the industrial knowledge of garment production and costing was more important than that of materials for the task of material sourcing even though the latter had been assumed to be the key training area.

For vendor sourcing, the following three industrial knowledge areas properly met the three performance objectives:

1) Garment assembly quality (22.6%)
2) Garment production quality (18.4%)
3) Garment processing technologies (14.2%)

“Garment defects” (13.4%) met the performance objectives of “Know if vendors have required technologies” and “Know if vendors have required skills” but failed in meeting the performance objective of “Know if vendors have required facilities”. “Garment production” (11.0%), “Garment production machinery” (10.8%) and
“Material knowledge” (9.5%) met the performance objective of “Know if vendors have required technologies” but failed in meeting the performance objectives of “Know if vendors have required facilities” and “Know if vendors have required skills”. Figure 5-32 shows the performance of the seven suggested industrial knowledge areas for meeting the three performance objectives of vendor sourcing.

Figure 5-32: Performance of the seven suggested industrial knowledge areas for meeting the three performance objectives of vendor sourcing

The results of the survey showed that the merchandisers considered learning garment quality, including that of assembly and production, important as this would assist them in assessing vendors’ potential to prevent quality problems. They also considered knowing the garment processing technologies, including those of washing and printing, to be important as this would be an important factor for adding value and enhancing quality for buyers.
3.4.2 Programme planning

The project team members grouped the seven industrial knowledge areas identified according to four main subject areas:

<table>
<thead>
<tr>
<th>Subject Area</th>
<th>Industrial Knowledge Areas To Be Covered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production</td>
<td>Garment production, Garment processing technologies</td>
</tr>
<tr>
<td>Quality</td>
<td>Garment assembly quality, Garment production quality</td>
</tr>
<tr>
<td>Material</td>
<td>Material knowledge, Material defects</td>
</tr>
<tr>
<td>Costing</td>
<td>Garment costing</td>
</tr>
</tbody>
</table>

Table 5-11: Four main subject areas of the training programme for material sourcing and vendor sourcing

All team members agreed that the training would be more related to the merchandisers’ job needs if the programme was delivered according to product lines, but the workload of preparing training materials and availability of suitable trainers would be the potential problems of the programme. As a consequence, instead of arranging for the programme to be solely delivered by the company, the training manager stated that she would check to see if it would be financially feasible to outsource the delivery of some of the subjects and/or classes.

In view of the task nature of material sourcing and vendor sourcing, the team members decided to use a problem prevention approach to design and organize the content. With regard to the four subject areas, the team members worked out the following preliminary training outline:
<table>
<thead>
<tr>
<th>Content</th>
<th>Format</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality requirement</td>
<td>Workshop</td>
<td>3 hours</td>
</tr>
<tr>
<td>From exploring the quality requirements of the product to defining the quality requirements of materials and production processes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic Production Process</td>
<td>Lecture &amp; Factory Visit</td>
<td>3 hours &amp; 2 visits</td>
</tr>
<tr>
<td>Key assembly or knitting process for turning materials into products</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Processing Technologies</td>
<td>Lecture &amp; Factory Visit</td>
<td>3 hours &amp; 2 visits</td>
</tr>
<tr>
<td>Common methods of washing, dyeing and printing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Materials</td>
<td>Lecture</td>
<td>12 hours</td>
</tr>
<tr>
<td>Common kinds of materials used for the product, including their manufacture processes, types, characteristics and uses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Garment Costing</td>
<td>Workshop</td>
<td>3 hours</td>
</tr>
<tr>
<td>Components of production costs and various ways of reducing the production costs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Defects</td>
<td>Lecture &amp; Workshop</td>
<td>6 hours</td>
</tr>
<tr>
<td>Garment defects, material defects, production defects, processing defects, etc.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5-12: Preliminary training outline for material sourcing and vendor sourcing

3.5 Discussion

The project received positive feedback from the training manager of the buying office. She claimed that there were several advantages to using the model for the project. First, and also foremost, the model offered an objective approach for identifying the needs and designing the training content. Instead of mixing up the personal performance and job performance of job incumbents, the discussion and the importance weighting exercise of the brainstorming session helped the merchandising managers to clarify exactly what they expected the merchandisers to
achieve for a particular task. Rather than directly ask the managers to suggest the subjects, their knowledge and experience could be used in a more constructive way if they were led to think about what would be useful for meeting the performance requirements. Besides, the surveys with the merchandisers could remove subjective opinions of a few dominant persons, and, the formation of project team was effective in consolidating different opinions and generating new ideas for the programme. Last but not least, the involvement of both the merchandising managers and the merchandisers could increase their acceptance of and support for the training, which would be a great advantage for programme implementation.

The project also received positive feedback from the two programme advisors. One of them claimed that the results of the merchandiser surveys made her realize that what was important to the merchandisers was different from what she had assumed. Another advisor claimed that the meetings were innovative and fruitful. The discussion between the project team members could stimulate some new ideas for meeting the needs of the management and the staff. Furthermore, the systematic approach efficiently framed the preliminary outline of the programme in only a few weeks. Both advisors and the training manager claimed that the initial task division for collecting performance requirements and final integration of the subject areas was useful for training development in the fast changing environment.
Chapter 6

Conclusion
1. **Summary**

This study contributes to industrial training curriculum development literature. Firmly adhering to the QFD principles and characterized by the performance-focused and job-incumbent-centred approach, the developed model is particularly suitable for developing industrial training curricula. In the face of the increasing knowledge content of the jobs and the educated workforce, the job incumbent’s participation in industrial training curriculum development is necessary. Individuals are the primary customers, or the users, of the training whilst employers are the secondary customers, or the users of individuals’ competency. They are partners and they play different roles in the curriculum development process. Recognizing the importance of dually meeting the job performance requirements and the knowledge needs of the incumbents, the model emphasizes that both the employers’ and individuals’ voices have to be carefully listened to and provides a mechanism for appropriately incorporated the voices into the development process so as to yield a curriculum that would satisfy the respective needs of the two parties. On the demand side, employers are invited to define the “Whats”, the technical performance requirements of the job incumbents’ tasks, and, job incumbents are asked to identify the important “Hows”, the kinds of industry-specific knowledge for meeting the “Whats”. On the supply side, it is the industrial training practitioners’ job to interpret the managers’ voices into “Whats”, to translate the “Whats” into “Hows” and to synthesize the important “Hows” identified by the job incumbents into a coherent curriculum. The deployment process of the model provides the curriculum developers with the opportunity of applying their expertise whilst the team approach stimulates interaction between the team members and fosters innovation for making improvement. Through logical task appropriation, the model creates an all-win
situation for the parties concerned. The employers and the individuals, the industrial training institutions and the industry all are the beneficiaries of the resultant virtuous cycle.

The results of the empirical studies provide evidence for demonstrating the model’s effectiveness in developing quality industrial training curricula and its practicability in actual implementation. On the one hand, the quasi-experiment revealed that the customer satisfaction levels obtained by the industrial training curriculum developed by using the model were over 82%. We could not claim such customer satisfaction levels are “high” or “low” as this would require a comparison with other methodologies or curricula. However, these are numerical data for showing that the model was able to develop quality industrial training curricula for meeting the customers’ needs. On the other hand, a number of positive comments were received from those who had used the model in the empirical studies. Major advantages of the model include the deployment process enhances the practitioners’ understanding with customers’ needs, the objective and systematic approach increases the convincingness of the developed curricula, and, the customers’ participation in the development process increases their support of the training. These advantages, which have been summarised from feedback provided by the users of the model, provide practical evidence to illustrate that the model is useful for developing industrial training curricula.

2. **Managerial and Practical Implications**

Taken as a whole, this study provides an effective and practical methodology for industrial training providers to develop curricula, plan programmes and design
courses. The model is applicable to the planning of in-house training programmes and the designing of training courses for individual companies; hence the deployment method could further help the authorities to establish industry-wide curricula. For example, the former part of the model could be incorporated into the process of specifying the competency standards of the Qualifications Framework, and, the latter part of the model could be employed by industrial training institutions to develop public courses for the industry to assist the incumbents of various job categories in acquiring the qualifications.

The applicability of the model could be extended to other training and education areas when adaptations and modifications are appropriately made. Practically, the model is equally applicable to developing industrial training curricula for various service-oriented manufacturing industries, such as electronics and toys, other than clothing industry; and, other knowledge-based job incumbents, such as purchasers and sales representatives, besides garment merchandisers. Conceptually, the performance-focus approach could be employed to develop industrial training curricula for skill-based job incumbents as well as other kinds of company training. In a similar vein, the job-incumbent-centred approach could be adapted to develop industrial training curricula for the production-oriented manufacturing industries as well as the newly emerged service industries, and, this approach could be transferred to develop vocational education curricula as well.

3. Limitations and Future Directions for Research

The model is methodological in nature and positive results repeatedly obtained from empirical studies are essential in order to confirm its validity. In regard to the
limited empirical data obtained in the course of this study, further experiments and applications are encouraged. Firstly, experimenting with the model to develop curricula for training garment merchandisers to perform other tasks and merchandisers of other industries to perform the tasks of order follow-up and provision of product development services is suggested so as collect more data about the levels of customer satisfaction that the developed curricula could attain. It is equally essential to experiment with the model in developing industrial training curricula for different job categories and different industries. Secondly, application of the model to developing different kinds of industrial training curricula for different customers of different industries is also suggested. The feedback obtained from the field work would be important for supporting the practicability of the model.

The original intention of the study was to apply the QFD principles for developing a curriculum development model to assist the industrial training providers in the implementation of TQM. To continue with this intention, there are three areas for which further research is suggested. First, this study contributes to the development of an industrial training curriculum development model but the focus was on achieving customer satisfaction. One may consider extending the research to explore other advantages of the model, such as whether it could assist in reducing curriculum development costs, and, incorporating new techniques for improving the efficiency and effectiveness of the model. Second, this study contributes to improving the quality of industrial training curricula, but the implementation of TQM for industrial training requires much more input and effort from the practitioners. As the nature of the jobs and the background of the incumbents have changed, so the content to be learnt and the ways in which the learnt content is to be
applied have also changed. Therefore, research on improving industrial training quality is essential in order to provide further impetus for continuing the TQM journey. To assist the industrial training industry in Hong Kong to enter a new era, strategic management for facing the challenge of financial independency of existing industrial training institutions and business management for helping those who want to open their businesses in this new market are worthy of investigation. On a final point, this study contributes a successful case of adapting QFD to the industrial training industry. However, the usefulness of QFD to industrial training is not limited to curriculum development. Research on the subject of manipulating the QFD principles for improving the quality of other industrial training elements, such as learning support and instructional design, is strongly recommended. With the increasing demand for remote learning, research on applying QFD to address the new needs arising from the use of the instructional methods and materials of this new study mode could contribute to the development of the global industrial training industry.
Appendices
Quality Deployment and Narrow Sense of QFD

Adopted from:
House of Quality

Adopted from:
Akao’s QD Model including Technology, Cost and Reliability

Survey with Garment Merchandising Managers

Order Follow-up

The aim of this questionnaire is to collect managers' opinions on the importance of the below four technical performance requirements for order follow-up, which to be executed by merchandisers.

Performance

<table>
<thead>
<tr>
<th>Performance Requirement</th>
<th>Qu</th>
</tr>
</thead>
<tbody>
<tr>
<td>Know How to Execute Order Follow-up</td>
<td>1</td>
</tr>
<tr>
<td>Know How to Coordinate with Different Department to Process Orders</td>
<td>2</td>
</tr>
<tr>
<td>Know How to Technically Communicate</td>
<td>3</td>
</tr>
<tr>
<td>Able to Deal with Problems</td>
<td>4</td>
</tr>
</tbody>
</table>

Instruction:
For each statement below, please compare the importance of every given pair of performance requirements in respect to the task of order follow-up. Please indicate your opinions by highlighting the corresponding "0".

Remarks: Please write down your name and e-mail address so that you could be contacted in case there is any inconsistency found within your responses.
Survey with Garment Merchandising Managers

Provision of Product Development Services

The aim of this questionnaire is to collect managers' opinions on the importance of the below four technical performance requirements for provision of product development services, which to be executed by merchandisers.

Provision of Product Development Services

- Able to Follow Up Technical Issues of Sample Making
- Able to Prepare Logical and Informational Quotations
- Able to Identify Potential Problems
- Able to Offer New Ideas

Including:
1. Able to follow up technical issues of sample making
2. Understand why revisions are needed
3. Able to give advice on material and sub-material applications

Including:
1. Able to identify the key constituents of a garment cost
2. Able to identify the costing options for a garment
3. Able to explain the cost difference between options

Instruction:

For each statement below, please compare the importance of every given pair of performance requirements in respect to the task of provision of product development services. Please indicate your opinions by highlighting the corresponding "( )".

<table>
<thead>
<tr>
<th>Qu</th>
<th>Performance Requirement</th>
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</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td>Able to Prepare Logical and Informative Quotations</td>
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<tr>
<td>6</td>
<td>Able to Follow Up Technical Issues of Sample Making</td>
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</tr>
</tbody>
</table>

Remarks: Please write down your name and e-mail address so that you could be contacted in case there is any inconsistency found within your responses.
Survey with Garment Merchandisers

Order Follow-up

The aim of this questionnaire is to collect garment merchandisers' opinions on the importance of some suggested industry-specific subjects for meeting the technical performance requirements of order follow-up.

Order Follow-up

Know How to Execute Order Follow-up
Know How to Coordinate with Different Departments to Process Orders
Know How to Technically Communicate
Able to Deal with Problems

Instruction:

Above stated 4 technical performance requirements and 7 suggested industry-specific subjects for order follow-up. For each statement on each of the following 4 pages, please compare the importance of every given pair of subjects for meeting the performance requirement stated at the top of the page. The major knowledge areas to be covered by the subjects are stated at the beginning of every following page. Please indicate your opinions by highlighting the corresponding "O".

~ Thank You ~

Remarks: Please write down your name and e-mail address so that you could be contacted in case there is any inconsistency found within your responses.
# Performance Requirement: Know How to Execute Order Follow-up

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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Order Knowledge</td>
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</tr>
<tr>
<td>Quality Control Knowledge</td>
<td>Quality control practices, administration for inspection of goods</td>
</tr>
<tr>
<td>Order Follow-up Practices</td>
<td>Workflow, things to do, approval items, sample inspection, light box operation</td>
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<tr>
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</tr>
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Performance Requirement: Know How to Coordinate with Different Departments to Process Orders

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<tr>
<td>Order Knowledge</td>
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1. Order Knowledge: 1
2. Quality Control Knowledge: 2
3. Order Follow-up Practices: 3
4. Product Making Knowledge: 4
5. Merchandising Operation Workflow: 5
6. Production Knowledge: 6
7. Order Knowledge: 7
8. Quality Control Knowledge: 8
9. Order Follow-up Practices: 9
10. Product Making Knowledge: 10
11. Merchandising Operation Workflow: 11
12. Shipping Knowledge: 12
13. Order Knowledge: 13
14. Quality Control Knowledge: 14
15. Order Follow-up Practices: 15
16. Product Making Knowledge: 16
17. Order Knowledge: 17
18. Quality Control Knowledge: 18
19. Order Follow-up Practices: 19
20. Quality Control Knowledge: 20
21. Order Knowledge: 21
Performance Requirement: Know How to Technically Communicate

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| Qu  | Subject                          | Quality Control Knowledge | Order Follow-up Practices | Product Making Knowledge | Merchandising Operation Workflow | Production Knowledge | Shipping Knowledge | Order Knowledge | Product Making Knowledge | Merchandising Operation Workflow | Production Knowledge | Shipping Knowledge | Order Knowledge | Product Making Knowledge | Merchandising Operation Workflow | Production Knowledge | Shipping Knowledge |
|-----|---------------------------------|---------------------------|---------------------------|--------------------------|--------------------------------|----------------------|-------------------|-----------------|-----------------------------|--------------------------|----------------------|-------------------|-----------------------------|--------------------------|----------------------|-------------------|
| 1   | Order Knowledge                 |                           |                           |                          |                               |                      |                   |                 |                             |                          |                      |                   |                             |                          |                      |                   |
| 2   | Quality Control Knowledge       |                           |                           |                          |                               |                      |                   |                 |                             |                          |                      |                   |                             |                          |                      |                   |
| 3   | Order Follow-up Practices       |                           |                           |                          |                               |                      |                   |                 |                             |                          |                      |                   |                             |                          |                      |                   |
| 4   | Product Making Knowledge        |                           |                           |                          |                               |                      |                   |                 |                             |                          |                      |                   |                             |                          |                      |                   |
| 5   | Merchandising Operation Workflow|                           |                           |                          |                               |                      |                   |                 |                             |                          |                      |                   |                             |                          |                      |                   |
| 6   | Production Knowledge            |                           |                           |                          |                               |                      |                   |                 |                             |                          |                      |                   |                             |                          |                      |                   |
| 7   | Order Knowledge                 |                           |                           |                          |                               |                      |                   |                 |                             |                          |                      |                   |                             |                          |                      |                   |
| 8   | Quality Control Knowledge       |                           |                           |                          |                               |                      |                   |                 |                             |                          |                      |                   |                             |                          |                      |                   |
| 9   | Order Follow-up Practices       |                           |                           |                          |                               |                      |                   |                 |                             |                          |                      |                   |                             |                          |                      |                   |
| 10  | Product Making Knowledge        |                           |                           |                          |                               |                      |                   |                 |                             |                          |                      |                   |                             |                          |                      |                   |
| 11  | Merchandising Operation Workflow|                           |                           |                          |                               |                      |                   |                 |                             |                          |                      |                   |                             |                          |                      |                   |
| 12  | Order Knowledge                 |                           |                           |                          |                               |                      |                   |                 |                             |                          |                      |                   |                             |                          |                      |                   |
| 13  | Quality Control Knowledge       |                           |                           |                          |                               |                      |                   |                 |                             |                          |                      |                   |                             |                          |                      |                   |
| 14  | Order Follow-up Practices       |                           |                           |                          |                               |                      |                   |                 |                             |                          |                      |                   |                             |                          |                      |                   |
| 15  | Product Making Knowledge        |                           |                           |                          |                               |                      |                   |                 |                             |                          |                      |                   |                             |                          |                      |                   |
| 16  | Order Knowledge                 |                           |                           |                          |                               |                      |                   |                 |                             |                          |                      |                   |                             |                          |                      |                   |
| 17  | Quality Control Knowledge       |                           |                           |                          |                               |                      |                   |                 |                             |                          |                      |                   |                             |                          |                      |                   |
| 18  | Order Follow-up Practices       |                           |                           |                          |                               |                      |                   |                 |                             |                          |                      |                   |                             |                          |                      |                   |
| 19  | Order Knowledge                 |                           |                           |                          |                               |                      |                   |                 |                             |                          |                      |                   |                             |                          |                      |                   |
| 20  | Quality Control Knowledge       |                           |                           |                          |                               |                      |                   |                 |                             |                          |                      |                   |                             |                          |                      |                   |
| 21  | Order Knowledge                 |                           |                           |                          |                               |                      |                   |                 |                             |                          |                      |                   |                             |                          |                      |                   |

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## Performance Requirement: Able to Deal With Problems

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<td>Shipping practices, administration for shipment of goods</td>
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</tbody>
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| Qu | Subject                          | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
|----|----------------------------------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|
| 1  | Order Knowledge                  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2  | Quality Control Knowledge        | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3  | Order Follow-up Practices        | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4  | Product Making Knowledge         | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5  | Merchandising Operation Workflow | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6  | Production Knowledge             | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7  | Order Knowledge                  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8  | Quality Control Knowledge        | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9  | Order Follow-up Practices        | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | Product Making Knowledge         | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | Merchandising Operation Workflow | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12 | Order Knowledge                  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13 | Quality Control Knowledge        | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14 | Order Follow-up Practices        | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 15 | Product Making Knowledge         | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 16 | Order Knowledge                  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 17 | Quality Control Knowledge        | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 | Order Follow-up Practices        | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 19 | Order Knowledge                  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 | Quality Control Knowledge        | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 21 | Order Knowledge                  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
Survey with Garment Merchandisers

Provision of Product Development Services

The aim of this questionnaire is to collect garment merchandisers' opinions on the importance of some suggested industry-specific subjects for meeting the technical performance requirements of provision of production development services.

Instruction:

Above stated 4 technical performance requirements and 7 suggested industry-specific subjects for provision of product development services. For each statement on each of the following 4 pages, please compare the importance of every given pair of subjects for meeting the performance requirement stated at the top of the page. The major knowledge areas to be covered by the subjects are stated at the beginning of every following page. Please indicate your opinions by highlighting the corresponding "O".

~ Thank You ~

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<tr>
<th>Subject</th>
<th>Major Knowledge Areas To Be Covered</th>
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</thead>
<tbody>
<tr>
<td>New Ideas for Product Development</td>
<td>New development of technologies and materials</td>
</tr>
<tr>
<td>Product Knowledge</td>
<td>Sizes &amp; measurements, garment features, product testing and safety regulations</td>
</tr>
<tr>
<td>Fit Evaluation and Pattern Alteration</td>
<td>How to conduct garment fit, how to correct garment fit problems</td>
</tr>
<tr>
<td>Product Making Knowledge</td>
<td>Knowledge of pattern making, garment making and fitting</td>
</tr>
<tr>
<td>Production Knowledge</td>
<td>Knowledge of grading and marker planning, production machinery</td>
</tr>
<tr>
<td>Material and Sub-material Knowledge</td>
<td>Characteristics and applications of various materials and sub-materials</td>
</tr>
<tr>
<td>Production Costs</td>
<td>Components of production costs, ways of reducing production costs</td>
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</tbody>
</table>

<table>
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<tr>
<th>Qu</th>
<th>Subject</th>
<th>Product Knowledge</th>
<th>Fit Evaluation and Pattern Alteration</th>
<th>Production Knowledge</th>
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### Performance Requirement: Able to Prepare Logical and Informative Quotations

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## Performance Requirement: Able to Identify Potential Problems

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**Industrial Training Curriculum for Entry-level Garment Merchandisers**

This curriculum is developed as a guideline for planning induction programs of in-house training for merchandising trainees and public short courses provided by industrial training institutions for training new entrants of the industry.

Objective: Provide the kinds of basic industry-specific knowledge which are important for the entry-level garment merchandisers to perform the tasks of: (1) order follow-up, and, (2) provision of product development services.

Target Trainee: Those who work at trading firms and local buying offices of overseas importers and possess less than two years’ working experience in the field of garment merchandising.

Remarks: This curriculum mainly uses woven items as examples. However, the principles and concepts of development are applicable to knit items and products which consist of both woven and knitted components.

1. **Trade and Order Knowledge** *(General Module)*

   **Trade Fundamentals**
   - Two major partners of trade: buyer and seller
   - Two major activities of international trade: imports and exports
   - Variety of service agents and facilitating functions they play in the trade process
   - Typical trade process from inquiry, offer, counter offer, acceptance and signing of the contract
   - Brief introduction of exporting and importing procedures

   **Order Elements**
   - Basic order elements, including quality, quantity, packing, price, shipment, delivery and payment, and, how these elements relate to the exchange between the seller and the buyer of an order
   - Different forms of each of each of the order elements
   - Order specification, i.e., how the elements of an order are to be specified
Trade, Delivery and Payment Terms

- Finance, logistics and transportation arrangements for international trade of garment merchandise
- Trade terms, such as FOB, CIF and LDP
- Shipment modes, such as sea shipment and air shipment, FCL and LCL
- Payment terms, such as D/A, D/P and L/C

2. Merchandising Business Workflow (General Module)

Retail Operation

- Store forms, such as department stores, specialty stores and mass merchandise
- Non-store forms, such as catalogue order

Product Development and Purchasing Procedure

- Product development operation process: from defining customer; conducting industry research; preparing theme and inspiration boards, design and concepts boards; choosing fabrications and trims; developing style specifications, cost sheets, size specification; to pre-production preparation
- Responsibilities of those who may work closely with the trainee, such as buyer, assistant buyer, designer and technician
- Seasons of product line, such as Spring/Summer and Fall/Winter, and major sales promotion activities

Production Order Processing Procedure

- Production order operation process: from inquiry, sample making, material purchase, scheduling, production, to delivery
- Responsibilities of those who may work closely with the trainee, such as production merchandiser, sample room manager, purchaser and production manager
- General production lead-times to be required for different types of garments
3. **Product Knowledge** (Product-specific Module)

**Categorizations of Garment Merchandise**
- According to products, such as dress, denim jeans and shirt
- According to wearers, such as men’s, misses’, boys’, girls’ and infants’

**Product Terms**
- Common silhouettes and styles of the product, e.g., Bermuda, Capri, shorts, sailor and hip huggers, for the product category of pants
- Basic components of the product, such as collar, yoke, front and back bodices, sleeve and cuffs of a man’s shirt
- Different styles of each basic component of the product, e.g., V-neck, off-the-shoulder, scoop, cowl neckline for ladies’ blouse
- Patterns and decorative features commonly found on the product, such as various print and stripe patterns

**Sizes and Measurements**
- Common size ranges used for the product, such as misses and petites sizes for ladies’ sportswear; infants, toddlers’ and children’s, girls’ and boys’ for children’s wear, etc.
- Key measurement points of the product, e.g., measurement points of front and back lengths, chest, sleeve length and collar for men’s shirts; and, key measurement points of the components of the product, e.g., neck width, front neck drop and back drop for V-neck

**Specification**
- Uses of specification of different parties, e.g., designers’ planning and control tool for a sample garment of designer and standards for goods inspection
- Items and measurement points commonly found on the specification of the product

**Testing and Safety Regulations**
- Kinds of materials and product testing which are commonly required for the product
- Safety regulations of the product, e.g., Flammable Fabrics Act for infants’ and children’s clothing, and, guidelines for drawstrings on children’s outerwear
4. **Product Making Knowledge**  

**Pattern Making Fundamentals**
- Two major methods, i.e., flat pattern and draping, of transforming 2-dimensional fabrics into garments that fit 3-dimensional bodies
- Major lines of human body for pattern making
- Shaping methods: darts and various kinds of dart equivalent
- Impacts of fabric grain on shaping garments
- Roles of underlying fabrics, including interfacing, lining, underlining and interlining in supporting garment shapes

**Garment Making Fundamentals**
- Principles of sewing and basic properties of seams
- Applications and styles of seams commonly used for the product, e.g., French seam used for inseam of pants and underarm seam of a shirt
- Applications and styles of stitches commonly used for the product, e.g., chain stitches, lock stitches and covering stitches
- Appearance and causes of the sewing problems of stitch formation, pucker and damage to the fabric along the stitch line
- Basic sewing machinery and automatics, such as buttonholing, button-sewing and bar-tacking machines
- Alternate methods of joining materials, e.g., fusing, welding and moulding

**Fitting Standards and Fitting Problems**
- Elements of fit, i.e., grain, set, line, balance and ease
- Fit standards for the product, such as a good-fit pair of tailored trousers should have a comfortable crotch area with no excess fabric, legs hang naturally with no turn-in or turn-out
- Fit standards for different parts and components of the product, like a good dart should point towards the crown of the curve being accommodated, etc.
- Common fitting problems of the product
5. Production Knowledge (Product-specific Module)

From Product Making to Production
- Brief introduction to grading, marker planning and spreading, with emphasis placed on the principles of these activities for meeting the cost and efficiency concerns of mass production
- Brief introduction to the principles and layout concepts of the commonly used production systems, such as progressive bundle system, unit production system and modular system, with emphasis on the difference between the sample system and the production systems used in sewing rooms

Production Processes
- Basic assembly activities of the product with focus on the key terms that are related to each of the activities, like ply and fabric direction for spreading, tolerance and cut pieces for cutting, etc.
- Common processing processes which may be involved in producing the product, such as wet-processing and dry-processing methods for denim products, with focus on the effects, characteristics and applications of each of the methods

Common Production Defects
- Sewing defects, such as seam pucker, skipped stitches, needle chewing, etc.
- Pressing defects, such as improper pressing, gloss, pressing marks, etc.
- Overall product defects, such as different colour shades between the bodice and sleeves, skewed bodice, etc.

6. Material (Product-specific Module)

From Fibre to Fabric
- General introduction to the fabric making process from sourcing or synthesizing fibres, spinning, weaving, dyeing and finishing
- Kinds of fibres which are commonly used in the fabrics of the product; characteristics of those fibres, and, their influence on the aesthetic and functional performance of fabrics and garment, such as warming and cooling effects, etc.
• Types of yarns which are commonly found in the fabrics of the product; their influence on the aesthetic and functional performance of fabrics and garments, e.g., hand, lustre, strength and abrasion resistance, which maybe affected by yarns
• Common fabrics structures of the product, such as plain weave and twill weave for men’s’ shirts; characteristics of these structures, and, their influence on the aesthetic and functional performance of fabrics and garments
• Colour and applied design, i.e., various kinds of dyeing and printing applied in fabric making
• Defects commonly found in each stage of fabric making

Fabric Performance
• Fabric factors contributing to the aesthetic performance of garments, e.g., colour consistency and hand
• Fabric factors contributing to the functional performance of garments, e.g., shrinkage, insulation and moisture transfer

7. Components and Trims (Product-specific Module)

Functionality
• Major categories of components and trims, including thread, fastener, supporting items and trims, commonly used for the product
• General functions of the items of each category of components and trims, e.g., thread for holding fabric pieces together, underlining for adding structure and improving the hand of fabric

Applications
• General applications of each type of components and trims commonly used for the product, e.g., single-ended separating and double-ended separating (style), metal and nylon (material), and 3mm and 5mm (size) of zippers
• Common application practices of components and trims, like slot zipper for centre applications and lapped zipper for side applications of skirts, and, button sizes for different parts of dress shirts, etc.
• Performance properties of components and trims, e.g., shrinkage and resistance to heat of lace, rustproof of metal buttons and clasps, colour matching of sewing thread to fabric
8. **Production Costs**  
(dreduct-selenium Module)

**Components**
- Cost-plus method used by manufacturers for calculating production costs
- Main components of the production costs, i.e., material costs and cut-make-trim (CMT)

**Methods of Reducing Production Costs**
- Methods of reducing material costs for the product, e.g., trim and fabric replacement, and various ways of reducing fabric utilization
- Methods of reducing production costs, like change of assembly and washing method, change of garment construction, etc.

*Areas which may be affected by the methods will be discussed.*

9. **Order Follow-up Practices**  
(General Module)

**Issues to be Followed Up**
- Aspects of an order than needed to be followed up, such as quality, quantity and delivery, and, common order problems
- Quality aspects of the product of an order that need to be followed up, such as product liability and safety, conformity to specification, professional workmanship

**Pre-production Approvals**
- Kinds of pre-production approvals which the merchandiser may need to follow up, including testing of fabric, components and trims, colours and shades, care label and other labels, samples, etc.
- General workflow of order follow-up
- Common techniques used for order follow-up

**Sample Inspection**
A practical session is arranged on teaching trainees the skills of checking measurements and the ways of inspecting quality of samples.

**Light Box Operation**
A practical session is arranged for teaching trainees how to operate the light box and do colour matching of samples.
Satisfaction Survey

Industrial Training Curriculum for Entry-level Garment Merchandisers

~ Merchandising Managers ~

Thank you again for your participation in this study and your views on the merchandising task performance requirements. After conducting several surveys, we have made use of the collected data to develop a curriculum for the industrial training of two basic tasks which are commonly performed by garment merchandisers, namely, order follow-up and provision of product development services. As a garment merchandising expert, we would like to know if you find the curriculum is useful for training the entry-level merchandisers or not. Enclosed is the developed curriculum. Please review and let us know your satisfaction with it by indicating a score for each of the three criteria of the curriculum provided below.

Criterion 1

<table>
<thead>
<tr>
<th>Practicability of the content in helping entry-level merchandisers to perform the two tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Satisfied</td>
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<tr>
<td>10</td>
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Criterion 2

<table>
<thead>
<tr>
<th>Ease of the module sequence for entry-level merchandisers in acquiring the knowledge</th>
</tr>
</thead>
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<td>Very Satisfied</td>
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Criterion 3

<table>
<thead>
<tr>
<th>Appropriateness of the course structure for the training</th>
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</table>

Comments (if any): __________________________________________________________

~ Thank You ~
Satisfaction Survey

Industrial Training Curriculum for Entry-level Garment Merchandisers

~ Merchandisers ~

Thank you again for your participation in this study and your views on what might be included in the industrial training for merchandisers. After conducting several surveys, we have made use of the collected data to develop a curriculum for the industrial training of two basic tasks which are commonly performed by garment merchandisers, namely, order follow-up and provision of product development services. As an experienced garment merchandising practitioner, we would like to know if you find the curriculum is useful for training the entry-level merchandisers or not. Enclosed is the developed curriculum. Please review and let us know your satisfaction with it by indicating a score for each of the three criteria of the curriculum provided below.

Criterion 1

| Practicability of the content in helping entry-level merchandisers to perform the two tasks |
| Very Satisfied | Very Dissatisfied |
| 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |

Criterion 2

| Ease of the module sequence for entry-level merchandisers in acquiring the knowledge |
| Very Satisfied | Very Dissatisfied |
| 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |

Criterion 3

| Appropriateness of the course structure for the training |
| Very Satisfied | Very Dissatisfied |
| 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |

Comments (if any): __________________________________________________________

~ Thank You ~
We would like to collect your opinions on the importance of the suggested subjects for teaching sample measurement checks. Your opinions are valuable for us to design an effective training course for this merchandising task.

Instruction:
Above stated the performance requirements and suggested subjects for sample measurement checks. For each statement on each of the following 2 pages, please compare the importance of every given pair of subjects for meeting the stated performance objective of sample measurement checks. Definitions of the subjects, in the form of major topics and examples, are attached on the last page of this questionnaire.

~ Thank You ~
For each question, pairwisely compare the subjects listed on the left and on the right. Indicate your assessment on their relative importance for achieving the stated objective by putting a tick into the appropriate circle.

**Performance Objective: Measure with Appropriate Techniques**

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</tbody>
</table>

Subject

- Measuring Techniques
- Clothing Terminology
- Garment and Human Figures
- Fundamental Knowledge of Pattern Making
- Basic Measurements
For each question, pairwisely compare the subjects listed on the left and on the right. Indicate your assessment on their relative importance for achieving the stated objective by putting a tick into the appropriate circle.

Performance Objective: Measure at the Right Position

<table>
<thead>
<tr>
<th>Qu</th>
<th>Subject</th>
<th>Basic Measurements</th>
<th>Measuring Techniques</th>
<th>Clothing Terminology</th>
<th>Garment and Human Figures</th>
<th>Fundamental Knowledge of Pattern Making</th>
<th>Subject</th>
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<td>Garment and Human Figures</td>
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<tr>
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<td>Garment and Human Figures</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Fundamental Knowledge of Pattern Making</td>
</tr>
<tr>
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<td></td>
<td></td>
<td>Garment and Human Figures</td>
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<tr>
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<td></td>
<td>Fundamental Knowledge of Pattern Making</td>
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<td></td>
<td>Garment and Human Figures</td>
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<tr>
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<td></td>
<td>Fundamental Knowledge of Pattern Making</td>
</tr>
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<td>Basic Measurements</td>
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</table>
## Definitions

<table>
<thead>
<tr>
<th>Subject</th>
<th>Major Topics</th>
<th>Topic Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Measurements</td>
<td>Definitions of measurements</td>
<td>Sleeve muscle - The widest part of the arm.</td>
</tr>
<tr>
<td></td>
<td>Measurement points</td>
<td>Sleeve muscle - 1&quot; below armhole</td>
</tr>
<tr>
<td></td>
<td>Different common names of measurements and abbreviations used on specifications</td>
<td>Hip same as seat, &quot;HPS&quot; stands for &quot;high point shoulder&quot;</td>
</tr>
<tr>
<td>Measuring Techniques</td>
<td>Techniques for taking measurements</td>
<td>V-measure, curve measure, how to measure bulky items</td>
</tr>
<tr>
<td></td>
<td>Techniques for measuring different positions</td>
<td>Imaginary line for neck drops, slope for shoulder drop</td>
</tr>
<tr>
<td>Clothing Terminology</td>
<td>Garment types</td>
<td>Jacket, pants, skirt, shirt, ...</td>
</tr>
<tr>
<td></td>
<td>Various positions and parts of garments</td>
<td>Waistband, pockets, crotch, sweep, ...</td>
</tr>
<tr>
<td></td>
<td>Types of garment parts</td>
<td>Welt pocket, coin pocket, scoop pocket, ...</td>
</tr>
<tr>
<td></td>
<td>Various positions and components of garment parts</td>
<td>Upper collar, collar stand, collar spread, ...</td>
</tr>
<tr>
<td>Garment and Human Figures</td>
<td>Reference points and lines of human figures</td>
<td>High point shoulder, center back, upper seat, knee, ...</td>
</tr>
<tr>
<td></td>
<td>Geometry for lines, angles, surfaces and solids</td>
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</tr>
<tr>
<td></td>
<td>Mechanisms for creating shapes and fullness of garments</td>
<td>Darts, pleats, shirring, ...</td>
</tr>
<tr>
<td>Fundamental Knowledge of Pattern Making</td>
<td>Construction of garment parts</td>
<td>Pattern making for sleeve of shirt, legs of pants, ...</td>
</tr>
<tr>
<td></td>
<td>Purposes of measurement to dimensional design of garments</td>
<td>Measure shoulder by taking the measurement of shoulder slope</td>
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</table>
## Revised Course Outline for 
the Training of Sample Measurement Checks

<table>
<thead>
<tr>
<th>Subject</th>
<th>Method</th>
<th>Time Allocation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Introduction</strong></td>
<td>Lecture</td>
<td>3 hours</td>
</tr>
<tr>
<td>• Purpose of sample measurement checks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Roles of measurement check in sample inspection, provision of merchandising services and product development</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Uses and key items of garment specification</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>2. Garment and human figure</strong></td>
<td>Lecture &amp; illustration</td>
<td>3 hours</td>
</tr>
<tr>
<td>• Basic principles of garmenting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Position of major reference points and lines in pattern construction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Techniques for creating and reducing fullness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Geometry for lines and angles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Different kinds of opening and closures for garments</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>3. Basic measurements</strong></td>
<td>Lecture &amp; illustration</td>
<td>2 hours</td>
</tr>
<tr>
<td>• Measurement points (positions and definitions) for the major garment items: shirt, skirt, pants, dress, jumpsuit, jacket and coat</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Different names and abbreviations of some common measurement points</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>4. Measuring techniques and practice</strong></td>
<td>Demonstration, &amp; practice</td>
<td>16 hours</td>
</tr>
<tr>
<td>• General guidelines for taking measurements</td>
<td></td>
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<tr>
<td>• How to measure the major garment items: shirt, skirt, pants, dress, jumpsuit, jacket and coat</td>
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</tr>
<tr>
<td>• How to record the taken measurements</td>
<td></td>
<td></td>
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<tr>
<td>• Measuring techniques (e.g. straight and curve, firm and elastic, bulky and delicate, etc.)</td>
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<tr>
<td><strong>Total:</strong></td>
<td></td>
<td>24 hours</td>
</tr>
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</table>
We would like to collect your opinions on the importance of some suggested industrial knowledge areas to performing material sourcing. Your valuable opinions could help us to design an effective training program for our merchandising staff.

**Instruction:**
Above stated the performance requirements and suggested industrial knowledge areas for the task of material sourcing. For each statement on each of the following 3 pages, please compare the importance of every given pair of knowledge areas for meeting the stated performance objective of material sourcing. Major topics or examples of what to be included of the knowledge areas are briefly explained at the beginning of each of the pages.
### Performance Requirement: Add Value to Merchandise

<table>
<thead>
<tr>
<th>Industrial Knowledge Area</th>
<th>What To Be Included</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material Production</td>
<td>Spinning, weaving for woven fabrics; flat knit, circular knit for knitted fabrics</td>
</tr>
<tr>
<td>Material Knowledge</td>
<td>Properties, characteristics and end uses of materials</td>
</tr>
<tr>
<td>Material Defects</td>
<td>Broken end, weave knot and hole of woven fabrics; skew, broken yarn of knitted fabrics</td>
</tr>
<tr>
<td>Garment Production</td>
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|-----|--------------------------|------------------------------------------------------------------|-------------------------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|--------------------------|-----|
| 1   | Material Production      | 0 0 0 0 0 0 0 0 0                                                 |                                                             |                                                              |                                                              | Material Knowledge      | 1   |
| 2   | Material Knowledge       | 0 0 0 0 0 0 0 0 0                                                 |                                                             |                                                              |                                                              | Material Defects        | 2   |
| 3   | Material Defects         | 0 0 0 0 0 0 0 0 0                                                 |                                                             |                                                              |                                                              | Garment Production      | 3   |
| 4   | Garment Production       | 0 0 0 0 0 0 0 0 0                                                 |                                                             |                                                              |                                                              | Garment Costing         | 4   |
| 5   | Garment Costing          | 0 0 0 0 0 0 0 0 0                                                 |                                                             |                                                              |                                                              | Regulations and Material Testing | 5   |
| 6   | Material Production      | 0 0 0 0 0 0 0 0 0                                                 |                                                             |                                                              |                                                              | Material Defects        | 6   |
| 7   | Material Knowledge       | 0 0 0 0 0 0 0 0 0                                                 |                                                             |                                                              |                                                              | Garment Production      | 7   |
| 8   | Material Defects         | 0 0 0 0 0 0 0 0 0                                                 |                                                             |                                                              |                                                              | Garment Costing         | 8   |
| 9   | Garment Production       | 0 0 0 0 0 0 0 0 0                                                 |                                                             |                                                              |                                                              | Regulations and Material Testing | 9   |
| 10  | Material Production      | 0 0 0 0 0 0 0 0 0                                                 |                                                             |                                                              |                                                              | Garment Production      | 10  |
| 11  | Material Knowledge       | 0 0 0 0 0 0 0 0 0                                                 |                                                             |                                                              |                                                              | Garment Costing         | 11  |
| 12  | Material Defects         | 0 0 0 0 0 0 0 0 0                                                 |                                                             |                                                              |                                                              | Regulations and Material Testing | 12  |
| 13  | Material Production      | 0 0 0 0 0 0 0 0 0                                                 |                                                             |                                                              |                                                              | Garment Costing         | 13  |
| 14  | Material Knowledge       | 0 0 0 0 0 0 0 0 0                                                 |                                                             |                                                              |                                                              | Regulations and Material Testing | 14  |
| 15  | Material Production      | 0 0 0 0 0 0 0 0 0                                                 |                                                             |                                                              |                                                              | Regulations and Material Testing | 15  |
Performance Requirement: Avoid Production Problems

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## Performance Requirement: Meet Regulations and Standards

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Questionnaire

Vendor Sourcing

We would like to collect your opinions on the importance of some suggested industrial knowledge areas to performing vendor sourcing. Your valuable opinions could help us to design an effective training program for our merchandising staff.

Instruction:

Above stated the performance requirements and suggested industrial knowledge areas for the task of vendor sourcing. For each statement on each of the following 3 pages, please compare the importance of every given pair of knowledge areas for meeting the stated performance objective of vendor sourcing. Major topics or examples of what to be included of the knowledge areas are briefly explained at the beginning of each of the pages.

~ Thank You ~

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Performance Requirement: Know if Vendors have Required FACILITIES

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Performance Requirement: Know if Vendors have Required SKILLS

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<th>Industrial Knowledge Area</th>
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<td>Garment Assembly Quality</td>
<td>Workmanship, various aspects of sewing quality</td>
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<td>Alignment and matching quality like matching stripes, left/right balance, free of shading</td>
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<td>Basic sewing machines like overlock and single-needle, specialty machines</td>
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<td>Characteristics and applications of washing, printing and dyeing</td>
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<td>Cut-sew-finish process for woven garments, knitting process for knit garments</td>
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<td>Material Knowledge</td>
<td>Properties, characteristics and end uses of materials</td>
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<td>Garment Defects</td>
<td>Various kinds of common defects found on finished products</td>
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References


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