

QFD: Past, Present, and Future

Yoji Akao
Asahi University

Introduction

It is a delight to see that the International Symposium on QFD has developed into a truly worldwide event, this third time in succeeding the first one in Japan and the second one in the U.S. In light of this progress, it is fitting to share the author's retrospect on the beginning days of QFD, how it was first conceptualized in 1966, its transmittal and introduction to the U.S., as well as later advancements and challenges for the future. It is my hope that this article will contribute to further advancement of QFD.

The bibliography at the end begins the listing with the books and documents that are available in English [1-11]. For historical details, please see reference [3].

The Past

Quality Function Deployment (QFD) was conceived in Japan in the late 1960s, during an era when Japanese industries broke from their post-World War II mode of product development through imitation and copying and moved to product development based on originality. QFD was born in this environment as a method or concept for new product development under the umbrella of Total Quality Control. The subtitle "An Approach to Total Quality Control" added to *Quality Function Deployment* [1], the very first book on the topic of QFD written by the late Dr. Shigeru Mizuno and myself, illustrates this relationship.

After World War II, statistical quality control (SQC) was introduced to Japan and became the central quality activity, primarily in the area of manufacturing. Later, it was integrated with the teachings of Dr. Juran, who during his 1954 visit to Japan emphasized the importance of making quality control a part of business management, and the teaching of Dr. Kaoru Ishikawa, who spearheaded the Company Wide Quality Control movement by convincing the top management of companies of the importance of having every employee take part. This evolution was fortified also by the 1961 publication of *Total Quality Control* by Dr. Feigenbaum. As a result, SQC was transformed into TQC in Japan during this transitional period between 1960 and 1965.

It was during this time that I first presented the concept and method of QFD. The Japanese automobile industry was in the midst of rapid growth, going through endless new product development and model changes. At that time, the following two issues became the seeds out of which QFD was conceived.

- (1) People started to recognize the importance of design quality, but how it could be done was not found in any books available in those days.
- (2) Companies were already using QC process charts, but the charts were produced at the manufacturing site *after* the new products were being churned out of the line.

"By the time design quality is determined, there should already exist critical quality assurance (QA) points that are needed to ensure certain qualities. Why then, could we not note these critical points on the QC process chart as predetermined control points or check points for production activity, prior to production startup?" I questioned.

In 1966, a process assurance items table was presented by Mr. Kiyotaka Oshiumi [12] of Bridgestone Tire Corp. This table showed the links from the substitute quality characteristics, which were converted from true qualities, to the process factors. It gave a clue to my quest for the QC process table, a table that should be created prior to production startup. To this process assurance items table, I added a field called “Design Viewpoints” and tried to get the new table used in new product development.

The idea was taken to various companies for trials, but it did not generate much public attention. In 1972, I assembled this concept and the experiences in a publication [13] where the approach was described with the term “*hinshitsu tenkai*” (quality deployment) for the first time. This established a method to deploy, prior to production startup, the important quality assurance points needed to ensure the design quality throughout the production process. The approach at the time, however, was still inadequate in terms of setting the design quality.

What resolved this inadequacy was the quality chart [14] [15] that was created and made public by the Kobe Shipyards of Mitsubishi Heavy Industry. Their table was defined the following year as a table that “systematized the true quality (customers’ needs) in terms of functions, then showed the relationship between these functions and the quality characteristics, which were the substitute quality characteristics.” [16] Dr. Shigeru Mizuno and Dr. Yasushi Furukawa provided guidance to the company in developing this table.

All these ideas and developments were integrated and eventually shaped into Quality Deployment (QD). QD is defined as a methodology that “converts user demands into substitute quality characteristics (quality characteristics), determines the design quality of the finished good, and systematically deploys this quality into component quality, individual part quality and process elements and their relationships.” [3]

There was another flow that merged into QFD from Value Engineering. Value Engineering showed a way to define functions of a product. It was Mr. Katsuyoshi Ishihara who expanded this thinking to business process functions. Business process function deployment subsequently became linked to what we later called narrowly defined QFD. Dr. Mizuno described narrowly defined QFD as a “step-by-step deployment of a job function or operation that embodies quality, into their details through systematization of targets and means.” [1] It is useful when creating a “quality assurance activity table,” a part of the QA system documentation.

In contrast, broadly defined QFD refers to the combination of the quality deployment (QD) described earlier and the narrowly defined QFD. What we call QFD today was molded and took shape through multiple flows and concepts. These include the initial flow that showed how to map out QA control points, the flows from quality deployment and value engineering, the narrowly defined QFD, and the quality chart.

In 1975, the Computer Research Committee (headed by myself and later named the QFD Research Group in 1978) was appointed by the Japanese Society for Quality Control (JSQC). The committee devoted the next 13 years to ongoing research of QFD methodology. In 1987, it published a final survey report on the status of QFD application among 80 Japanese companies. [7] [17] The companies surveyed listed the following as the purpose of using QFD: setting design quality and planned quality, bench-marking competitive products, new product development that sets the company apart from competitors, analyzing and accumulating market quality information, communicating quality related information to later processes, deploying design intent into manufacturing, identifying control points for the *gemba*, reducing initial quality problems, reducing design changes, cutting development time, reducing development costs, and expanding market share.

Please see figures 3 and 4 in reference [3] listed in the bibliography. They show the changes in the number of QFD related articles and papers published in the QC-related Japanese specialty magazines and books every year for 20 years from 1967. QFD received very little interest in the beginning until 1972 when the publications of the articles by Mitsubishi Heavy Industry and me paved the way for more QFD related articles to be published later. Following 1978 publication of “*Quality Function Deployment*,” [1] the first book on the topic, the number of QFD applications leaped. In recent years,

about 50 to 60 application case studies in new product development are publicly reported and put in print each year in the specialty books and magazines. To this day, a total of 1,000 case study reports have been published.

In 1987, the Japanese Standards Association published a book focused on QFD case studies. This book was later translated and published in the U.S. and Germany. [2] An introductory QFD book and work books were published in 1990 (by JUSE). [18-20] These are used by many companies today.

The introduction of QFD to America and Europe began in 1983 when an article of mine was published in *Quality Progress* [5] by the American Society of Quality Control. At the same time, I was invited to give a 4-day seminar in Chicago on “Corporate Wide Quality Control and Quality Deployment.” Later Mr. Bob King of GOAL/QPC invited me to give QFD lectures to American audiences for every year starting in 1986.

Meanwhile, the American Supplier Institute and past chairman Mr. Larry Sullivan began disseminating QFD to the automotive industry, mainly the Big Three car manufacturers. Mr. Akashi Fukuhara headed these efforts. Additionally, Dr. Don Clausing brought his QFD knowledge from his Xerox days to MIT when he became a professor there, thus contributing to the education and dissemination of QFD. Also in the U.S., Mr. Robert M. Adams spearheaded the North American QFD Symposium in 1989, contributing greatly to advancement of QFD in America by providing a place for QFD research and case study reports to be broadly viewed. In order to bring together all these activities, the QFD Institute was founded by Mr. Glenn H. Mazur in 1994 together with Mr. Richard Zultner and Dr. John Terninko. The QFD Institute later instituted the Akao Prize in 1996. In its inaugural year, the Institute awarded the prize to Mr. King, Mr. Sullivan, and Professor Tadashi Yoshizawa. This year, Dr. Clausing, Mr. Adams, and Professor Hisakazu Shindo will be honored with this Prize. Professors Yoshizawa and Shindo received the prize in recognition of their contribution toward building the framework of QFD methodology in the very early days when they were colleagues of mine at Yamanashi University in Japan.

In Europe, the author was given opportunities to lecture on QFD at Galgano & Associati in Italy in 1987 and for several years thereafter. Italy was the first to implement QFD in Europe, hosting the 1st European QFD Symposium in 1993. Mr. Alberto Galgano, chairman of Galgano & Associati, will be another recipient of Akao Prize for his contribution toward education and dissemination of QFD in Europe.

Regrettably, the first QFD book published in Japan in 1978 [1] did not get translated into English until much later. As a result, incorrect historical facts seem to be widely accepted. The author would like to take this opportunity and provide an accurate account in this paper.

(1) *Incorrect: Quality deployment originated at the Kobe Shipyards of Mitsubishi Heavy Industry.*

What Mitsubishi Heavy Industry devised was a quality chart. It is true that this chart has become the core of QFD methodology. I first wrote about quality deployment, however, in an article published in April of 1972, [13] which described both the terminology and the procedure. This article was a compilation of what I had taught and experimented with at various companies over a six year period beginning in 1966. The writing of this article took place before the MHI quality chart was made public in May of 1978 [14, 15]. It should be noted that the MHI paper where the first quality chart appeared covered only as far as setting the design quality; the terminology “quality deployment” was not used there.

(2) *Incorrect: Quality deployment originated with Toyota.*

Please be aware that quality deployment had already a 10 year history preceding the application by the Toyota Group. As chronicled in reference [3], the first companies in the Toyota Group to try quality deployment were Hino Motors under my guidance and Toyota Auto Body under the guidance of Mr. Nobuo Takezawa who learned the method from my papers. Mr. Yabuta, general manager of Toyota Motors, attended one of the QFD lectures I gave at JUSE and expressed a desire to introduce the method to the entire Toyota Group. It was around 1979 when a seminar was put together for about 100 QA managers from Toyota af-

filiates. Following my keynote speech, a lecture was given by Mr. Takezawa and case studies from Hino Motors were presented. After this event, QFD was more quickly disseminated among the group affiliates than at the parent Toyota Motors itself, largely because of its size. When the name “Toyota” is cited in QFD history, most usually assume it is Toyota Motors, but that is not correct. It was actually Toyota Auto Body where Mr. Akashi Fukuhara was a QA manager. Mr. Fukuhara, who later joined the Central Japan Quality Control Organization, was eventually dispatched to ASI where he spread his QFD knowledge in the U.S. and made a great contribution.

(3) *The true reason why the quality chart is called “House of Quality” in the West.*

The quality chart topped with a triangular peak, a shape that became a standard in the U.S., was the brainchild of Toyota Auto Body. The table of this shape was already in use by Mr. Tsuneko Sawada when they were working on the development of the Light Ace van. It was at a JSQC research presentation conference [21] when the table was for the first time referred by the name “House of Quality” because of its shape. Mr. Fukuhara later introduced the table in the U.S., using this name. This is believed to be the true origin of how this nickname came to be popular.

(4) *The origin of the term Quality Function Deployment.*

Quality Function Deployment is a literal translation of the Japanese words *hinshitsu kino tenkai*, but was initially translated as quality function evolution in 1978 [1]. When I was a visiting scholar at Kansas State University in 1972, an associate researcher, Dr. L.T. Fan, had suggested that name. Having looked the word *tenkai* up in his dictionary, of the words development, deployment, and evolution listed, evolution seemed the most creative he thought.

At the first QFD seminar in the U.S. [5], our sponsor Mr. Masaaki Imai felt that the term evolution inappropriately connoted the meaning of “change” and that *hinshitsu tenkai* was better translated as quality deployment. Although deployment had militaristic implications in Japanese, in this usage, it was entirely acceptable. And so the term Quality Function Deployment was born.

The Present

The first QFD seminar (a 2-day seminar) in Japan was organized in 1983 by Japan Productivity Center, and was followed by many others. Today QFD classes are available through the Japan Standards Association (a 2-day seminar), Central Japan Quality Control Organization (a 3-day seminar), and Union of Japanese Scientists and Engineers (a 4-day seminar). Over the past ten years, I have also been regularly invited to lecture on QFD in JUSE’s basic QC course and in their middle management course.

Following the creation of the QFD Research Group by JSQC, another QFD Research Committee was organized in 1987 by JUSE, which I have chaired until Dr. Yoshizawa succeeded me in 1997. This committee, which celebrated its tenth anniversary this year, has held five meetings every year with research foci on these topics: methods for identifying demanded quality and its relationship with marketing, *kansei*, seeds and needs in technology deployment, quality deployment methodology, cost deployment, reliability deployment, QFD in software development, narrowly defined QFD, Comprehensive QFD, QFD as development management engineering. These topics were discussed in a series of articles in *Quality Control* magazine for a period of one year beginning in 1996 [22].

Utilization of QFD by American companies is particularly noticeable in recent years. Its early days were reported by Mr. Bob King [23]. Further developments were presented by Mr. Glenn Mazur in 1994 at the 4th Japanese QFD Symposium sponsored by JUSE. Mr. Mazur also detailed the historical development of QFD since 1983 and the dissemination in America in his Japanese paper titled “QFD Inroads to North America and The First 10 Years.” [25] At the 1st ISQFD, a speech made by Mr. Harold M. Ross of General Motors, “The Status of Automotive QFD in the USA,” [26] revealed to

what extent and in how many vehicle models QFD is actually used in the U.S., drawing a strong interest from the audience.

QFD lectures were also given in Korea from 1978 through 1985 at the Korean Standards Association, but these did not lead to actual applications. In recent years, however, the country is showing heightened interest in QFD. In January of last year, a QFD Research Committee was created in Korea. Taiwan was also introduced to QFD from 1982 through 1986, but actual applications have just begun recently. The Chinese Productivity Center is the leading force in dissemination of QFD in the country. In Brazil, QFD was first introduced in 1989 at ICQC-1989 in Rio de Janeiro [8]. Later dissemination efforts have been led by Mr. Ohfuji. In China, where the importance of new product development is gaining attention, the Quality Bureau from the State Bureau of Technical Supervision, a national agency of The People's Republic of China, has invited the author to give QFD seminars in Peking and Shanghai since 1994. In Australia, the 1st Pacific Rim Symposium on Quality Deployment was organized in 1994 by Mr. Bob Hunt. Australia will host the 3rd International Symposium on QFD in Sydney next year.

The 1st International Symposium on QFD was attended by 174 people, including 63 from overseas, notably 39 from Korea and 21 from Brazil. The 2nd ISQFD was held in Novi, Michigan, a suburb of Detroit, in the US. It was attended by about 250 people from all over the world, with 36 papers presented from 16 different countries. The organizers of the 2nd ISQFD reported that the number of papers submitted was actually double the number allowed to present.

A survey was conducted through a collaboration of Tamagawa University and the University of Michigan, on recent trends in QFD applications. [27] The Japanese side selected 400 Japanese companies for the survey who were involved with the QFD Research Committee of JUSE or attended introductory QFD seminars. The U.S. side selected 400 U.S. companies with a similar background. An identical survey form was sent to these companies. 146 of the Japanese companies (37%) and 147 U.S. companies (37.6%) responded. According to the survey results, 31.5% of Japanese companies used QFD in their development process, while 68.5% of American companies did the same. It was determined that QFD was most often used in the automotive industry and electronics industry. Interestingly in the U.S., QFD was used by the aerospace industry. Application of QFD was higher in the U.S. than in Japan. Companies cited that they used QFD in order to attain 'better design' and 'better customer satisfaction.' American companies paid more emphasis on the latter purpose than their Japanese counterparts. 'A tool for cross-functional communication/coordination' and 'to shorten product cycle time' were also cited by American companies as their reason for using QFD. What caught my attention was the difference in the products to which QFD was applied. In Japan, QFD was used more often for product improvement based on an existing model. In the U.S., QFD was more often used for a totally different product or the next generation product. The majority of QFD teams consisted of appointed members from several job functions. They reported that over 80% of decision making was done in meetings. In both Japan and the U.S., each team had ten or fewer members and met for two hours or less at a time. American companies reported more teams meetings, at least once a week or more often was not uncommon.

For the information source for creating a quality chart, American companies used 'personal interviews with customers,' 'customer surveys specifically designed for QFD implementation,' and 'focus group interviews.' Japanese companies listed 'experiences of the product design team' and 'customer claims information.' American companies in the survey reported that they had corporate support in QFD implementation in the form of 'sufficient budget for QFD implementation,' 'sufficient resources,' and 'adequate time for QFD implementation.' This attests that QFD is given an organizational importance in American companies.

The Future

Professor Yoshizawa listed the following two points as the significance of QFD in industry. [28]

- (1) QFD has changed what we have known as quality control in manufacturing processes, and established quality control for development and design. In other words, QFD has established quality management in product development and design. QFD has played a significant role when the focus of TQC shifted from process-oriented QA to design-oriented QA and creation of a new product development system.
- (2) QFD has provided a communication tool to designers. Engineers, positioned midway between the market and production, need to lead new product development. QFD renders a powerful arm to engineers as they build a system for product development.

New product development and strategic management were the key topics that JUSE selected at their 61st QC Symposium (1995) as important for future TQM. New product development methodology needs to be further established in TQM. It is hoped that QFD in particular will develop into a methodology that aids new product development based on strategic product planning, a method for creating more attractive products. In order to be able to develop a more attractive product, a linkage between QFD and marketing needs to be developed, and new methods to do so need to be developed. The Seven Product Planning Tools, tools developed in recent years, deserve recognition for their good timing.

Although using QFD is not new to the software industry, the quality of information provided will draw more attention as we move toward the advanced information era of the 21st century where every social infrastructure, not just production systems, will be affected by the change. There, such quality can be identified only through QFD. Furthermore, QFD will be positioned as the core methodology for building systems that ensure such quality.

Future TQM will find more importance in how to align company-wide activities to customer focus. It is this author's belief that Voice of Customer should be common bedrock for creating a partnership of such activities. For companies to attain customer satisfaction, it is important that all employees acquire customer focused thinking through the value chain created by the awareness that "the next process is your customer." It is with QFD that companies will be able to accomplish this future challenge. QFD will serve as a tool for creating this alignment, where true partnership can sprout. [29]

New product development will also require price design along with quality design. Recently Professor Mochimoto has proposed QDm, his new concept and method in this attempt. In the future, cost design and deployment method need to be developed, in addition to price design.

Americans are trying to combine many new ideas with QFD. These include conjoint analysis, TRIZ, conflict management, Taguchi methods, and so forth. How these efforts will develop in the future is something that is worth looking forward to. Furthermore, *Quality Progress* magazine reports that QFD is included in 30 some software products advertised through ASQC. These developments give a good reason to anticipate much more QFD advancement in America.

Development Management Engineering

Next, I would like to discuss development management engineering. At the 4th QFD Symposium in Japan (March, 1994), I advocated Development Management in my keynote speech titled "QFD for a New Era." Concurrent engineering, a concept that recently gained attention in America, originated in Japan, where traditionally Japanese car companies have used this management method experientially and later brought it to America. QFD and Taguchi methods which were also developed in Japan are now gaining attention in the U.S. as effective methods for concurrent engineering.

The traditional view is that new product development belongs in the arena of marketing and market research. Development of a vehicle, however, requires two years from the start of design through product launch. The fact that Japanese-made products showed rapid quality improvement attests that the Japanese companies exerted excellent quality control from the design phase through product launch.

New product development, a function that traditionally fell under marketing responsibility, should encompass in its scope every process from marketing, planning, design, production preparation, inspection, through sales, from the perspective of management of new product development. QFD, which prevents problems from materializing thus brings a smooth, trouble-free production launch, offers a way to manage the upstream end of the development process. Traditional engineering constituted control engineering that focused on providing control of technical aspects of the finished product and production control. The main emphasis in production control was research of the production operation and speed in post-production launch, or research of production efficiency. It was a grave oversight and a blind spot in the traditional control engineering that it did not address the engineering area that encompasses from initial design activities through product launch. Concurrent engineering, mentioned earlier, is one form of a simultaneous development method, but its name does not give one a general description. More readily, concurrent engineering should be recognized as one form of engineering looked at from a management perspective. For these reasons, I advocated the study of management in product development. "Development Management" was the general term I adopted at the 4th QFD Symposium in Japan in 1994. In doing so, I tried to appeal to the need for further advancement of QFD and concurrent engineering as part of development management. The 1st International Symposium on QFD in 1996 reflected this thinking and selected a theme "QFD Toward Development Management."

The important challenge of the future is to advance this method to build a trouble-free way to churn out new products efficiently, at low cost, and in less time. This will bring even more effectiveness. This challenge is now a research topic of the QFD Research Committee at JUSE under the leadership of Mr. Tadashi Ohfujii who advocates a real time database and Mr. Takashi Tanaka who has devised a concept diagram. It is believed that *Total Quality Development*, a book by Dr. Don Clausing and a culmination of his independent research, also came about based on the similar thinking.

These concepts should be further advanced as important management technology for new product development management. They should be advanced to a methodology for creating more attractive quality. Another important research topic should be a management methodology for making QFD more effective inside an organization.

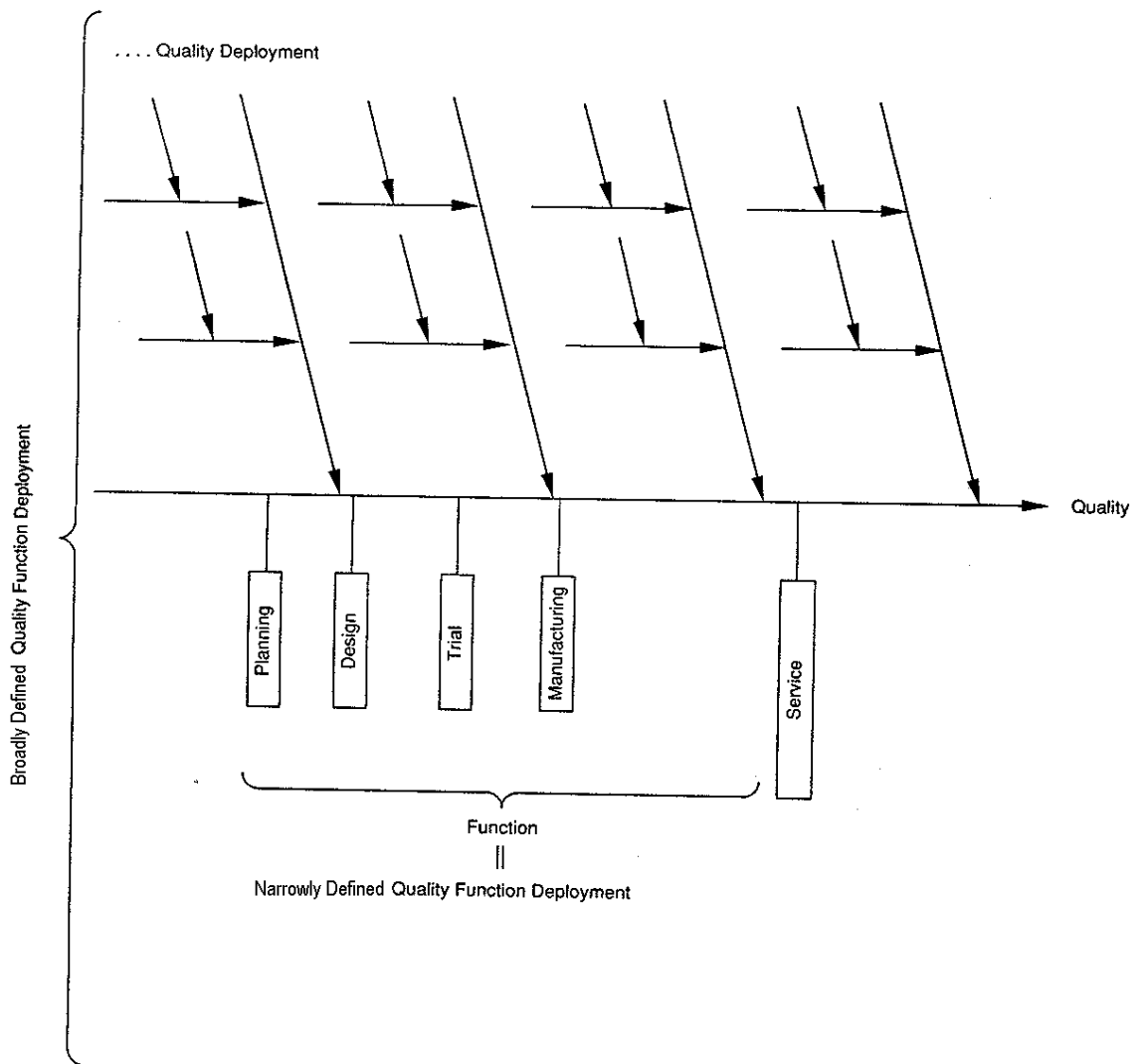


Figure 1 Quality Deployment and Quality Function Deployment

QFD and ISO 9000

The global deployment of the ISO 9000 series has brought a great influence to the flow of quality control. It established a globally common standard for the first time. It has contributed greatly to elevating the world quality control level by encouraging advanced industrial nations as well as many developing nations to embrace quality control for the audit certification.

As it is well known, the ISO 9000 series require companies to “earn their customer’s trust by demonstrating a system of quality assurance, i.e., the quality system” to external customers so as to assure that “the given quality requirement is satisfied.” The audit looks at this aspect.

Meanwhile, TQC has devoted to providing a quality product that satisfies the customer by forcing the production people to take the side of customers or the consumers, previously an opposite position for manufacturers. This is the reason why TQC uses the market-in activities. It is meaningful to show one’s system to the customer so as to put him at ease in order to earn his trust. Genuine quality assurance, however, must ultimately produce a product that fulfills satisfaction of the customer who receives it.

ISO defines quality system as the “organizational structure, responsibility, procedure, process and resource for implementing quality control.” The origin point lies in the following definition that Dr. Feigenbaum, the proponent of TQC, set forth: A quality system is a “network of the management/control and procedure that are required to produce and deliver a product with a specific quality standard.” [30] Good quality is born from a good system. This is why a quality system is valued in the ISO. Dr. Juran called the quality function as “job functions that create quality.” In Figure 1, these are the functions in the boxes, such as ‘planning,’ ‘design,’ --- ‘service,’ the job functions that create quality, or “quality functions.” A good system is where quality functions are clearly identified. The network of this procedure is called “narrowly defined quality function deployment” or QFD (N).

As long as we use the expression quality system however, we need to clearly identify the network of quality itself, not just the network of procedures. The upper portion of the above diagram is also important. This portion is called quality deployment.

When QFD (N) and QD are combined, we call it broadly defined quality function deployment or QFD (B). It is the QD portion of QFD (B) that is examined in more common QFD practice. Conversely, what the ISO is looking at is QFD (N), although it is not mentioned by this name. I have always asserted that the quality system advocated by Dr. Feigenbaum (as well as the one under ISO) comprises of the lower portion of this diagram, and that we need to include both upper and lower portions of this diagram in a quality system.

QS-9000 which has recently received attention is said to be a combination of ISO 9000 and the audit systems that American Big Three auto makers already had, plus some Japanese TQC. Figure 2 was created by Mr. Mazur. It shows that QS-9000 incorporates QFD. In the future, ISO itself will take on this trend. In Japan, Professor Yoshizawa is spearheading the effort in getting QFD recognized as an international standard and incorporated in the ISO.

With wider application of the ISO 14001 audit certification system that standardized the requirements of environmental management system, we need to work for further advancement of QFD that integrates the entire life cycle of a product, from demanded qualities that reflect environmental requirements through recovery of scrap and recycling.

Conclusion

This paper has reflected on the early days of QFD, the current status, and future challenges. Much more progress is expected in the QFD world, as it renders a tangible method to manage new product development, an area that will be most important in future TQM. QFD will be also positioned as an effective tool for quality assurance of systems in the information age. For these goals, QFD methodology needs to be standardized and incorporated in the ISO.

This paper was written with a focus on Japan. Information pertaining to overseas QFD was not adequately available at the time of writing. It is this author's hope that reports about each country's QFD status will be shared in future symposia.

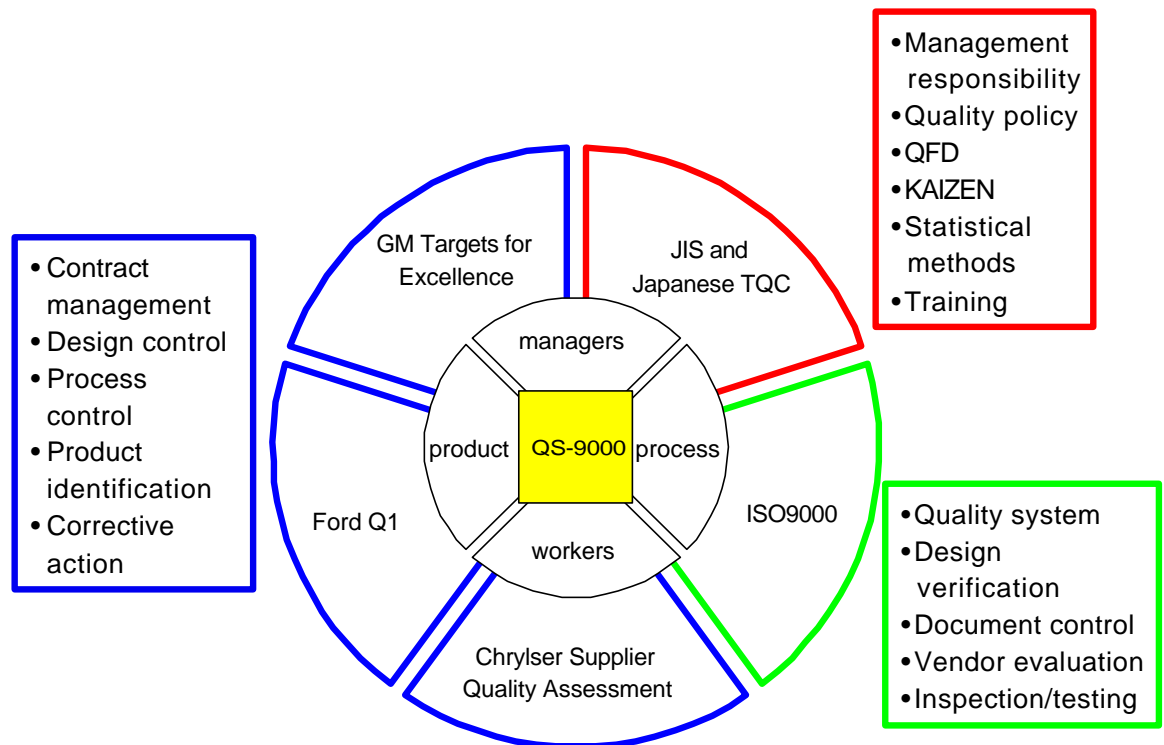


Figure 2. World Wide Quality

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