Quality Engineering
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/lqen20

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Version of record first published: 20 Jun 2012

To cite this article: Glenn H. Mazur (2012): Using Quality Function Deployment to Write an ISO Standard for QFD*, Quality Engineering, 24:3, 436-443

To link to this article: http://dx.doi.org/10.1080/08982112.2012.682510

Quality Engineering, 24:436–443, 2012

ISSN: 0898-2112 print/1532-4222 online
DOI: 10.1080/08982112.2012.682510

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Using Quality Function Deployment to Write an ISO Standard for QFD*

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ABSTRACT Quality function deployment (QFD) is methodology designed to improve customer satisfaction by increasing the quality of new products and services. Unlike traditional quality methods that focus on solving existing, known problems to achieve "zero defect," QFD is driven by the voice of the customer to explore high-priority spoken and unspoken needs that must be met for a new product or service to be accepted. To achieve this first-time quality, developers must know what problems the customer has, how important those problems are to helping the customer do their job better, and what level of improvement is necessary for the customer to accept it in place of their current practice. Thus, QFD is highly dependent on the customer and their business, the industry of the product or service, and what competitive alternatives the customer has access to. This article will discuss how these same methods are used to write the QFD standard itself.

KEYWORDS ISO standards, quality function deployment (QFD), voice of the customer (VOC)

INTRODUCTION AND BACKGROUND

Quality function deployment (QFD) was developed in Japan during the 1960s during its period of modernizing traditional approaches to quality management (Akao 1990; Mizuno and Akao 1994) to assure that not only was negative quality (customer dissatisfaction) addressed in the design and development of new products and services but that positive quality (customer satisfaction) become the hallmark of competitiveness. In other words, a lack of dissatisfaction does not guarantee satisfaction; that is, nothing $\neq$ anything right. The concept was extraordinary at the time. Traditional approaches to product design were typically driven by technical advancements that often failed in usability or made downstream manufacturability or service delivery a nightmare. The QFD approach recommended the following:

- Assuring product quality required a multifunctional team approach. Quality engineers typically engage too late in the process to truly affect customer satisfaction and value.
- For customer-focused design, it is critical to involve the users, buyers, and other stakeholders who can make or influence a purchase decision. QFD

Editor's Note: In this issue we have invited Glenn Mazur, expert in quality function deployment (QFD), to present his views and experience on using QFD for standards development, particularly on how this has been used in new development work for applying QFD itself. This is particularly significant in standards development in general because in addition to technical substance, a high-quality standards development process requires team identification, customer identification, customer requirements, consensus building, balloting, and compromise.
*Edited by Stephen N. Luko, Hamilton Sundstrand Corporation, Windsor Lock, Connecticut.

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recommends that marketing play a leading role in acquiring and analyzing the voice of the customer (VOC) to determine what matters most to these stakeholders.
- Different stakeholders have different needs with different strengths. It is important to get an accurate priority from them before detailed development and implementation begin. This will improve quality, acceptance, and timing, and lower costs due to waste and rework.

Since then, QFD has been successfully applied to services such as financial, hospitality, health care, and education; manufacturing such as aerospace, electronics, appliances, and transportation; software such as communications, databases, and Web sites; and business processes such as strategic planning and corporate governance.

In 2009, the Japan Standards Organization (JSA) initiated a proposal to write a standard for QFD under the auspices of the Technical Committee 69 for Statistical Methods Subcommittee 8 (TC69/SC8) for New Product Development. The initial idea was that QFD was able to "transform" VOC data into engineering parameters of a solution. Because VOC involved statistical methods to prioritize and measure customer value, and engineering parameters involved statistical methods to measure and control performance and functional quality to assure that VOC was met, the process of transforming VOC into engineering parameters would optimally use statistical methods as well. QFD fits that definition well.

In the years between 1966 and 2009, both industry needs and QFD tools evolved significantly. Early QFD efforts through the 1990s focused on creating elaborate charts (called *house of quality*) to help the multifunctional teams visualize the complex cause-and-effect correlations among users, developers, builders, and deliverers of products and services. Statistical models were incorporated so that market priorities could be maintained and tracked as they drove priorities for engineering and manufacturing. By the late 1990s, companies began adopting lean practices to reduce resources, time, and cost, and this spread to QFD efforts as well. The elaborate "houses" required more time than most project teams could spare, so QFD usage began to taper off. Dr. Yoji Akao, one of the cofounders of QFD, then asked the QFD Institute to modernize the method to better meet the emerging needs of its practitioners. The resulting Blitz QFD® (QFD Institute, Ann Arbor, MI, USA) is fast becoming a global best practice and will be recommended along with classical QFD in the standard under development.

I, the executive director of the QFD Institute and the International Council for QFD (ICQFD), was asked to convene Working Group 2 to write this standard. It seemed both practical and demonstrative to use QFD in writing the QFD standard. This was because the standard would be a new product, would have customers/users with needs, and, if the standard met their needs (satisfaction) and made their work easier, faster, and better, it would be widely accepted.

THE STEPS

Step 1—Scope of the Project

A common concern of all process, service, and product planners is scope "drift" and "creep." Once a project has been chartered with a budget, resources, deliverables, and time schedule, any change in scope can be significant. Communications from the JSA Secretariat for TC69/SC8 described my task as:

> The convener has the Chair/Secretary role in a Working Group. A Working Group is comprised of experts who will contribute to the development of new standards. Working Group will have several projects led by a project leader who will be the main person to draft the new standards.
>
> There is a timeframe for developing ISO [International Organization for Standardization] standard, and we are required to develop a standard in three years (typical for a new development), including a balloting period for the national standards bodies around the world. (TC69 secretariat, personal communication)

An existing Japanese Standard for QFD, Q-9025, was recommended as a starting point for this development.

Step 1.1—Confirmation of Roles and Responsibilities

To better understand this task, I was referred to several U.S. members of TC69, referred to as the Technical Advisory Group 69 (TAG69). They were able to clarify the role of the convener as being both a project leader and working group chairman and were authorized to recruit subject-matter experts. Upon confirmation from JSA that these roles and responsibilities were acceptable, I accepted the convenership of ISO/TC69/SC8/WG2 in June 2009.

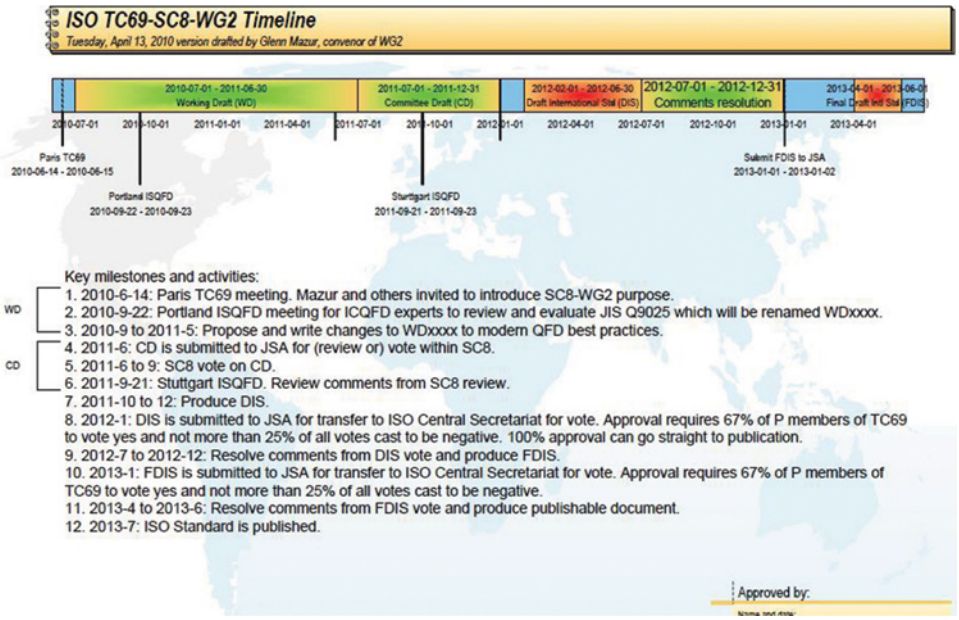

FIGURE 1 **Draft writing timeline for QFD standard. (Color figure available online.)**

Step 1.2—Define Process Steps for WG2 Activities

The task of writing the standard was broken down into a series of tasks as follows:

1. Define timeline for WG2. Ask SC8 to please provide this information to me as soon as possible.
2. Develop WG team member selection criteria. Based upon the purpose and scope, develop a prioritized list of criteria from which to propose and select membership in WG2.
3. Identify users (customers) of the proposed QFD standard.
4. Interview and/or survey users in order to understand their problems and wishes.
5. Translate problems and wishes into user needs.
6. Have users prioritize their needs.
7. Translate prioritized needs into prioritized technical characteristics of QFD, including recommendations for methods, tools, and approaches.
8. Develop standards and recommendations in accordance with the priorities of the technical characteristics.
9. Identify potential failure modes for QFD and recommendations.
10. Propose QFD implementation guidelines for successful and sustainable QFD applications.
11. Propose criteria for measuring the success of a QFD application.
12. Propose guidelines for continuous improvement of QFD activities within the organization.
13. Recommend resources for obtaining QFD knowledge and best practice.
14. Provide examples of QFD applications.

Step 1.3—Develop Timeline

Creating, submitting, receiving commentary, revising, and publish a standard has its own scheduling requirements that must be managed like any other project. To make sure the proper experts, draft editors, and other resources are available when needed, as well as interim meeting attendance and appropriate review periods, a timeline was created and approved by the chairman of Subcommittee 8 (see the timeline Figure 1).

Step 2—Select Team Members

Discussions with several members of other U.S. TAG69 conveners revealed what makes a good working group team member. Because not every potential team member would epitomize all

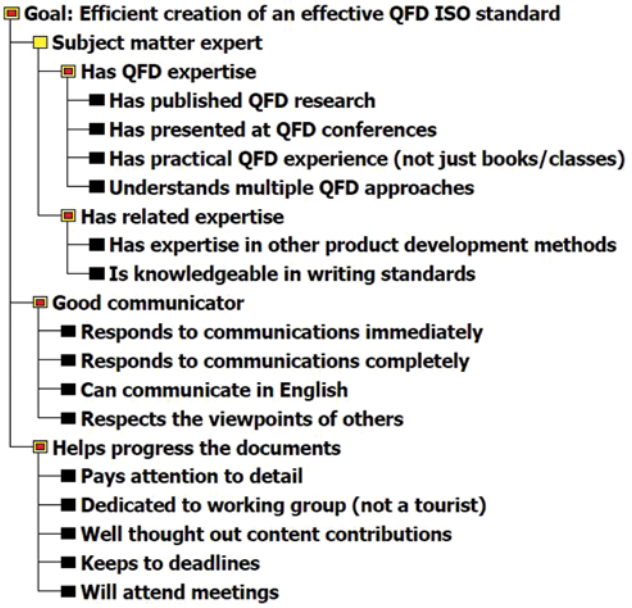

FIGURE 2 Hierarchical diagram of working group team membership selection criteria. (Color figure available online.)

attributes, it was useful to prioritize these attributes and use them as criteria for nominations.

Step 2.1—Identifying WG Team Membership Nomination Criteria

Private conversations with U.S. TAG69 members produced a number of positive and negative cautions about managing a team of volunteer subject-matter experts. The expression "herding cats" comes to mind. It was useful to convert all of the statements into expressions of positive expectations for which each candidate member could be evaluated objectively or subjectively. These were structured into the hierarchy in Figure 2. The hierarchy helps organize criteria by layers of abstraction, which will improve the prioritization process described below.

Step 2.2—Prioritizing WG Team Membership Nomination Criteria

Prioritization in multicriteria decision making was advanced by the research of Dr. Thomas Saaty in the 1970s at the U.S. Department of Defense and later at the Wharton School of Business at the University of Pennsylvania. Saaty found that decision makers facing a multitude of elements in a complex situation innately organized them into groups sharing common properties and then organized those groups into higher level groups, and so on, until a top element or goal was identified. This is called a *hierarchy*, and when making informed judgments to estimate importance, preference, or likelihood, both tangible and intangible factors must be included and measured.

Modern QFD uses Saaty's analytic hierarchy process (AHP; Saaty 1990) technique to manage this process in a manner that captures the intuitive understanding of the participants and also yields mathematically stable results expressed in a numerical ratio scale. A numerical ratio scale is preferred for the following reasons:

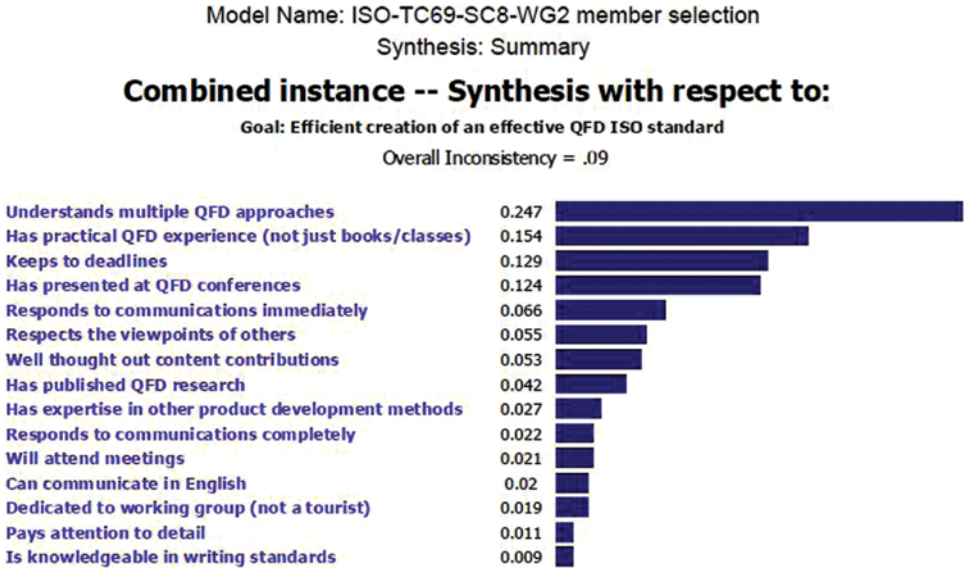

FIGURE 3 AHP-derived prioritized working group membership selection criteria. (Color figure available online.)

- Numerical priorities can be applied to later analyses to derive downstream priorities. This will be important in guiding the developers and implementers of new solutions.
- Ratio scale priorities show precisely how much more important one issue is than another. Ordinal scales only indicate rank order but not the magnitude of importance.
- Numerical scales can be tested for judgment inconsistency, sensitivity, and other useful properties. Because AHP does not require rational responses, an inconsistency check will quantify and identify judgment inconsistencies by looking for instances of $a > b$, $b > c$, but $c > a$, etc.

The hierarchy was prioritized by the same U.S. TAG69 members who advised on the criteria. The AHP method has the leaves of each hierarchical branch compared pair-wise using a verbal scale to determine which of the pair is more important and by how much. The verbal scale is as follows: *equally important, moderately more important, strongly more important, very strongly more important*, or *extremely more important*. A pair-wise survey was e-mailed and the results were entered into an AHP matrix from which the right principle eigenvector was calculated to approximate the ratio scale priorities shown in Figure 3.

Step 2.3—Nominating WG Members

Based on the above weighted criteria, individuals were evaluated according to how well they met the criteria. Because this is to be an international standard, members from the worldwide QFD community were considered first. These included QFD leaders from countries that had hosted one or more international symposia on QFD. Members were then asked to join their country's ISO member body so that they could participate and vote fully. These individuals are also country representatives of the ICQFD and the chairman of the SC8 recommended that the ICQFD be appointed a liaison organization of the SC8. ICQFD members, in alphabetical order:

Ms. Veronica Gonzalez Bosch (Mexico, ITESM and QFD-LAT)
Dr. Nicklas Bylund (Sweden, Sandvik Corporation)
Dr. Catherine Chan (Hong Kong, China, Hong Kong QFD Association)
Dr. Georg Herzwurm (Germany, University of Stuttgart, QFD Institute Deutschland)
Dr. Robert Hunt (Australia, Macquarie University)
Dr. Aysun Kapucugil (Turkey, Dokuz Eylul University)
Mr. Glenn Mazur (United States, QFD Institute)
Dr. Paulo Augusto Cauchick Miguel (Brazil, University of Sao Paulo)
Dr. Hisakazu Shindo (Japan, Yamanashi University)
Dr. Kim Stanfield (UK, CSC Corporation)

The first formal WG2 interim meeting was held prior to the 2010 International Symposium on QFD in Portland, Oregon, and was attended by 8 of the above 10 members. At this meeting, several projects and teams were formed to begin writing the draft, and deadlines were established. Additional interim WebEx conference calls were also scheduled. The project teams were as follows:

1. Voice of customer—engineers
2. Review of the Japanese standard Q-9025
3. Architecture and structure of standard
4. Scope setting
5. QFD in design life cycle
6. ISO terminology alignment
7. QFD definitions
8. QFD principles
9. Minimum QFD effort
10. QFD methods
11. Related methods bibliography
12. Integration of all work in first draft

Step 3—Voice of the Customer—Engineers

QFD, at its core, is about designing in customer satisfaction from the beginning in order to assure first-pass quality acceptance. This requires that the developers understand clearly what customers want before design work begins. Though QFD is widely used in manufactured products, service products, and software products, I believe it was best to start with the voice of engineers who would use this QFD standard in the process of developing new products for their companies.

TABLE 1 Voice of the customer table for aerospace engineers (partial)

Segment	VOC (Standards User)	Customer needs	Design ideas
Aerospace Engineer	Where to look standard, how to find	Easy to find when I need it.	Put ISO links on ICQFD member websites?
	differs from our std	Easy to know how stand differs from our internal standards.	
	simple enough for average person to understand	Easy for non-QFD specialist to understand.	
	too loosey-goosey-is it worth the trouble	Standard is useful to my work.	Sufficient detail. Role specific (marketing, design, engineering, manufacturing, quality, supply chain, etc.)
	morphs over time to cover new req't-are we using current version? User wants to stay up to date with standard, offer suggestions on how to improve or make more relevant.	I am always from the current versio. I know when next version will be released so I can plan for it. Standard is useful to my future work.	Ongoing VOC feedback gathering.
	have multiple implementation levels within the standard. Common level, plus special areas with more meat.	Standard is easy for beginners to utilize. Standard is useful to my work.	Multiple implementation levels.
	make sure your customer and vendors buy into the standard-cost/benefit ratio.	Benefits of following standardare easy to explain to my customers. Easy for my vendors to follow the standard. Easy to follow standsrd.	
	easily accommodate changes in my business as technology changes.	Standard is easy to adapt to changes in my business.	Publish case studies?
	make something people want to use. must be easy to use, especially if voluntary.	Standard is useul to my work. Easy to follow standard.	
	must be on website. Best if no charge because of the effort to rationalize to my boss or company the need to pay for the documentation.	Easy to find standard when I need it. Benefits of following standard are easy to explain to my mamagement.	Standard published website.

Step 3.1—Identify Users of the QFD Standard

Most development projects today struggle to meet all requirements of all users and must accept that at best they should focus on meeting the most important requirements of the most important users. In a business environment, user importance can be measured by such criteria as revenue potential, profitability, market share, and other financial metrics. In ISO standards development, financial benefit is replaced by the sense of professional contribution and recognition the volunteer team members receive. Instead, we looked at industries that were most recently adopting QFD methods and selected aerospace, automotive, medical devices, and information technology business architects. The next step was to identify representatives from these industries for in-depth interviews in order to capture the voice of the customer.

Step 3.2—Capturing and Analyzing the Voice of the Customer

Voice of the customer starts our analysis of true customer needs, which QFD defines as the following

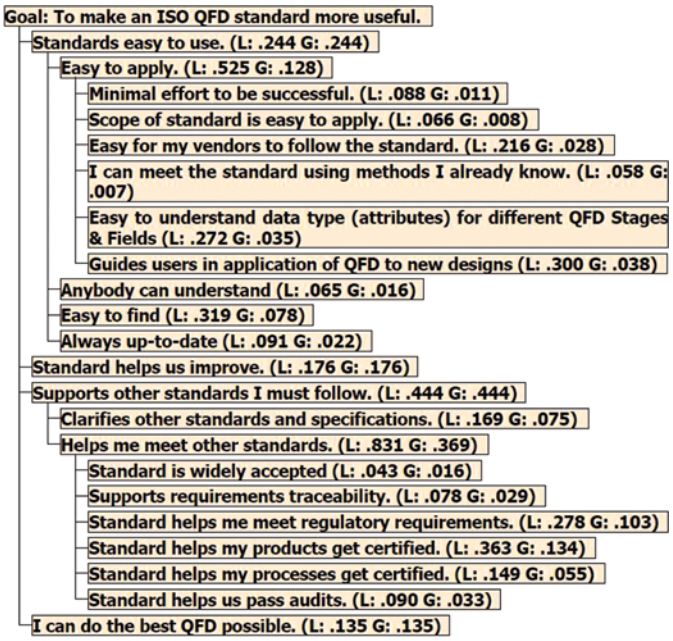

FIGURE 4 **Prioritized hierarchy of customer needs for QFD standard. (Color figure available online.)**

benefits to the customer: a problem solved, an opportunity enabled, or an image enhanced, *independent* of the solution. This is absolutely critical because customers, trying to be helpful, may suggest ways in which we can do things better. This presents two problems: (1) for the customer, *better* means *better for me* and may create conflict with better for another customer and (2) customer suggestions are based on their past experience—hardly the fodder for developing new and potentially game-changing solutions based on emerging technology. So, the QFD process encourages us to ask the customers what benefit they are seeking. This helps us think outside the box for solutions (if the need later turns out to have high priority) and not waste precious team time on solutions to low-priority needs. The QFD tool for analyzing customer needs and translating into true customer needs is the customer voice table, exemplified in Table 1.

Step 3.3—Prioritizing Customer Needs

Using the hierarchy diagram and AHP described above, users were asked to prioritize the needs from the voice of customer tables. The hierarchy had 51 customer needs at the tertiary level of the hierarchy, which is shown with priorities in Figure 4. Based on the global weights (indicated after G:), these customer needs were the highest priority for the standard:

- QFD standard helps my products get certified (G: 0.134).
- QFD standard helps me meet regulatory requirements (G: 0.103).

In other words, the QFD standard is most needed to help engineers get their products to pass other standards and requirements.

Step 4—Developing and Writing the Draft Standard

Based on the above customer needs, critical parts of the standard were written. At the time of this writing, the first draft was submitted to the ISO in June 2011. The draft generated intense interest in other ISO technical committees, particularly TC176, which is responsible for quality management. TC69/SC8/WG2 asked to coordinate with TC176/SC3 and have since drafted a new outline to include additional scope and materials. This is currently under development. A new timeline is also under construction.

CONCLUSION

Harnessing volunteer subject-matter experts is difficult. Having a plan for drafting a new standard was treated like any other new product development project, and QFD tools and methods were employed to find focus and direct efforts where they matter the most to prospective users of the standard. A follow-up paper is proposed to document the next steps in creating the final document.

ABOUT THE AUTHOR

Glenn H. Mazur, B.A., M.B.A., and QFD Red Belt®, has been active in QFD since its inception in North America and has worked extensively with the founders of QFD on their teaching and consulting visits from Japan. He is a leader in the application of QFD to service industries and consumer products, conducts advanced QFD research, and is the conference chair for the annual North American

Symposium on Quality Function Deployment. Glenn is the Executive Director of the QFD Institute and International Council for QFD, adjunct lecturer on TQM at the University of Michigan College of Engineering (ret.), President of Japan Business Consultants Ltd., and a senior member of the American Society for Quality (ASQ) and the Japanese Society for Quality Control (JSQC). He is a certified QFD Red Belt® (highest level), one of two in North America. He is a certified QFD-Architekt #A21907 by QFD Institut Deutschland. He is convenor of the ISO Technical Committee 69 Subcommittee 8 Working Group 2 to write an international standard for QFD. He is an academician of the International Academy for Quality. He is the honorary president of the Hong Kong QFD Association.

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