# Integrating QFD into Phase-Gate Product Design

**Glenn Mazur, QFD Red Belt®**
President, Japan Business Consultants, Ltd.
Executive Director, QFD Institute & ICQFD

## Abstract

Quality approaches to new product development as a pipeline for commercialization has been growing in recent years. Methods such as Stage-Gate™, Design for Six Sigma, Design for Lean Sigma, and others have been helping organizations structure their new product development processes. QFD has been recognized by all these methods as an important tool set within the process, but exactly what QFD tools to use and when to use them must be determined on a case-by-case basis by custom-tailoring the QFD process to the organization and the development process being used. This paper will show how experts integrate QFD into different processes and different companies, through similarities and differences in each. The discussion will focus on the characteristics of Stage-Gate™, but can be similarly applied to Design for Six Sigma (DFSS), Design for Lean Sigma, and how to truly benefit from these and other New Product Development (NPD) techniques by efficiently and correctly integrating QFD through customization into your unique NPD process and business strategy.

## Key words

Stage-Gate™, Design for Six Sigma (DFSS), Design for Lean Sigma, Narrowly-Defined QFD, QFD Customization, New Product Development (NPD), Quality Methods

## The "F" in QFD

In my translation of the seminal work, *QFD: The Customer-Driven Approach to Quality Planning and Development*,[1] the revised edition of the 1978 *Hinshitsu Kino Tenkai*, Dr. Mizuno cited the quality guru A.V. Feigenbaum's definition of a quality system as "the network of administrative and technical procedures required to produce and deliver a product of specified quality standards." Mizuno encouraged that such procedures should follow Shewhart's PDCA[2] (Plan-Do-Check-Act) quality management process. This system, Mizuno advised, was "a complex one formed from structural components such as manpower and machines." Dr. Mizuno then explained the manpower as "the corporate activities to achieve quality," the quality function that must be clarified in "each phase from product planning through final scrapping and then to execute them fully. To do so, we must understand the *who, what, when, where, why,* and *how* of these corporate functions." What Mizuno did was to apply the concept of "function" from quality disciplines such as value engineering, to the human functions common in any product development organization. This is the definition of the "F" in QFD, *not* the incorrectly cited reference to the mechanization of a component part.[3] Thus, QFD's combination of manpower and machines can be seen as a type socio-technical system.[4]

In Akao's second book of QFD case studies, *QFD: Integrating Customer Requirements into Product Design* this system was diagrammed,[5] as illustrated in **Figure** 1, a 1997 adaptation for software development by Richard Zultner of the QFD Institute.[6]

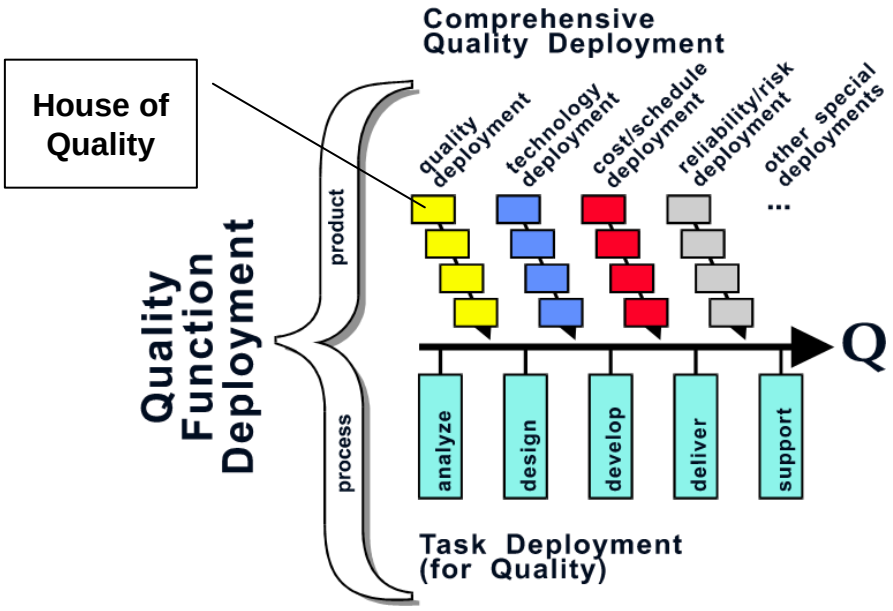


**Figure 1 QFD as a socio-technical system.**

This diagram warrants explanation. First, Akao described the entire diagram as "broadly defined quality function deployment" as indicated to the left of the bracket, and which has the goal of achieving quality (the arrow pointing to Q). This was divided into the socio-technical parts, which Zultner clarified as "process" (socio) and "product" (technical). Akao called the product deployment "comprehensive quality deployment" and further broken that into specific deployments, which he called quality deployment, technology deployment, cost deployment (Zultner added schedule deployment since for software development, the largest cost was scheduling resources), reliability deployment (Zultner added risk deployment since software does not "wear out" but design mistakes create project risk that must be managed), etc.

- Quality deployment drills down from high level functional requirements into component part design and production. The four charts shown here are the ones commonly used in the 4-Phase QFD promoted in the 1980s by the American Supplier Institute to auto parts suppliers building to print. The upper left square is the well-known House of Quality.
- Technology deployment drills down new innovations into functions and parts to assure they are designed to fulfill customer needs.
- Cost deployment is to proportion target costs to components based on the importance of the customer needs they correspond to.
- Reliability deployment is to prioritize failure modes during design according to correspondence to customer needs (failure to satisfy), quality characteristics (failure to perform), and functions (failure to function), and parts.
- The entire second row of matrices is assigned to the product's functionality (mechanical or human in a service product), and is also referred to as function deployment.

The details of Akao's Comprehensive QFD charts are shown in **Figure 2**.[7] This became the basis of Bob King's (of GOAL/QPC) Matrix of Matrices.[8]

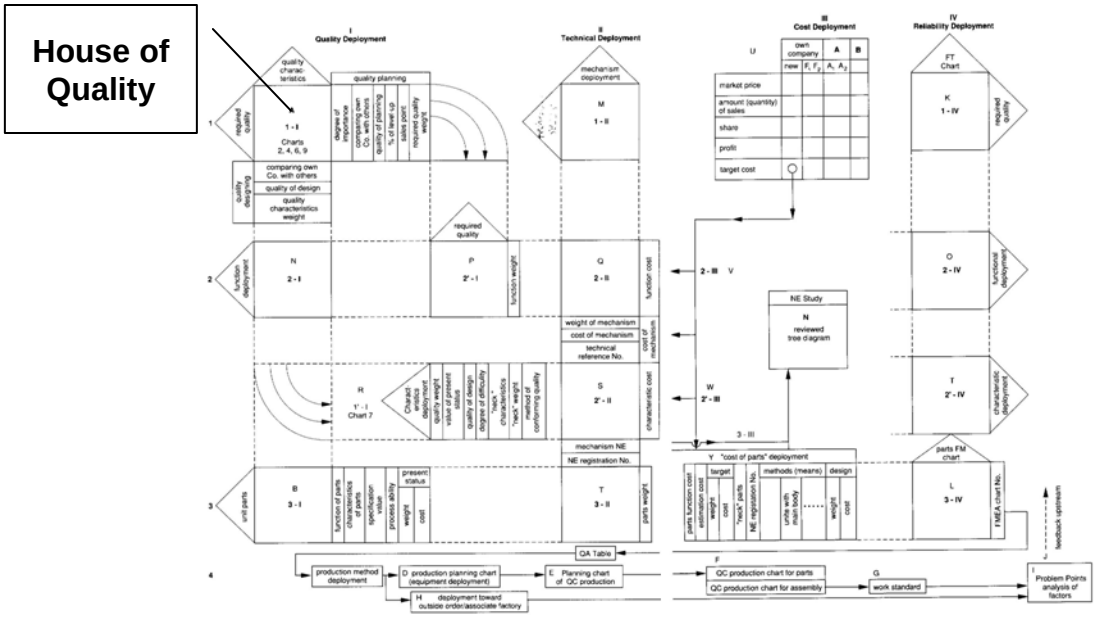


**Figure 2 Comprehensive QFD matrix details.**

The process part of the bracket shown below the Q arrow, refers to Mizuno's discussion of the organizational functions that perform job activities or tasks in order to develop and deliver the product. Akao lists the major ones for a physical product such as planning, design, trial, manufacturing, and service, and Zultner added major tasks for software development such as analyze, design, develop, deliver, and support. Akao labeled this section as "narrowly defined quality function deployment." In addition, the triangles on the matrices in figure 2, which are data hierarchy diagrams, *not* roofs, were labeled required quality deployment table and quality elements deployment table in the case of the house of quality (which was called a quality table).

So we have:

1. broadly defined quality function deployment
2. comprehensive quality function deployment
3. quality deployment
4. function deployment
5. narrowly defined quality function deployment
6. required quality deployment table
7. quality elements deployment table
8. quality table

that use the words quality, function, and deployment in some combination. And then there are all the specialty deployments.

As the translator and interpreter for both Drs. Mizuno and Akao, it was my job to properly clarify these combinations, and it took me some time to master the nuances. This was made possible through the joint efforts of the members of the GOAL/QPC Cross-Functional Management research committee[9] who met quarterly from 1987-1990, and included at various times Mary Lou Kotecki of John Deere, Stan Marsh, Jack Moran and Satoshi "Cha" Nakui (visiting graduate student of Akao and consultant with Mizuno) of GOAL/QPC, Jack ReVelle of Hughes Aircraft, and Richard Zultner, John Terninko, and Glenn Mazur who later established the non-profit QFD Institute in 1993 to continue the work of this committee.

Needless to say, the confusion of these similar sounding phrases eventually led to generalizations. Those who studied the automotive parts-oriented 4-Phase model used the term QFD to refer to Akao's quality deployment. Those who studied GOAL/QPC's matrix of matrices used the term to QFD to refer to Akao's comprehensive quality deployment. No one, it seemed, paid sufficient attention to the human process, the socio side that Mizuno was describing.

## QFD and the New Product Development Process

What Mizuno and Akao were describing was that in a true quality system, we needed to address not only the quality of the products being designed and produced, but the quality of the new product development (NPD) process itself that creates those products. In other words, not just the quality of an assembly of parts, but the quality of the human activities needed to design and produce those parts – human activities such as product planning, marketing, engineering, procurement, testing, manufacturing, packaging, after-sales support, etc.

This, of course is the true meaning of QFD in Japanese. The quality function is to be deployed across all the company. In product or process improvement activities such as kaizen[10], six sigma[11], quality story A-3s[12], etc. the focus is on existing products in production that fail to meet internal quality standards or fail in the field. This is definitely in the realm of the quality department to address. In new product development, however, there is no design, product, manufacturing process, etc. *yet* and so it is unrealistic to wait until there is in order for the quality department to do its job.

In NPD, quality must begin before design, when the business case is being developed that defines the scope and financial deliverables of the project, who the key customers are and how they are to be researched, what is the project timeline and what are the resource and budget constraints, etc. The quality of the answers to these questions can greatly affect what decisions, tradeoffs, technologies, production locations, vendors, etc. will be utilized. Since these are in the realm of different organization functions such as business planning, marketing, R&D, engineering, procurement, manufacturing, quality, distribution and logistics, customer support, etc. the only way quality can be assured is for these functions to work together from the start. This is what is called cross-functional management (CFM) and it is one cornerstone of total quality management (TQM); QFD is the CFM system for assuring new NPD quality by deploying the quality function across the total organization.

For example, what is marketing quality or the quality of the business plan? How do you assure these activities are done well enough? How do you measure the quality of forecasting the next ten years sales potential, or how do you measure the strength of competitive threats, etc. When doing customer visits, where do you go, who do you visit and when, etc. What is the most mathematically precise way for customers and their needs to be prioritized?[13] Of course, you could wait until post-launch numbers roll in, but then it is too late to design quality in. In many organizations, unfortunately, these activities are not well defined, and when the product does not meet expectations, fingers start to point in all directions. It seems we are better at cross-functional blaming than cross-functional management.

This requires an examination of all business activities from the board room to the plant floor. Quality targets must be set for each activity, team members, leads, and reporting requirements (including who, what reporting templates, where data is stored and how to retrieve, etc.) must be identified, when each activity is due, what standard operating procedures must be followed, what to do if there is a problem, etc. In other words, the same quality rigor that is expected from blue collar line workers is expected of the white collar managers. This is none other than Dr. Deming's 14 Points for Management[14] and Theory of Profound Knowledge[15] in action.

After each departmental function defines their activities and sets quality targets, these can be visually displayed in what Mizuno called a quality assurance systems diagram. This chart has vertical "swim lanes" for each function and horizontal sections for each NPD step, divided at the most abstract level into a Plan-Do-Check-Act sequence. In **Figure 3**,[16] we see one of the fascinating aspects of this diagram, customers are included and executives (called directors in Japan) are on parallel footing with other functions, not sitting atop some organizational chart. Bubbles indicate shared activities for which there are standard operating procedures, quality targets, time frames, and reporting templates (the House of Quality is one such template), etc. These are documented separately so as not to clutter the visual display of the flow chart. Each bubble extends to the department that has functional inputs to the activity. From each bubble flows a solid feed-forward line to the next activity or a dotted feed-back line from subsequent activities for information to be considered in the next product development cycle.

In the example here, we see that the process begins with an executive level strategic policy decision that flows to management for long term planning, to engineering for long term R&D planning, etc. Based on this strategy, sales begins market research that requires data from customers. This chart goes on for pages, covering the rest of the planning phase - product development, production planning, followed by the doing phase – trial manufacturing, procurement, followed by the checking phase - testing, prototyping, followed by acting phase - refine and release to manufacturing. It is a full PDCA process.

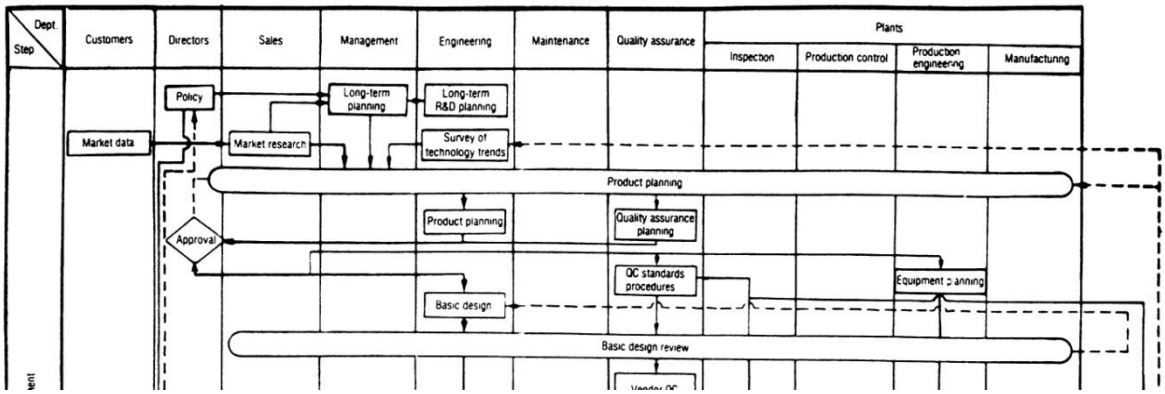


**Figure 3 Quality assurance system diagram (partial).**

The benefits of this quality assurance system include:

1. A documented process that can be followed on all projects creates a quality standard operating procedure. Standard procedures can be measured and data from one project can be a benchmark for other projects. Standard procedures can capture the intrinsic knowledge of senior staff and be used to train new hires.
2. This intrinsic knowledge now becomes explicit, forming the base of a Knowledge Management System[17], and can be applied to all new projects. This means that accumulated knowledge does not have to be relearned with each new project. Companies that routinely rotate staff gain confidence that projects will remain in scope regardless of changes in team membership.
3. Faster time to market results because the focus of new product development is on new issues, not relearning past ones. Data, once organized, becomes accessible more quickly.

## Custom Tailoring QFD

The chart in Figure 3 will change depending on what steps and activities are undertaken to develop a new product (the y-axis) and the organizational structure (the x-axis). In the body of the chart, the bubbles may join differently and the feed forward and feedback lines may connect differently. As these are based on the separate standard operating procedures that define each of these activities, it is likely these will call for different supporting documents and methods, depending on several factors, including:

- Organizational structure and reporting requirements.
- The customers, users, channels, competitors, and other marketing factors.
- Manufacturing, supply chain and materials. For example, if your product relies on natural materials, such as animal or vegetable products like leather or wood, your tailored process will require different steps than a software company because the natural variation in plant and animal materials due to weather and other phenomena does not exist in software code, which one written does not change unless by intent.
- Your technology and its future evolution.

Among the Japanese companies I have worked with, this tailored quality assurance system is considered more confidential than QFD charts like the House of Quality. The QFD managers explain that while the product specific matrices may contain useful information, competitors trying to copy them will only produce a "me-too" product some time after their product has been launched and they are busy working on the next generation. The quality assurance system, however, reveals the very heart and soul of the company and must be protected from outside eyes.

Still, high level diagrams are published from time to time. In Akao's 1990 case study book[18] several of the examples are preceded by a high level tailored QFD process flow. This is also true for the case studies published on the author's website and available for free download at www.mazur.net. Tailoring a QFD process is no trivial matter. One must have a deep understanding of QFD and other product development tools and combine this with an honest understanding of the strengths and weaknesses of an organizations product development process. Like Dr. Deming's admonition that "a system cannot understand itself. The transformation requires a view from outside," [19] QFD custom tailoring should not be undertaken by managers within the company, but by someone outside the organization who possess both the deep QFD understanding and an appreciation for the interdependence of members of the new product development system and how QFD can help them manage knowledge, how the tools of QFD can help control variation and help transform information into knowledge, and how the psychological benefits of a job well-done will help not only their company but their customers. This is a process of ongoing improvement and requires knowing what to change, what to change to, and how to cause the change – the basis of Eliyahu Goldratt's Theory of Constraints.[20]

The custom tailoring is done by a Technical Diagnosis of the NPD process, and the results are presented to management in a QFD Gold Belt® session to assure their understanding and support of the subsequent QFD activities. QFD Red Belts® at the QFD Institute administer a QFD Master Black Belt® program for the purpose of training QFD experts to do this custom tailoring. The program is based on our direct study with the founders of several management and decision approaches including Drs. Mizuno, Akao, Deming, Goldratt, and Saaty.

## Stage-Gate™ and QFD

While the need to address the NPD process itself has been well recognized, Mizuno's quality assurance system was difficult for most non-Japanese companies to embrace. Among the reasons were that Dr. Deming's PDCA (later called PDSA – S for study instead of check) was not well understood by management groups. What was more prevalent were P-P (planning without executing) and Do-Do (executing without planning), resulting in Do-Redo as an operating philosophy. In other words, management was not well systematized – with many believing the two were diametrically opposed. Managers needed freedom, not systems. Another reason was that the planning process required data collection and analysis beyond just financial and marketing metrics, and few organizations were equipped for that. Finally, the way QFD was taught outside Japan with an emphasis on the House of Quality, product and customer satisfaction offered more tangible results than fundamentally changing management.

Fortunately, improving NPD was being addressed in other ways. Among the most successful and imitated ways has been Dr. Robert Cooper's Stage-Gate™ approach. Cooper's investigations paralleled in time the development of QFD. His first publication, *Winning at New Products*, was published in 1986 based on research from 1972-1985. In the second edition published in 1993,[21] Dr. Cooper acknowledged the contribution of QFD, but describes only the 4-Phase approach and within that, only the House of Quality as a Stage 2 tool. Unfortunately, this limited perspective was not corrected in the third edition published in 2001.[22] In both editions, he dismisses QFD as too "complex and cumbersome … more as a conceptual tool." In fairness to Dr. Cooper, how could he know more about QFD than the sources he cites in the books? Nonetheless, Stage-Gate™ is now widely used both as a custom-tailored approach by Cooper's own specialists and in the more generic phase-gate approach by organizations attempting self-improvement.

Cooper's research of North American manufacturing firms detailed 13 activities in new product projects as shown in **Figure 4** which he then describes in great detail, including very valuable suggestions on how to improve the quality of each activity. In a 2000 paper, I showed how the tool and methods of Comprehensive QFD could be integrated into these activities to improve the quality of their execution.[23] In essence, I was looking to westernize the full Akao "broadly defined QFD" in figure 1 by replacing Mizuno's "narrowly defined QFD" with Coopers Stage-Gate™ process.

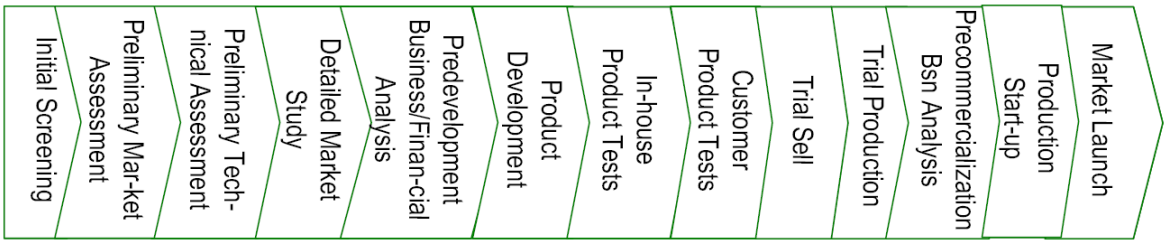


**Figure 4 Cooper's 13 NPD activities.**

Stage-Gate™ is a process for doing projects right and doing the right projects, which Cooper defines as "building in the voice of the customer, doing the necessary up-front homework, using cross-functional teams," combined with "astute project selection and portfolio management." There are several versions of generic Stage-Gate™ as well as numerous tailored approaches which are understandingly kept confidential by the companies using them. The generic models depend on the project – is it a refresh, next generation, or new discovery; is the project timeline tight; what is the competitive threat; and other considerations. The model Dr. Cooper advances in his books is shown in **Figure 5** during which the above NPD activities occur. At each stage (box) there is research

that must be conducted and then presented at each gate (diamond) to a product steering committee for review and a go/kill decision.


**Figure 5 Cooper's typical Stage-Gate™ model.**[24]

Cooper explains eight factors that make this process successful.

1. Quality process.
2. Manages risk with stages and gate decisions.
3. Gates are central to weeding out bad projects, assuring homework is done, and setting up following stages.
4. Parallel activities improve speed to market.
5. Cross-functional team with authority.
6. Market-driven and customer-focused.
7. Pre-development homework.
8. Superior differentiation and customer value.

The QFD world is quite familiar with these benefits. Mizuno's quality assurance system in figure 1 is build by a PDCA analysis of all NPD activities. While the stages are not grouped the same as in Stage-Gate™, the nonetheless exist along with gate or decision diamonds to manage risk. Parallel activities, cross-functional teams, and of course customer focus are also standard in QFD.

Here is a quick review of the stages, gates, and tools. Where relevant, QFD tools that equal or add to Cooper's tool set are noted. Also, since Cooper has suggested that the House of Quality is a Stage 2 tool, note that many of the pre-HoQ Blitz QFD® tools work extremely well for Discovery and Stage 1. Examples of the QFD tools can be found in several of the case studies on the author's website at www.mazur.net/publishe.htm.

**Discovery (also called Stage 0)**

Cooper defines two approaches to discovery – bottom up based on technological possibilities and top-down based on unmet market needs. Cooper recommends several tools such as the Thomson Solutions Process, market maps, customer value chain mapping, customer industry drivers and competitors, and Porter's Five Forces model to assess industry changes. Parallel to this, the company should examine its own industry with an analysis of strengths, weaknesses, and core competencies. Also recommended are scenario analyses of alternative futures, customer problem analysis, Sear's Product Value Analysis™ to have customers interact with product concepts and express their opinions, customer surveys, and focus groups. In general, these tools help harness the company's perceptions about the customer. This is one of Stage-Gate's™ strongest phases.

Akao diagrammed the interrelating flows between market driven innovation and scientific discovery so that unmet needs drive the science and science develops solutions before the needs are known. [25] The QFD and other related tools that can then strengthen this stage include Hoshin Kanri[26] to capture and execute long term strategies and policies, TRIZ technology evolution,[27] customer process and value stream mapping, customer segments table and scene deployment to visualize alternative scenarios, Lead User Research, and gemba visits to observe customers at work. **Table 1** Customer segments table. is an example of the customer segments table in which various customer and use scenarios are re-connected in alternative combinations.[28] These QFD tools help harness the customer's perceptions about themselves.

**Table 1 Customer segments table.**

| # | Criteria | Customer Segment | Who Benefits From | Cust/ Stake? | Key? | What | Where | When | Why | How |
|---|---|---|---|---|---|---|---|---|---|---|
| CS1 | Revenue | Oncology Radiation | Patient | Cust | ■ | Emotional Comfort | DI | Day shift | BuildTrust | Verbal |
| CS2 | ease of identification | MRI Outpatient | PCP | Stake | □ | inform | Oncology | Evening shift | Consistency | body language |
| CS3 | growth | Laboratory | Physician specialist | Stake | □ | Individualized Care | Lab | Weekday | Preferred choice/Reputation | best practice |

## Gate 1: Idea screening

Cooper suggests three project selection methods – benefit to company, economic (investment), and portfolio (set of projects).

In QFD, we might employ these same analyses and then link the results to upstream and downstream decisions, such as why projects are key to some customers that need to be studied further. Strategic QFD and Speed Deployment can be used to not only look at the benefits of a project, but to sequence and release projects to optimize resource utilization.[29]

## Stage 1: Scoping

This is a quick and low cost investigation into the potential for projects from both market and technology perspectives based on secondary sources such as sales and distribution channels, internet searches, etc.

The modern Blitz QFD® approach can add a great deal of information here. This process is quick, low cost, and uses customers to better understand both the customer needs and the product solutions that will drive the project. After key segments are determined in table 1, gemba visits[30] are made to map out both the satisfiers and dissatisfiers in the customer's work and life, capture their "voice" employing all the senses, translate the VOC into true customer needs, find unspoken needs, have customer prioritize their needs, and then define functional requirements and technology challenges for the most important needs only. The Maximum Value table is also used to assure that project tasks necessary to address critical-to-customer needs are not de-scoped to meet budget or schedule constraints. The Blitz QFD® tool flow is shown in **Figure 6**.

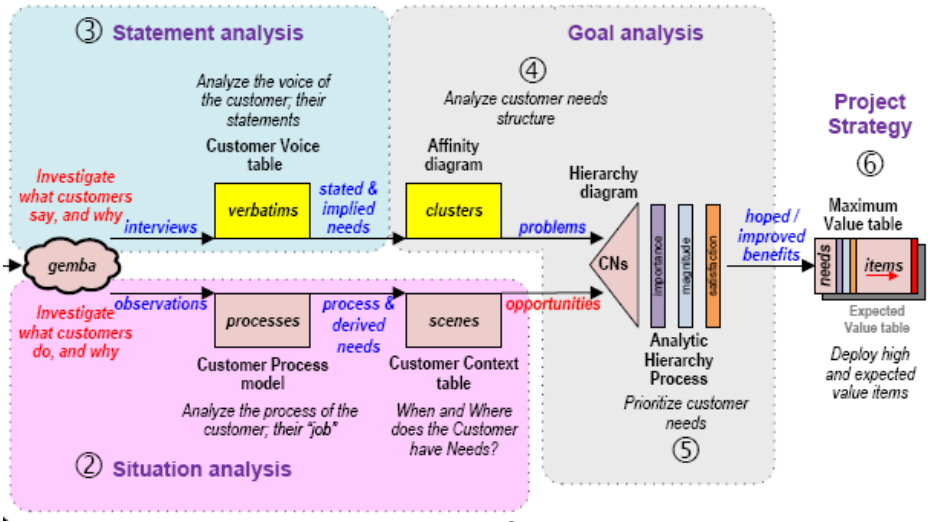


**Figure 6 Blitz QFD® flow chart.**

**Gate 2: Second screen**
Projects that are still under consideration undergo another go/kill decision. Criteria may include both quantitative and qualitative factors. Cooper prioritizes these criteria as "must-meet" and "should meet."

In QFD, we use Saaty's Analytic Hierarchy Process to build a project prioritization model that yields an absolute value for each project in ratio scale by prioritizing both quantitative and qualitative project selection criteria, and then scoring the project alternatives against each of the criteria. "Must" and "should" words give way to a more scientific analysis that allows all decision makers to cast their votes even if consensus cannot be achieved. The resulting portfolio of projects can adjusted for project management concerns using strategy and speed deployment.

**Stage 2: Building the business case**
The three components of the business case are product and project definition, project justification, and project plan. This includes an in-depth analysis of customer needs and competitive alternatives translated into a product design and technical feasibility, and then concept tested with customers. Financial deliverables are detailed. Stage-Gate™ templates ask a series of questions such as how does the customer solve his problem now, are there unsolved problems, what is the preferred brand, what are the choice criteria and how do competitors rate, what features are looked for, etc.

QFD can strengthen this process by creating visual maps to the above questions which not only display what is known, but trigger questions about what data is missing. As Cooper acknowledges, the House of Quality can not only capture the answers to these questions, but quantify them and map the degree to which customer value is fulfilled by product target specifications. Saaty's Analytic Hierarchy Process not only models what is most important to customers, but adds measurability to both perception and performance of competitive alternatives in the quality planning table and design planning table, and precise relationships between customer needs and product requirements. The application of AHP to customer needs is shown in **Table 2**. Additional gemba visits can also be made to learn more about how customers operate their business or achieve their life goals.

**Table 2 AHP to prioritize customer needs.**

| Tertiary CNs | Occupation of my time | Comfort while waiting | Comforting environment | Test Done at RRMC | Test done right the first time | *normalized columns* | | | | | sum | row avg |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Occupation of my time | 1 | 3 | 1/4 | 3 | 3 | 0.167 | 0.305 | 0.135 | 0.200 | 0.265 | 1.072 | **0.214** |
| Comfort while waiting | 1/3 | 1 | 1/5 | 3 | 2 | 0.056 | 0.102 | 0.108 | 0.200 | 0.176 | 0.642 | **0.128** |
| Comforting environment | 4 | 5 | 1 | 5 | 5 | 0.667 | 0.508 | 0.541 | 0.333 | 0.441 | 2.490 | **0.498** |
| Test Done at RRMC | 1/3 | 1/3 | 1/5 | 1 | 1/3 | 0.056 | 0.034 | 0.108 | 0.067 | 0.029 | 0.294 | **0.059** |
| Test done right the first time | 1/3 | 1/2 | 1/5 | 3 | 1 | 0.056 | 0.051 | 0.108 | 0.200 | 0.088 | 0.503 | **0.101** |
| | 6.000 | 9.833 | 1.850 | 15.000 | 11.333 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 5.000 | 1.000 |
| | | | | | | | | | | Inconsistency Ratio | | **0.08** |

**Gate 3 and Stage 3: Development**
The outcome of Stage 3 is a prototype that has been validated with customers. Cooper promotes continuous customer involvement throughout this stage to avoid mistakes, especially if requirements change during development.

Comprehensive QFD deployments shown in figure 2 are called for at this stage. These can include function, technology, reliability, cost, safety, parts, and other design dimensions that affect realization of the product concept. The New Kano Model[31] can be used to understand what features or levels of performance meet basic expectations and what it takes to excite the customer. Lifestyle Deployment using Kansei Engineering[32] can be used to add emotional quality and attractiveness to

a product. In QFD, the prototype is not used to find mistakes, but rather to validate that the initial design is correct. In other words, changing customer requirements are often the result of misunderstanding and poor customer needs analysis in Stages 1 and 2. The QFD tools emphasize quality thinking to get the customer needs right the first time. QFD gate decisions at this point are no longer go/kill but rather go/do more homework.

**Gate 4 and Stage 4: Testing and Validation**
Cooper encourages beta and field testing to allow customers to use the product and to capture their reactions. Test marketing is a way to clear up any remaining uncertainties.

QFD can support this by test deployment which helps prioritize the tests so that if shortcuts are taken due to schedule or budget issues, the most critical tests are conducted first. Test deployment might use criteria such as past test results, which tests most impact the most important customer needs, etc. The QFD matrices allow what-if analyses to be run both up- and downstream.

**Gate 5 and Stage 5: Launch**
Cooper focuses most attention on the marketing plan, accounting for economic, social, technological, and other trends that might influence market acceptance. Target markets are selected and positioning and value propositions are delineated. Channels, pricing, and advertising are evolved into sales strategies.

While all these are critical, QFD veterans are already asking – where is manufacturing and production quality, sourcing and supply chain considerations, standard operating procedures and operator training, quality control and improvement? Of course, we have several deployments in QFD to address these and other pre-production and production issues. After all, the customer buys a finished product not just a concept. So, all of these must be added as a kind of Stage 4.5 I think. Further, in QFD, issues like segmentation, market trends, channels, packaging, etc. are addressed much earlier since these can all influence design decisions. It is simply too late to leave these to Stage 5 in this author's opinion.

**Post-launch review**
Most companies using Stage-Gate™ conduct a financial post-mortem. Were initial financial and market goals met, and why/why not.

QFD can stretch this review to include analyses like who is responsible for maintaining the product for upgrades, problem solving, etc. Also, work on the next generation begins by taking market feedback (remember the dotted feedback lines in figure 3?) into improving not only the product but the NPD process itself. QFD is now seen as a cradle-to-cradle process where there is no rest in the quest for customer satisfaction and competitiveness.

## Other NPD Models

There are other approaches to improving the new product development process. In addition to Mizuno's quality assurance system and Stage-Gate™, there are phase gate variations that apply similar principles. Other programs the author has integrated QFD into are Advance Product Quality Planning (APQP) and QS-9000[33] used widely throughout the auto industry, Design for Six Sigma,[34] Product and Cycle Time Excellence (PACE®),[35] and portfolio management systems.

One of the most powerful the author has integrated QFD into is called the DREAM[36] process which is built on a very robust phase gate model. It was developed by Douglas A. Horne and the Institute for Quality Advancement located in Toronto, Ontario, together with Darren Childs, Vice President

of Quality Improvement at Rutland Regional Medical Center in Rutland Vermont. Doug's roots are in Bell Canada and he worked extensively with Michael Brassard of GOAL/QPC (author of the Memory Jogger[37] series). DREAM follows the PDCA model, like Mizuno, and divides the process into these steps:

**Plan**

Step 1. Define Requirements
Step 2. Feasibility Check
Step 3. Initial Design Proposal

**Do**

Step 4. Final Design
Step 5. Plan & Test the Design

**Check**

Step 6. Check the Results

**Act**

Step 7. Fully Deploy
Plan for Continuous Improvement

DREAM is very strong in the project charter, scope, and gate reviews as well as the downstream development and implementation quality, but weak in getting unspoken customer needs. The integration of Blitz QFD® tools into DREAM is shown in Figure 7 DREAM and Blitz QFD® integration.**Figure 7**. This has proven valuable in determining key customer needs so they can receive the most attention during product development.

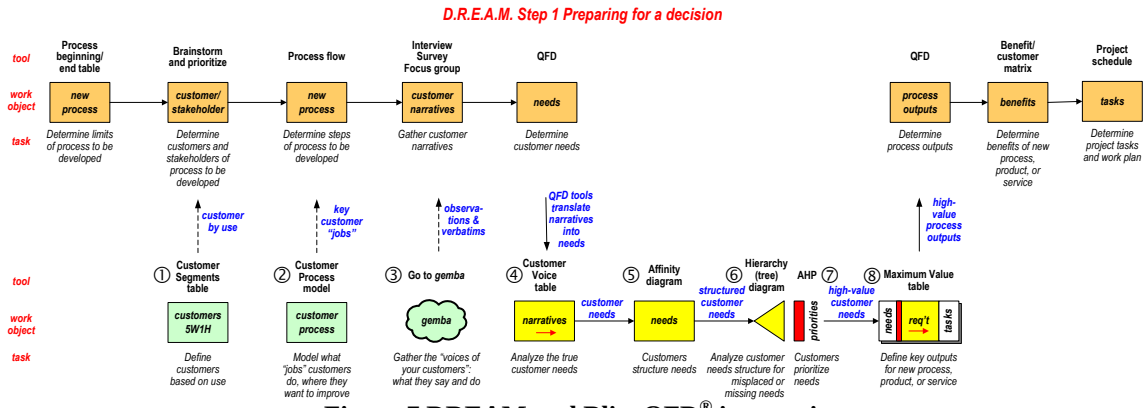


**Figure 7 DREAM and Blitz QFD® integration.**

## Conclusion

Since its earliest inception in the 1960s, QFD has had a dual focus – improve products and improve the process by which they are developed. As a TQM method, a rigorous application of the Plan-Do-Check-Act model has been followed. In the West, product improvement captured attention first because it lead quickly to improved customer satisfaction and profits. Long term prosperity, however, requires fundamental changes in the way an organization operates. These changes are more difficult because they are not about one project, but about management philosophy and quality principles – easy to pay lip service, hard to sustain.

Yet, if QFD is to make sustainable impact on improving customer satisfaction, competitiveness, and financial bottom lines, it must not be relegated to a project-by-project status, but must be inte-

grated in the new product development process of the organization. A one-size-fits-all model is not the best way to do this. It requires custom tailoring QFD to fit into the company in terms of its management style, products, customers, technology etc. The 4-Phase QFD model that was truncated from Akao's quality deployment model in figure 1 worked well for auto parts suppliers in the 1980s building to customer supplied requirements. But that model does not hold for most companies today, not even auto part suppliers.

Design for Lean Sigma[38], right sizing, global competitiveness, economic pressures, speed to market concerns, and other factors mean that organizations cannot afford to do all the QFD they would like. It may be best that QFD start slowly; addressing the most pressing issues the organization is facing in new product development. Integrating some of the Blitz QFD® tools first can bring fast and powerful results that draw the attention of others. Success breeds more success, and within a few projects, enough data will accumulate to build more Comprehensive QFD tools. Of course, these efforts must add value to the NPD staff – marketing, engineering, manufacturing, etc. or they will be abandoned. Since 2000, this process of integrating QFD into Stage-Gate™ and similar NPD processes through the QFD Gold Belt® and Technical Diagnosis, followed by QFD Green Belt® training on real projects and QFD Black Belt® training to develop in-company facilitators and trainers has met with outstanding success. As new tools and methods are created, QFD has the flexibility to incorporate them into the quality thinking of its users.

The real winners are our customers, of course, who face the pleasurable quandary of having so many good choices to make when spending their hard-earned money.

## About the Author

**Glenn H. Mazur** 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 is 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. **Glenn@Mazur.net**

## Notes

[1] Mizuno, Shigeru and Yoji Akao, ed. 1994. *Quality Function Deployment: The Customer-Driven Approach to Quality Planning and Deployment*. 2nd edition. Translated by Glenn Mazur. Tokyo:Asian Productivity Organization. pp. 6-8. ISBN 92-833-1122-1
Mizuno, Shigeru and Yoji Akao, ed. 1978. *Hinshitsu Kino Tenkai.* 1st edition in Japanese. Tokyo: JUSE Press.

[2] Gabor A. 1990. *The Man Who Discovered Quality*, Penguin Books

[3] The incorrect definition of the word "function" in QFD is found in non-Japanese books in the US, Europe, and elsewhere almost as soon as it was introduce to the US. It is so pernicious, that it can be found in even recent books on QFD such as *Quality Function Deployment and Six Sigma, Second Edition: A QFD Handbook* (2nd Edition) by Joseph P. Ficalora and Louis Cohen in section 1.3.1 on the origins of QFD.

[4] Socio-technical systems are a design approach that recognize the complex interactions between people and technology. In computer design, this has come to include the direct participation of end-users in the information system design process, a concept we find in QFD and gemba visits. The term socio-technical systems is attributed to Eric Trist and Fred Emery of the Tavistock Institute in London, UK in the 1960s.

[5] Akao, Yoji, ed. 1990. *Quality Function Deployment: Integrating Customer Requirements into Product Design.* Translated by Glenn Mazur. Cambridge, MA: Productivity Press. p. 13 ISBN 0-915299-41-0 1990.

[6] Zultner, Richard E. 1997. "Project QFD: Managing Software Development better with Blitz QFD." *Transactions of the 9th Symposium on QFD.* QFD Institute. pp. 391-402. ISBN 1-889477-09-5

[7] ibid Akao. 1990. pp. 16-17.

[8] King, Bob. *Better Designs in Half the Time.* 1987. GOAL/QPC. p. 4 ISBN 1-879364-01-8

[9] "Quality Function Deployment Advanced QFD Application Articles." 1991. GOAL/QPC Research Committee, 1990 Research Report, No. 90-12-03.
"Cross-Functional Management." 1991. GOAL/QPC Research Committee, 1990 Research Report, No. 90-12-01.

[10] Imai, Masaaki. 1986. *Kaizen: The Key to Japan's Competitive Success.* McGraw-Hill. ISBN 0-07-554322-X

[11] Breyfogle III, Forrest W. 1999. *Implementing Six Sigma: Smarter Solutions Using Statistical Methods.* John Wiley & Sons. ISBN 0-471-29659-7

[12] Dennis, Pascal. 2006. *Getting the Right Things Done: A leaders guide to planning and execution.* Lean Enterprises Institute. ISBN 0-9763152-6-2

[13] In early QFD studies from the 1960s before the age of personal computers, charts were manually drawn and priorities quantified with an abacus-friendly 1-5 ordinal scale. In the late 1980s, widespread use of PCs enabled more precise ratio scale methods, such as the Analytic Hierarchy Process, developed by Dr. Saaty. See Saaty, Thomas L. 1990. *The Analytic Hierarchy Process.* Pittsburg:RWS Publications. ISBN 0-9620317-2-0

[14] Deming, W. Edwards. 1982, 1986. *Out of the Crisis.* MIT-CAES. ISBN 0-911379-01-0

[15] Deming, W. Edwards. 1993. *The New Economics: For Industry, Government, Education*. MIT-CAES. ISBN 0-911379-05-3

[16] ibid Mizuno and Akao. 1994. p. 110.

[17] Akao, Yoji. 2007. "QFD and Knowledge Management: QFD Application on the Development of a Finger Vein Authentication Device." *Transactions of the 19th Symposium on QFD & 13th International Symposium on QFD.* QFD Institute. ISBN 1-889477-19-2

[18] ibid Akao 1990.

[19] ibid Deming 1993. p. 94.

[20] Goldratt, Eliyahu M. 1990. *Theory of Constraints.* North River Press. pp. 7-8. ISBN 88427-085-8

[21] Cooper, Robert G. 1993. *Winning at New Products. 2nd edition.* Addison-Wesley. ISBN 0-201-56381-9

[22] Cooper, Robert G. 2001. *Winning at New Products. 3rd edition.* Basic Books. ISBN 0-7382-0463-3

[23] Mazur, Glenn. 2000. "QFD 2000: Integrating QFD and Other Quality Methods to Improve the New Product Development Process." *Transactions of the 12th Symposium on QFD & 6th International Symposium on QFD.* QFD Institute. ISBN 1-889477-12-5

[24] ibid Cooper 2001. Inside front cover.

[25] ibid. Akao 1990. pp. 256-257.

[26] Akao, Yoji, ed. 1991. *Hoshin Kanri – Policy Deployment for Successful TQM.* Translated by Glenn Mazur. Productivity Press. ISBN 0-1915299-57-7
Mazur, Glenn and Hisashi Takasu and Michiteru Ono. 1998. *Policy Management – Quality Approach to Strategic Planning.* Integrated Quality Dynamics. ISBN 0-9-664655-0-4

[27] Mazur, Glenn. TRIZ website at www.mazur.net/triz

[28] Childs, Darren, Dom Serino, Melissa Bartlett, Shannon Stover, and Glenn Mazur. 2010. "DREAM/QFD to Re-design Staff Service Excellence at Rutland Regional Medical Center." *Transactions of the 22th Symposium on QFD & 16th International Symposium on QFD.* QFD Institute. ISBN 1-889477-22-2

[29] Zultner, Richard E. 1998. "QFD Schedule Deployment – Doing Development Faster with QFD." *Transactions of the 10th Symposium on.* QFD Institute. pp. 521-533. ISBN 1-889477-10-9

[30] Mazur, Glenn and Nicklas Bylund. 2009. "Globalizing Gemba Visits for Multinationals." *Transactions of the 15th International Symposium on QFD.* Monterrey MX

[31] Mazur, Glenn and Richard Zultner. 2007. "Kano Model: The Latest Developments." *Transactions of the 18th Symposium on.* QFD Institute. ISBN 1-889477-18-4

[32] Mazur, Glenn. 2005. "Lifestyle QFD: Incorporating Emotional Appeal in Product Development." *Transactions of the 17th Symposium on.* QFD Institute. ISBN 1-889477-17-6

[33] *Quality System Requirements QS-9000.* 1st edition 1994. AIAG.

[34] Creveling, C.M., J.L. Slutsky, and D. Antis Jr. 2003. *Design for Six Sigma.* Prentice Hall. ISBN 0-13-009223-1

[35] McGrath, Michael E. 1996. *Setting the Pace in Product Development*. Butterworth Heinemann. ISBN 0-7506-9789-X

[36] ibid Childs, et al
Letendre, Kathy, Jill Jesso-White, and Glenn Mazur. 2010. "QFD to Re-design New Physician Orientation and Induction: Connecting New Physicians into a Healthcare Community." *Transactions of the 22th Symposium on QFD & 16th International Symposium on QFD.* QFD Institute. ISBN 1-889477-22-2

[37] Brassard, Michael and Diane Ritter. 1994. *Memory Jogger II.* GOAL/QPC. ISBN 1-879364-44-1

[38] Kennedy, Michael N. 2003, 2008. *Product Development for the Lean Enterprise.* Oaklea Press. ISBN 1-892538-18-0