Keynote: QFD and the New Voice of Customer (VOC)

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Abstract

A systematic approach to translating the voice of the customer (VOC) into the voice of the engineer (VOE) has been the strength of quality function deployment (QFD) since its inception. Methods to acquire VOC have evolved since QFD in the 1960s. Early case studies used customer-supplied specifications, often from other engineers, to write a list of technical requirements that were then sorted into various QFD charts, called houses, in order to assure their quality through design, build, and commercialization. Case studies beginning in the 1980s exemplified that VOC acquisition could begin further upstream at the user level, and techniques for interviewing and observing customers using the products were employed. In the 2000s, these ad hoc customer visits grew more planned and purposeful by first identifying key customers based on use cases to be investigated. The Japanese term, *gemba* visit, demanded a more structured approach to researching customer pain points in order to discover what product improvements mattered most. This prioritization of customers and their pain points proved valuable in a lean development environment where budget, schedule, and resource constraints limited interactions between customers and the development team. Recently, the widespread availability of so-

cial media and big data collection has created new means to acquire VOC. This paper will discuss some of these trends and how QFD practitioners can best use them.

History of VOC in QFD

1966

Kiyotaka Oshiumi of Bridgestone Tire was among the first to publish on QFD in 1966[1] regarding production process assurance items. This article introduced the use of a fish-bone-like diagram to associate manufacturing process assurance items such as tread weight in the tread extrusion process with market assurance items such as maneuverability and feeling vibration. Since these market assurance items are related to the vehicle performance rather than tire characteristics, they define market assurance items as independent of the tire design and build. These market assurance items are extracted from spoken and latent customer needs, which were acquired through a process simply labeled "understand market."[2]

1978

Yoichi Negoro and Yasuhiro Tanaka of Kubota write

> the market research group should provide data on market-demanded quality, including sales information, service data, information on complaints, information from questionnaires, and so on. Market-demanded quality includes known and hidden needs. Known needs can be obtained easily, but identification of hidden needs is difficult. The Kubota division has been in contact with product users at product test locations and has talked with them in order to obtain firsthand information on the hidden needs of farmers.[3]

1986

Yoji Akao illustrated in Figure 1[4] how to observe customers using the product in the gemba in order to capture their voice. Unfortunately, this illustration was deleted in the later

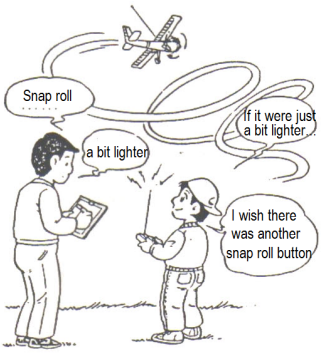


Figure 1 Capture VOC at the gemba

book version. Here we see the QFD team member confirming and noting the customer verbatims during reseach by Futaba on the design of a remote contol airplane.

1990

Tadashi Ohfuji, Michiteru Ono, and Yoji Akao add another source of voice of customer, the free-response sections of surveys.[5]

1994

Yoji Akao emphasizes that

> even when a customer specifies a certain characteristic value, the wants underlying the specified value (that is, why the value was specified) must be understood. If a means of implementation or measure has been specified, the demands underlying why such a means or measure must be captured. [6]

What we see is that over the formative years of QFD, a progression of Voice of Customer acquisition methods from

- market research to understand the customer
- observation of customers at a test facility
- going to gemba while customers use product
- free response in questionnaire.

VOC in 2000s

The growth in six sigma and lean thinking in recent years has promoted a quality perspective based on "going to the *gemba*" to see for oneself and to gather data about operations. While six sigma and lean experts focus on existing internal *gembas* in order to reduce variation and eliminate wasteful activities, the QFD connection is quite clear. Controlling processes variation and eliminating waste are internal concerns about existing products. For new product realization, the *gemba* shifts from internal operations (which are not yet designed) to external operations in the customer's world. With this mindset, our engineers must accompany our sales and marketing people to visit the customer's operations (or life) in order to help them solve problems like variation and waste in their tasks, help

them grasp business or life opportunities currently beyond their grasp, and help them improve their image to others or to themselves. The first two are related to "use" and the latter two to "esteem." To acquire this information, there are two modes of interactions with customers: semantic and situational.

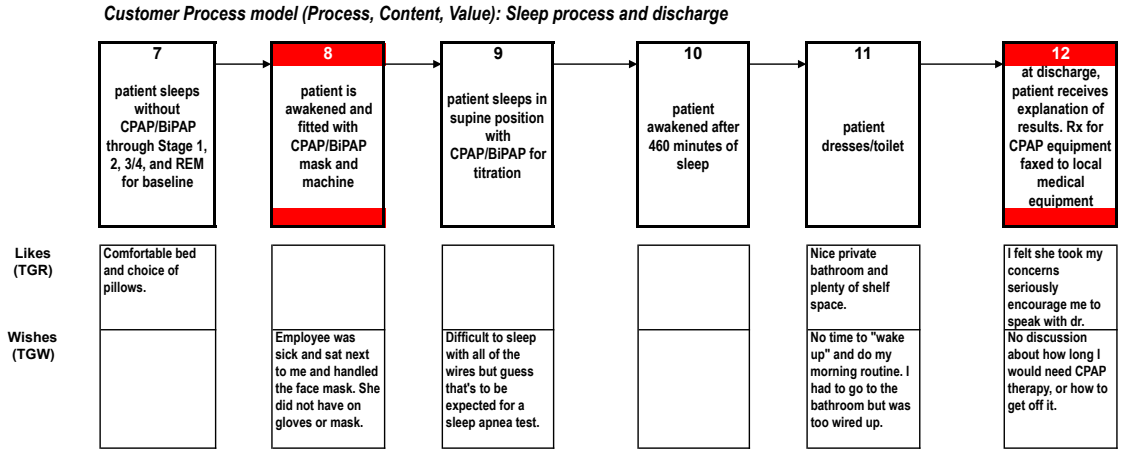
Semantic Analysis

This is an analysis of customer language in order to identify unspoken or latent requirements. Since surveys, questionnaires, focus groups, and similar market research tools follow scripts written by the company, they rarely get to unspoken issues. In other words, they confirm what "we know we know," answer what "we know we don't know," but cannot address "what we don't know we don't know." For this, we need to get the customer to discuss their work or life, rather than our product. Modern Blitz QFD® has incorporated new tools to accomplish this.

Customer Process Model

Similar to value stream mapping in six sigma, the QFD models in advance or at the first gemba visit, the customer's work or life process. The team then asks the customer to talk through each step expressing what works in their process well (so the team protects this in any new design) and what goes wrong in their process (so the team can address this in any new design). The team can ask the customer how they measure their (dis)satisfaction with their process as well as minimum acceptance levels and maximum benefit levels. Finally, the team can ask the customer which process steps are the biggest "pain points" that keep them from being more satisfied and productive. This kind of data is often referred to in six sigma as process (steps), content (things gone right/wrong), and value (measurement of satisfaction). An example from a sleep disorder clinic is shown in Table 1. These pain points will be more deeply examined with situational analysis.

Table 1 Customer process model



Situational Analysis

Ideally, the QFD should try to observe the customer's work or life process in full. However, time and access limitations of both the customer and the team often make it impossible to observe everything. At a minimum, a QFD team should go to the pain point steps first, as that is where any improvement is most likely to pay off big for the customer and the company.

Gemba Visit Table

This tool is used to document the details of the gemba visit and begin the analysis process. The table has two main sections: the particulars of the visit and the conditions of the gemba, and the particulars of the customer process step under examination. This second section documents input evidence such as what the customer does (observations), what the customer says (verbatims), physical or informational evidence, and team thoughts and perspectives. Essentially, the input evidence are from the five physical senses plus the sixth sense of mental thought. The QFD team works with the customer when time allows or later, to "clarify" or simplify these input evidence into single-issue statements. The value of single-issue statements is that they lead to crisper prioritization in later steps. This is also a chance for customers to explain how they measure (dis)satisfaction in greater detail. Finally, the team can begin to categorize these statements as either customer benefits (needs) or product features (functional requirements) that will populate

the rows and columns of a House of Quality matrix in later steps. An example from the sleep clinic is shown in Table 2.

Table 2 Gemba visit table

Interviewee:	John Doe		Interviewer(s):	MG & JC	
Email:	John@Doe.com		Date and Time:	12/30/12 7:10pm	
Phone:			Place:	Sleep Disorders Center	
Customer characteristics (*memorable):	52 year old male professional, obese, travels internationally for work * purple pajamas				
Environment: Early winter heat and dryness					
Process # Task	Observations	Verbatims	Team Notes	Clarified Items *(measurement)*	Benefit or Feature?
8 patient is awakened and fitted with CPAP/BiPAP mask and machine	Employee did not have on gloves or mask.	Employee was sick and sat next to me and handled the face mask. She did not have on gloves or mask.	What are standards and who is responsible for monitoring staff hygiene?	I don't catch anything from the staff. *(not sick within 3 days of procedure)* I don't catch anything from other patients. *(not sick within 3 days of* Clinic staff follow standard hygiene rules. *(rules are posted for all to* Management enforces hygiene rules. *(# sick staff interfacing with patients = 0)*	B B F F
12 at discharge, patient receives explanation of results. Rx for CPAP equipment faxed to local medical equipment center		No discussion about how long I would need CPAP therapy, or how to get off it.	Staff prepared to explain "next steps" for patient, not to answer non-routine questions, instead referring patient to discuss with doctor, who is not there.	I can choose where to have Rx filled, since on-line stores charge less than local retail medical equipment center. *(option to select supplier* Procedure for follow up visit to monitor progress is explained. *(make next appointment now)* Procdure for discontinuing CPAP when condition improves is explained.	B F F

The data in both the customer process model and the gemba visit table will later be refined into clear customer needs for prioritization by the customer.

VOC in 2010s

The technology to enter global markets creates new opportunities to understand customers' voices. First, we can learn that different cultures, different demographics can have similar problems and opportunities, but how they want to address them can be different than the methods familiar to the engineers of the maker. That means, in part, that we want customers to direct us to what is most important to them. Social media is an evolving window into self-demonstrated lifestyles. Product simulators allow customers to "virtually" experience different alternatives and even to custom design their own product features. Ubiquitous video cameras, aside from their security purpose, show how customers behave

both in purchase mode (which is good for packaging and label design and retail planograms) and in use mode. Big Data, the name given to acquiring preferences and shopping habits from retail and web stores are statistically mined for trends.

YouTube

One of the easiest ways to discover how your product is used, could be used, and should never be used is to search the internet by use case, your brand name, competitors' brand names, complaints, etc. YouTube self-made video clips range from the initial "unboxing" of a product (hints to package designers) to common and unexpected use and to disposal. Unexpected use modes can be useful to developers because it can predict unmet needs that the consumer is adjusting the product to achieve, or it can identify safety issues if the consumer is abusing the product. For example, one company found a user had added extra welds in order to handle more extreme applications. See Figure 2.

Figure 2 Added welds for extreme applications

In another part of the video, another user, wearing tennis shoes, is unsafely kicking a steel attachment, as shown in Figure 3.

Figure 3 Unsafely kicking steel attachment, wearing tennis shoes

When the QFD team sees the customer making adjustments to customize the product, they are hearing a VOC telling them that the standard design is inadequate for their use. Here are possible interpretations.

1. If this customer constitutes a significant segment, the QFD team should consider changes in design or in the product line.
2. This could be a clue about trends in user applications that next generation products could consider.
3. This could explain warranty and customer complaints. Many companies "blame the customer" for breaking a product because they used it beyond specified limits. The QFD team has a chance to make designs more robust to "reasonable" applications.

When the QFD team sees the customer making unsafe actions, they are hearing a VOC telling them that "safety" is either too much trouble or non-intuitive. Here are possible interpretations:

1. The safe operations are too difficult, such as adjusting the attachment in Figure 3, and in order to meet productivity goals, unsafe shortcuts are taken. The QFD team should evaluate usability and safety issues with the product.
2. Safety is non-intuitive or is not made impossible to violate. This means that the safe use is not easy. The QFD team should consider things like "customer *pokayoke*"[7] which is an adaptation of this lean six sigma mistake-proofing tool for customer operators.

Simulations

Simulators allow customers to test or practice with software the various functions and performance levels of a product under development. This allows engineers to see frustrations, problems, and opportunities before expensive hardware is designed. In one project involving air and water rescue operations, trainees identified that obstacles below the surface of the water were inadequately represented in the simulators, thus posing a safety hazard. Boeing used simulators in *Kansei* engineering studies to optimize the emotional quality of interior design on the new B787 Dreamliner.[8] Figure 4 shows customers standing in a 270^{o} projection of various interior architecture options.

Figure 4 Elumens dome projection for B787 interior

CCTV

Close circuit television is becoming ubiquitous in many countries for security concerns. When legal, it can also capture observation data on customer behavior during product use or during retail shopping. This can provide valuable data for both product and packaging design.

Big Data

"Big" data go beyond normal data because their size and complexity overwhelm traditional databases and data processing tools. Big data share three common characteristics:

1. Volume. In 2015, it is estimated to reach 8 zettabytes ($8x10^{21}$), partly due to the lowering costs of data storage.
2. Velocity. Data transfer is getting faster.
3. Variety. Databases, documents, email, audio and video files, financial transactions, etc.[9]

Big data are used to improve predictions by inferring the probabilities based on the historical data collected. By collecting all data (N), hidden connections may become evident, different hypotheses can be tested

As physical and on-line retailers encourage customers to share personal data, companies are now aggregating this into consumer profiles that can help drive advertising messaging by tailoring communications and recommending what similar customers have also selected.

How can big data work in QFD for gather the voice of the customer, and not just the response of the customer (replying to online forms for personal information and satisfaction surveys)? Here are some possible areas of integration.

1. Market segmentation. Statistical analysis can ferret out hidden differences in demographics and use modes. For example, one automotive company conducting a Kano survey was able to determine significant

differences in expectations about braking performance between men and women. Figure 5 illustrates part of the study that "discovered" that averaging survey responses hid segmentation differences. Analysis of the data helped "tease" out these differences allowing the auto maker to offer two braking experiences for entry level and performance level vehicles marketed to women and men.

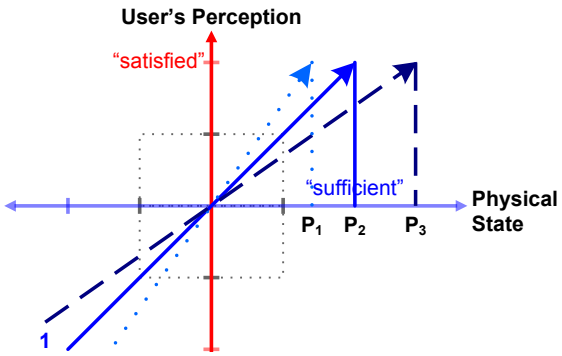


Figure 5 Kano data analysis "discovers" customer segment differences

2. Discovering preferences based on purchases of unrelated items. Big data can show correlations between segments and characteristics of other purchases. Big Data helps detect patterns in customer behavior that can help QFD teams predict future needs. In Kansei Engineering, cited above, studies can be conducted on other products the segment prefers. From this, the characteristics and performance level (both attribute and continuous variables) can be tested in the subject product.
3. Other uses of big data are the subject of work in the ISO Technical Committee 69 for Applications for Statistical Methods. Subcommittee 8 is writing ISO 16355 for QFD. Subcommittee 7 is formulating a proposal for Big Data.

Concerns about Big Data

Methodological concerns include:[10]

- Statistical predictions of a whole population improve with random sampling. But random sampling is difficult to break into segments.
- Data collection may introduce bias. However, since much of the data are collected through everyday transactions, conscious bias may be reduced.

- Data quality must be improved regarding variables and collection methods from multiple data sources that may have omissions and errors.
- Unlike *gemba* data, there is no context to Big Data, which could result in misinterpreting the data.

Security concerns[11]:

- Loss of personal and financial data.
- Discrimination and profiling predictions of financial risk, for example likelihood to repay a loan or likelihood to have certain health conditions. Algorithms can make errors.
- Violation of privacy.

Conclusion

Global markets and customers create new problems and opportunities for product realization teams. The need to predict what customers need and will buy is critical to building a solution with limited resources. The human intensive collection of data through surveys and focus groups will need to be augmented with other forms of VOC collection. This paper explored some new approaches to acquiring such data.

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 honorary president of the Hong Kong QFD Association. He is convenor of the ISO Working Group 2 of the Technical Committee 69, Subcommittee 8 to write the international standard ISO 16355 for QFD and a member of the Technical Committee 176 responsible for ISO 9000 series standards. He is an Academician and Secretary-Treasurer of the International Academy for Quality. Additional papers and related topics: www.mazur.net

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