

VOICE OF CUSTOMER ANALYSIS:

A MODERN SYSTEM OF FRONT-END QFD TOOLS, WITH CASE STUDIES

SUMMARY

Quality Function Deployment (QFD) has been used world-wide since 1966 (Mizuno and Akao 1994) by organizations to bring new products to market faster, better, and cheaper. The earliest QFD models focused on assuring quality in the factory so that production processes would deliver goods as designed. As early QFD adopters became proficient with the methodology, their improvement focus moved upstream in order to improve the quality of the designs themselves. In recent years, QFD has continued this upstream move towards improving the quality of understanding the customers' requirements that drive the design. The latest tools and techniques, called Voice of Customer analysis, are the subject of this paper. Here, they will be introduced, the steps explained, and case studies given to illustrate their power, in the hope that readers will be able to use these tools and techniques to enhance their own QFD and new product development processes.

INTRODUCTION

What is Quality Function Deployment? Basically, QFD is designed to improve customer satisfaction with the quality of our products and services. What can QFD do that is not already being done by traditional quality systems? To understand QFD, it is helpful to contrast the differences between modern and traditional quality systems.

TRADITIONAL QUALITY SYSTEMS

Traditional approaches to assuring quality often focus on work standards (Love 1986), automation to eliminate human error-prone processes, and in more enlightened organizations, Quality Improvement Teams to empower employees to resolve problems.

As organizations are finding out, however, consistency and absence of problems are not enough of a competitive advantage after the market shakes out suboptimal players. For example, in the automobile industry, despite the celebrated narrowing of the "quality" (read that fit and finish) gap between U.S. and Japanese makers, Japanese cars still win the top honors in the J.D. Powers Survey of New Car Quality. Suboptimal makers have all but disappeared from the North American market, the fit and finish of today's North American built vehicles are better than ever, but still the Japanese makes of Toyota, Nissan, and Honda grab top honors.

Nothing Wrong ≠ Anything Right

MODERN QUALITY SYSTEMS

QFD is quite different from traditional quality systems which aim at minimizing negative quality (such as poor service, broken product). With traditional systems, the best you can get is *nothing wrong* - which is no longer good enough. In addition to eliminating negative quality, we must also maximize positive quality (such as convenience, ease of use). This creates **value** which leads to customer satisfaction.

Quality Function Deployment is the only comprehensive quality system aimed specifically at satisfying the customer. It concentrates on maximizing customer satisfaction (positive quality) - measured by metrics such as repeat business. QFD focuses on delivering value by seeking out both spoken and unspoken needs, translating these into actions and designs, and communicating these throughout the organization. Further, QFD allows customers to prioritize their requirements, benchmark us against our competitors, and then direct us to optimize those aspects of our product and organization that will bring the greatest competitive advantage. What business can afford to waste limited financial, time and human resources on things customers don't want or where we are already the clear leader?

TYPES OF REQUIREMENTS

To satisfy customers, we must understand how meeting their requirements effects satisfaction. There are three types of customer requirements to consider (see Figure 1) (Kano, et al 1984).

Revealed Requirements are typically what we get by just asking customers what they want. These requirements satisfy (or dissatisfy) in proportion to their presence (or absence) in the product or service. Fast delivery would be a good example. The faster (or slower) the delivery, the more they like (or dislike) it.

Expected Requirements are often so basic the customer may fail to mention them - until we fail to perform them. They are basic expectations without which the product or service may cease to be of value; their absence is *very* dissatisfying. Further, meeting these requirements often goes unnoticed by most customers. For example, if coffee is served hot, customers barely notice it. If it's cold or too hot, dissatisfaction occurs. Expected requirements *must* be fulfilled.

Exciting Requirements are difficult to discover. They are beyond the customer's expectations. Their absence doesn't dissatisfy; their presence excites. For example, if caviar and champagne were served on a flight from Detroit to Chicago, that would be exciting. If not, customers would hardly complain. These are the things that wow the customers and bring them back. Since customers are not apt to voice these requirements, it is the responsibility of the organization to explore customer problems and opportunities to uncover such unspoken items.

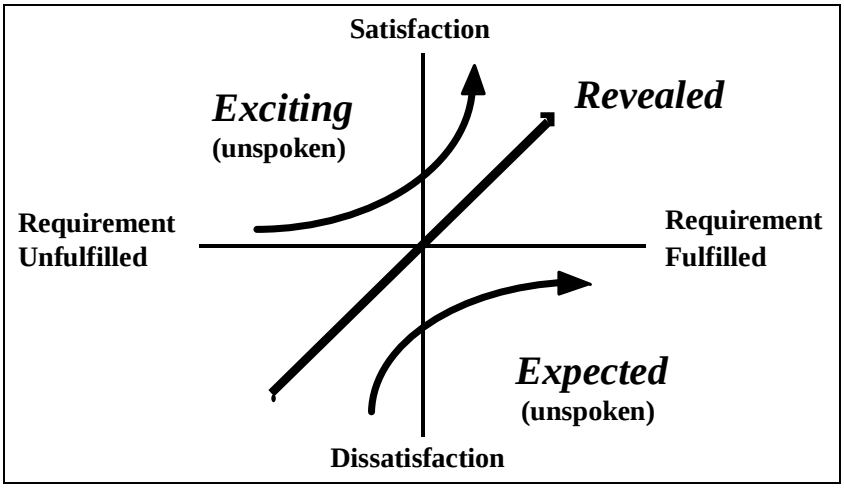


Figure 1. Kano Model (adapted). Products and services must meet all three types of requirements - not just what the customer says.

Kano's model is also dynamic in that what excites us today is expected tomorrow. That is, once introduced, the exciting feature will soon be imitated by the competition and customers will come to expect it from everybody. An example would be the ability to have pizza delivered in thirty minutes. On the other hand, expected

requirements can become exciting after a real or potential failure. An example might be when the passengers applaud after a pilot safely lands the airplane in rough and stormy weather.

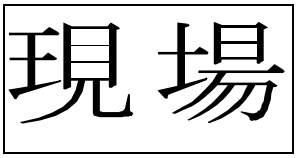
The Kano Model has an additional dimension regarding which customer segments the target market includes. For example, the caviar and champagne that's exciting on the domestic flight might be expected on the Concorde from New York to London. Knowing which customer segments you want to serve is critical to understanding their requirements.

Thus, eliminating problems is similar to meeting expected requirements. There is little satisfaction or competitive advantage when nothing goes wrong. Conversely, great value can be gained by discovering and delivering on exciting requirements ahead of the competition. QFD helps assure that expected requirements don't fall through the cracks and points out opportunities to build in excitement.

In summary, Kano found that the exciting needs, which are most tied to adding value, are unspoken and thus invisible to both the customer and the producer. Further, they change over time, technology, market segment, etc. The Voice of Customer analysis tools and techniques were created to break through this dilemma.

GEMBA: THE SOURCE OF VOICE OF CUSTOMER DATA

The Japanese have coined a word to describe the *true* source of information - the call it the *gemba.* The gemba is where the product or service becomes of value to the customer, that is, where the product actually gets used. It is in the gemba that we actually see who our customers are, what their problems are, how the product will be used by them, etc. We go the gemba in QFD to see our customer's problems and opportunities as they happen. Unlike other customer information gathering techniques, such as focus groups, we do not ask questions about our problems with technology or marketing, we are not removed to an artificial site such as a meeting room (unless our product is tables and chairs), and we are not relying on customers' memories to report problems to us. Rather, we can employ all of our senses to work for us by using contextual inquiry, video taping, audio taping, direct observation, direct interviewing with customer's employees, etc. for the larger purpose of trying to understand how we can help our customers better conduct their business with *their* customers.



Going to the gemba requires planning. While paying customer visits is not

new, books (McQuarrie 1993) on the subject are often long on advice and short on tools and techniques to maximize the value of such visits. QFD, as a quality based methodology, brings several tools together from the Seven Quality Control Tools (Brassard and Ritter 1994, JUSE 1991), the Seven Management and Planning Tools (Brassard and Ritter 1994, Mizuno 1988, Nayatani et al 1994), the Seven Product Planning Tools (Gustafsson 1996, Kanda 1994, Kanda 1995), and several specialized tools as will be described herein. A customer visit planning guide for using these tools developed by Mazur (1995) to assist those going to the gemba. Issues that should be dealt with in advance are summarized in Table 1 below.

Table 1. Planning to go to Gemba.

Which	Who	When	Where	What	How
customers to visit?	from your company should go?	is the customer using your product?	is the customer using your product?	information do you need?	will data be captured?
employees at the customer?	has what roles?			problems/opportunities are customers facing?	will data be analyzed?

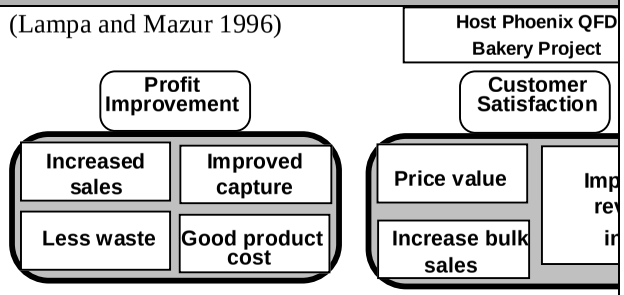
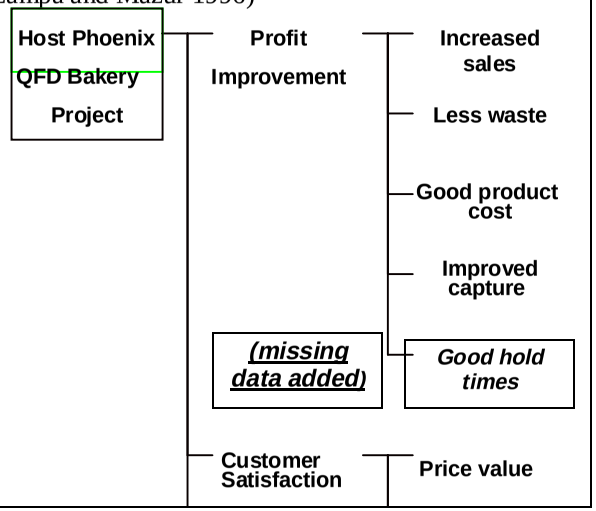
The tools and techniques will be presented here with examples from real products and services, although in some cases, products still under development with which the author has non-disclosable knowledge will be disguised. The tools will be presented in the most common order of use, although customization for specific projects is encouraged. They are organized into a table that describes the task at hand, the tool, what the tool does, step-by-step instructions for using the tool, and a case study. Since these tools are meant to be used by the reader, this quick look-up chart format seemed eminently more logical than pages of prose describing the same thing.

HOW MANY GEMBAS

In a study reported by Pouliot (1992), about 70% of customer requirements were captured in as few as ten to twelve gemba visits. Additional visits yielded little more than repetitious data. Since the purpose of the gemba visit is to get an understanding of customer voices, not a statistically valid sample from which to determine

preferences and choice (this is done later in the QFD process in the Quality Planning Table), it takes much less effort than other quantitative research methods. It has been the author's experience that fifteen gemba visits are sufficient to elicit nearly all revealed requirements (the 70%) and that the other 30% which represent the unspoken expected and exciting requirements can be analyzed with the Voice of Customer tools and techniques explained in this paper.

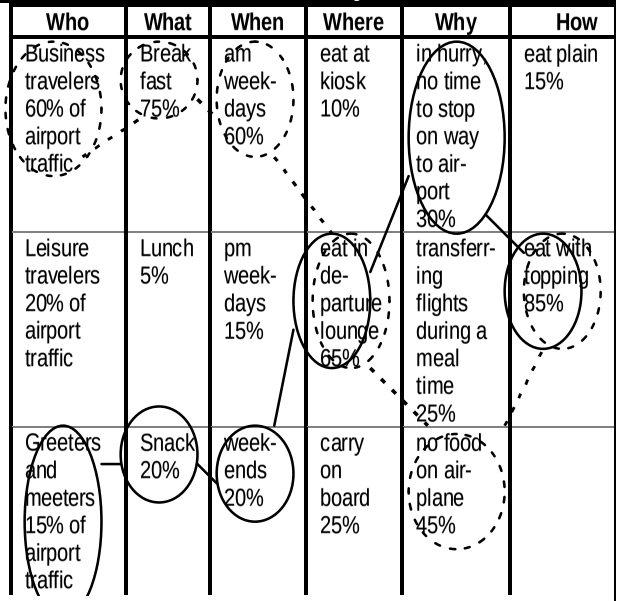
Since the number of customers visits is small, it is best to optimize them by focusing on customers who are significant to the success of the project. The Chart of Tools begins at this point with Task No. 1.

Task	Tool	Purpose	Step-by-step Instructions	Case Study
1. Define and prioritize project success criteria. • This aligns to same goals, team members who work for different functional bosses. • Develop selection criteria for determining to which gemba to go.	**Brainstorming** (Brassard and Ritter 1994)	Quickly generate ideas in a process that promotes discussion without criticism.	1. Define goal (not action) statements with clear measurable targets, measurement method, and deadline. 2. Common goals are profit, ROI, market share, utilization of capacity, time to market, etc.	Increase customer satisfaction as measured by J.D. Powers and Associates from 13th place to 5th place by 2000.
	Affinity Diagram (Brassard and Ritter 1994, Mizuno 1988, Nayatani et al 1994)	Reveal underlying structure of ideas. Rather than predetermine categories and slot ideas into them, this allows ideas themselves to form natural groupings.	1. Write each criterion on a Post-It™ Note. 2. Arrange silently into clusters based on a shared affinity 3. Discuss header cards to represent each cluster. Grouping groups is permitted.	(Lampa and Mazur 1996) 
	Hierarchy Diagram (Tree) (Brassard and Ritter 1994, Mizuno 1988, Nayatani et al 1994)	To refine Affinity Diagram groupings in terms of overlap between levels of abstraction, and to identify missing ideas.	1. Lay Affinity Diagram out left to right with most abstract level to the left. 2. Adjust hierarchy nodes so that they represent same degree of abstraction at each level. Nodes at each level should be mutually exclusive. 3. For each node, review leaves and add any missing items. For each node, leaves should represent collectively exhaustive set.	(Lampa and Mazur 1996) 

Task	Tool	Purpose	Step-by-step Instructions	Case Study
	Analytic Hierarchy Process (Matrix) (Saaty 1990, Zultner 1993)	AHP uses pairwise comparisons to measure importance and yields ratio scale priorities. These are more accurate than other prioritization methods such as rank order since they show distance between values, and can be mathematically manipulated.	1. Create a matrix with the same data in both the rows and columns. This can be done for each node and its leaves immediately to the right. In the case study, only the most abstract level is illustrated. 2. Compare each pair of data in terms of importance on a one to nine scale, with one meaning equal in importance and nine meaning the row is extremely more important than the column. The diagonal is all ones and the numbers below the diagonal are the inverse of numbers above the diagonal. 3. Normalize columns and then add the normalized values across the rows and normalized again to yield the ratio scale % of priority. 4. When team members cannot agree on the degree of importance, the geometric average of their votes is entered into the matrix instead. In other words, neither the team nor the managers have to agree for the process to yield accurate results. Saaty has software that does this easily.	

AHP Case Study
(Lampa and Mazur 1996)

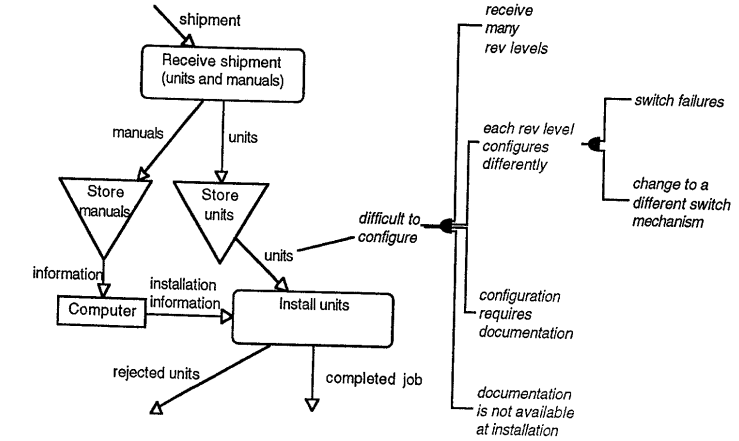
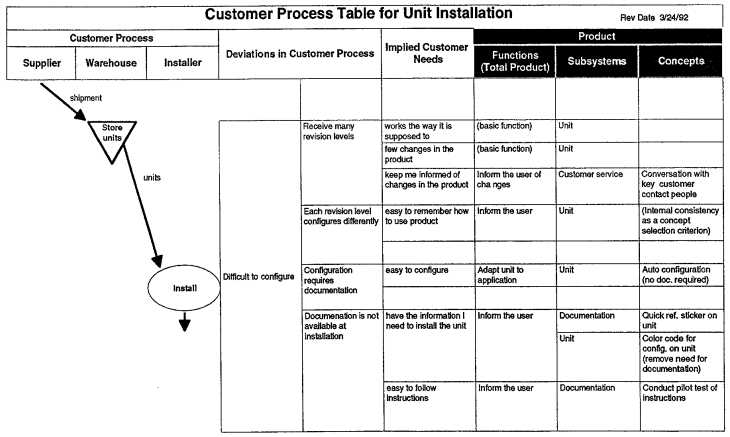
	CS	AS	LL	PI	WR	NORMALIZED COLUMNS						ROW SUM	%
						CS	AS	LL	PI	WR			
CUSTOMER SATISFACTION (CS)	1	5	9	5	9	0.62	0.77	0.45	0.44	0.27		2.55	**50.9%**
ASSOCIATE SATISFACTION (AS)	0.2	1	5	5	9	0.12	0.15	0.25	0.44	0.27		1.24	**24.8%**
LANDLORD SATISFACTION (LL)	0.11	0.2	1	0.2	5	0.07	0.03	0.05	0.02	0.15		0.32	**6.3%**
PROFIT IMPROVEMENT (PI)	0.2	0.2	5	1	9	0.12	0.03	0.25	0.09	0.27		0.76	**15.3%**
WIN & RETAIN CONTRACTS (WR)	0.11	0.11	0.2	0.11	1	0.07	0.02	0.01	0.01	0.03		0.13	**2.7%**
TOTALS	1.62	6.51	20.20	11.31	33.00	1.00	1.00	1.00	1.00	1.00		5.00	100.0%

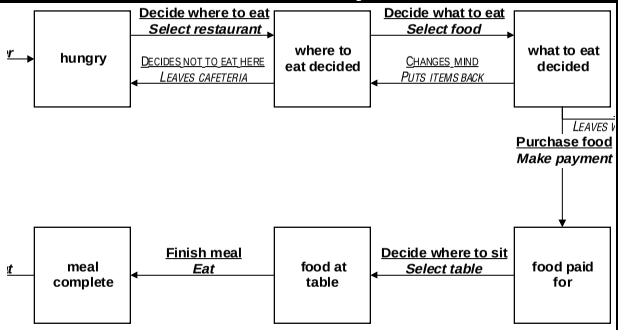
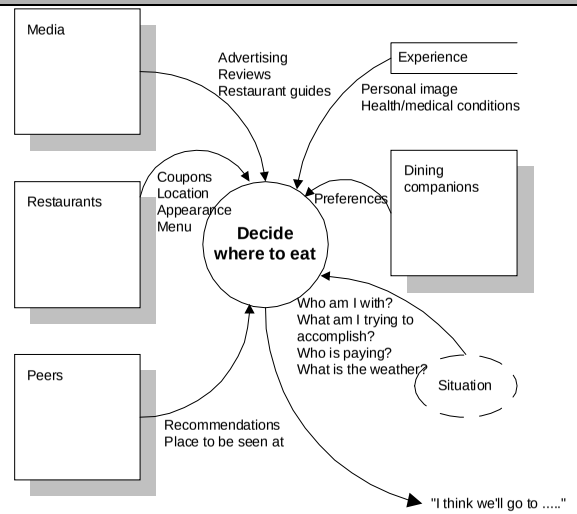
Task	Tool	Purpose	Step-by-step Instructions	Case Study
2. Define and apply selection criteria to key market segments. • QFD team can define both current and unknown potential markets. • Team can identify most promising customer segments. • Team can apply limited resources	**Customer Segment Table.** (Daetz et al 1995 Ch. 9, Mazur and Zultner 1996)	QFD team can quickly identify both use and demographic data about potential customer segments, and then quickly identify most important segments.	1. Create a table with 5W1H column headers of who will use product/service, what will they use it for, when will they use it, where will they use it, why will they use it, how will they use it. Other categories can be added as needed to define the customer segments. 2. In each column, list as many items as possible, including any market research data on market size, sales, % etc. for each item. 3. Circle promising characteristics of each customer and link together in a chain to profile a customer segment. Try to identify 10-15 promising customer segments this way.	 (Zultner and Mazur 1996.)

Task	Tool	Purpose	Step-by-step Instructions	Case Study
of time, people, and money to most promising customers first.	**Project Success Criteria / Customer Segments Matrix** (Zultner 1992, 297-319, Mazur 1995a) Variations of this are the Project Success Criteria / Core Competencies Matrix and the Core Competencies / Customer Segments Matrix (Mazur 1993).	The project success criteria are used to prioritize the customer segments to further focus on key customers' gembas. The approach here is that scarce customer visit resources should be applied first to customers most likely to help our project succeed, and to satisfy their needs first.	1. Put the hierarchy and weights from the AHP of the project success criteria into the rows of a relationship matrix (Brassard and Ritter 1994, Mizuno 1988, Nayatani et al 1994). Put the 10-15 most promising customer profiles into the columns. 2. Working row by row, identify the degree of contribution each customer profile has to each project success criteria. Enter a value of 0-9, with 9 being strongest in the intersecting cells. A variation of this is to use the QFD symbols (and points) of ◎ (9), ○ (3), △ (1). 3. Multiply the AHP weights by the strength of contribution values in each cell, and sum the products of these multiplications for each columnar customer segment. Normalize to a percentage. 4. Apply time, people, and money resources in proportion to the customer segment weights to making customer gemba visits. An alternative is to pick the highest weighted customers and ignore the others.	Japan Business Consultants, Ltd. Organization Goals vs Customer Segments (Mazur 1995a) Date: 23 Oct 93 c:\qfd\jbcqfd\capdata\goalcust Strong Relationship: ◎ 9 Medium Relationship: ○ 3 Weak Relationship: △ 1

Customer Segments	Automotive industry	Exporters	Management consultants	Translation agencies	Government	Japanese in U.S.	Org. Goal Wt.
Organization Goals							
Financial independence			○	◎		◎	49.5
Exploit expertise	○			◎		○	39.4
Control of time			◎		○		4.6
Gain knowledge		△		△	○	◎	6.5
Abs. Wt.	118	7	190	807	33	622	
Cust. Seg. Wt.	7	0	11	45	2	35	

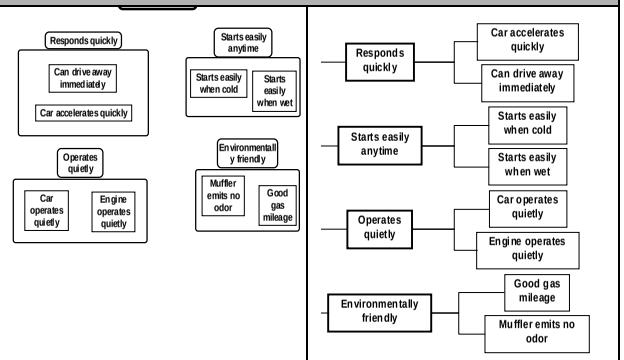
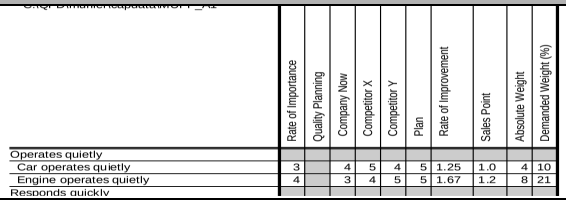
3. Go to the Gemba. • Walk a mile in your customer's shoes to un-	**Check list.** (McQuarrie 1993, 160-162, Mazur 1995a)	Assure that customer visit is well planned (see Table 1 above).	1. Determine team members. Have at least one inside and one outside person. Set roles and responsibilities, including observer, recorder, lead talker, etc. 2. Determine who in the customer's	**I. Set objectives *(Plan)*** **A. Kinds of information you want to collect** 1. clear, agreed upon objectives

Task	Tool	Purpose	Step-by-step Instructions	Case Study
derstand how he does business, what his customers need, and what problems he has satisfying their needs.			business, home, etc. you need to visit, and arrange time appropriately. 3. Determine what equipment will be needed to capture voice of customer, and become familiar with using it. 4. Make plans for debriefing other teams. 5. Rehearse with safe "customers" such as employees.	2.non-conflicting 3.limited number 4.not a sales call **B.Prioritize visit objectives** 1.Analytic Hierarchy Process (AHP) From Customer Visits Implementation Guide (Mazur 1995a)
	Flow Charts, Fault Tree Analysis. Customer Process Table. (Nelson 1992)	Diagram your customer's issues and processes.	1. Visit customer's gemba and discuss/observe customer's work and processes. 2. Map customer's processes. 3. Look for deviations, potential failures in customer's processes. 4. Uncover implied customer needs. 5. Clarify customer's functions and subsystems that perform those functions. Propose new concepts to perform those functions better than customer's current methods.	
	 (Nelson 1992, 322)			 (Nelson 1992, 325)	

Task	Tool	Purpose	Step-by-step Instructions	Case Study
	State Transition Diagram (STD). (Gane and Sarson 1977, Mazur 1995b)	Captures the customer's logic as states he passes through in the use of a product or service. Identifies events that can trigger customer needs.	1. In each box write the current state with an arrow pointing to the desired state. 2. On each arrow, write above the line the event triggering the change of state and below the line the process that takes place after the event occurs.	 Part of STD for cafeteria (Mazur 1995b)
	Data Flow Diagram (DFD). (Gane and Sarson 1977, Mazur 1995b)	The data flow diagram allows a process to be displayed at a logical level (everything a customer sees) without committing to a constraining physical implementation. Since customers will make decisions based on some knowledge (data), the DFD can help us understand influencing factors.	1. Draw double squares to indicate source of data. 2. Draw arrows to show the flow of data. 3. Draw a circle to show the process which uses the data (could come from the STD). 4. An open rectangle shows store of data. 5. Capture the complexities the customer manages in their decision making process, so that ways to influence that decision can be devised. 6. Organize the STD and DFD data with other software-derived tools such as an Event Table and Event Tree (Mazur 1995b).	 DFD for selecting a restaurant (Mazur 1995b).

<table>
<tr><th>Task</th><th>Tool</th><th>Purpose</th><th>Step-by-step Instructions</th><th>Case Study</th></tr>
<tr>
<td></td>
<td>Customer Context Table (CCT).

Verbatim Translation Table (VTT) (Ohfuji et al 1990. Marsh et al 1991), Mazur 1995a, Mazur and Zultner 1996)</td>
<td>CCT records the context of use of the product or service. Useful for understanding environment and other issues related to reliability and robust design, and setting performance targets in the House of Quality. Sometimes combined with VTT to translate words and observations to reveal unspoken customer needs.</td>
<td>1. Enter information about each customer and gemba on a separate sheet. Record context of use such as who uses it, what for, when, where, why, how, etc.
2. Capture spoken and observed “verbatims” as accurately as possible.
3. Translate each verbatim into unique expressions of customer requirements. Feel free to extrapolate as we are not concerned at this point with preference, importance, or likelihood, which will be measured later in the Quality Planning Table in the House of Quality.</td>
<td>CCT and VTT for Automobile Muffler.
<table>
<tr><th>Verbatim</th><th>Who</th><th>What</th><th>When</th><th>Where</th><th>Why</th><th>How</th><th>Translated Data</th></tr>
<tr><td>Hi performance, but car sounds quiet.</td><td>40 year old mail office worker</td><td>commute</td><td>morning, evening</td><td>highway</td><td>go to work</td><td>car pool</td><td>Accelerates quickly. Good gas mileage. Car is quiet. Engine is quiet. Absorbs</td></tr>
<tr><td>Muffler doesn't rust out.</td><td></td><td></td><td></td><td></td><td></td><td></td><td>Muffler doesn't rust out. Pipes</td></tr>
<tr><td>Starts easily when cold.</td><td></td><td></td><td></td><td></td><td></td><td></td><td>Starts easily when cold. Starts easily when wet. Can drive off immediately</td></tr>
</table>
</td>
</tr>
<tr><td colspan="5"></td></tr>
<tr>
<td>4. Analyze Gemba Data.
• The data gathered with the above tools is then analyzed for missing data, structured for later deployments, prioritized, and benchmarked.</td>
<td>Customer Voice Table (CVT). (Ohfuji et al 1990. Marsh et al 1991), Mazur 1995a, Mazur and Zultner 1996)</td>
<td>“Customers buy benefits, producers make features,” goes the old marketing saw. The CVT is used to determine if the gemba data represents the true need or benefit the customer, or an engineering description of performance, functionality, technology, solution, price, etc.</td>
<td>1. Review each piece of gemba data from the above tools. They should be unique, not compound expressions of requirements.
2. If the data is a qualitative expression of customer benefit, it is called “demanded quality” and is placed in the appropriate column on the CVT.
3. If the data describes a measurable level of performance, a function, a failure, a solution or methodology, price or cost, etc. put it in the appropriate feature column for later deployment in Comprehensive QFD.
4. For each feature, look for missing demanded quality items that un-</td>
<td>
<table>
<tr><th>Demanded Quality</th><th>Performan</th><th>Function</th><th>Reliability</th><th>Misc.</th></tr>
<tr><td>Car accelerates quickly
Music sounds good
Good gas mileage
Car operates quietly
Engine operates quietly
Starts easily when cold
Starts easily when wet
Can drive away immediately</td><td></td><td>Absorbs vibration</td><td>Muffler doesn't rust out
Pipes don't rust out
Muffler is attached securely</td><td></td></tr>
<tr><td>Starts easily anytime
Muffler emits no odor</td><td>Distance from windows</td><td>Carry exhaust</td><td>Muffler doesn't rust out
Muffler doesn't leak fumes
Muffler</td><td></td></tr>
</table>
DQ added
</td>
</tr>
</table>

Task	Tool	Purpose	Step-by-step Instructions	Case Study
			derlie the feature.	
	Demanded Quality Affinity Diagram and Hiearchy Diagram (Tree).	The Affinity Diagram is used to uncover the underlying structure of the Demanded Quality from the customers' point of view. The Tree is used to correct the structure and look for more missing data.	See detailed instructions above.	
	Quality Planning Table. (Mazur 1995a)	This is the right hand room of the House of Quality where the Demanded Qualities are prioritized.	1. Use modal survey data or AHP to determine rate of importance. 2. Enter survey data on customer view of competitive alternatives. 3. Set improvement targets, sales points, calculate % priorities.	

	Rate of Importance	Quality Planning	Company Now	Competitor X	Competitor Y	Plan	Rate of Improvement	Sales Point	Absolute Weight	Demanded Weight (%)
Operates quietly										
Car operates quietly	3		4	5	4	5	1.25	1.0	4	10
Engine operates quietly	4		3	4	5	5	1.67	1.2	8	21
Responds quickly										

CONCLUSION

Understanding the **true** needs of customers requires work on the part of designers and planners. It has never been an easy task, just ask anyone who has designed a product for what the customer thought he wanted, only to find out that the product was still not acceptable. Going to the gemba and analyzing the voice of the customer has come to be a tried and true way of getting a complete and accurate set of both the spoken and unspoken requirements of the customer, for later deployment with QFD into an assured design and delivery of the product, service, software, and even business processes. Following are some gemba stories that the author hopes will inspire readers to try even a few of the tools and techniques listed above.

- Isuzu sent tractor engine designers to farm rice paddies for two years to farm rice in order to develop an engine specifically for rice cultivation. Sales easily outpaced others which were retuned automobile engines.
- An American appliance manufacturer discovers in the gemba that customers cannot open theirs and competitive units on a kitchen counter under the cupboards. This lead to redesigning the product to open to the front. An added benefit was that it became more accessible to wheel chair bound users as well.
- The University of Michigan Medical Center learned so much in the patients' and referring doctors' gembas that they spent two years just correcting problems.
- Host Marriott's Phoenix Sky Harbor Airport's units went to gemba and found that customers could not hold food and open the beverage coolers at the same time. They installed air curtains, took off the doors, and sales shot up within a week. In their bagel offerings, gemba research led to doubling sales within a month. (Lampa and Mazur 1996).

  And so the list of successful users in all industries, all markets, goes on. On a cautionalry note, be sure to schedule ample time in your QFD project for VOC analysis. What your customers aren't telling you can be overwhelming.

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