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A QFD PROCESS AT MEDTRONIC DIABETES

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SUMMARY

Changes in technology and customer expectations are creating many new opportunities for medical device organizations. As the oldest and most respected medical device organization in the world, Medtronic strives to stay ahead of the competition by quickly responding to these changes with new and improved products and services. Recently, we have begun using QFD (Quality Functional Deployment) to discover the customer needs for targeted customer segments. QFD has allowed us to convert their needs into new products, services, and features to delight and attract new customers as well as retain current customers. This paper will describe some of the new opportunities we are facing, and show step by step how we are addressing them by understanding the VOC (Voice of the Customer) and innovating and implementing exciting solutions.

INTRODUCTION

What is Quality Function Deployment? Basically, QFD is designed to improve customer satisfaction by increasing 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. With traditional systems, the best you can get is *nothing wrong*. As organizations are finding out, however, consistent quality 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" gap between U.S. and Japanese makers, Japanese cars still win the top honors in the J.D. Powers Survey of New Car Quality. There must be something more.

MODERN QUALITY SYSTEMS

Like traditional quality systems, modern QFD seeks to minimize negative quality, but it differs from traditional quality systems in that it also seeks maximize positive quality end-to-end throughout the organization. This creates **value** which leads to increased customer satisfaction. In fact, the customer's expectations are raised, making it more difficult for competition to keep up.

Nothing Wrong ≠ Anything Right

Quality Function Deployment is the only comprehensive quality system aimed specifically at satisfying the customer. It concentrates on maximizing customer satisfaction (positive quality) by seeking out both spoken and unspoken needs, translating these needs into actions and designs, and communicating these throughout the organization end-to-end. Further,

QFD allows customers to prioritize their needs, allowing Medtronic to optimize those aspects of our products, processes, and organization that will bring the greatest customer value. In today's highly competitive environment, what business can afford to waste limited time, human resources and finances on things customers don't care about?

VOICE OF CUSTOMER

In its earliest uses in the 1960s, QFD concerned itself primarily with end-to-end alignment of requirements throughout the organization. As internal business processes improved, QFD began to look upstream at where the requirements came from and where improvements could be made. As a result, QFD invited the marketing and sales efforts, traditionally the most customer oriented, to the join. In the ensuing years, QFD has devised numerous tools to bring this fuzzy front end into clearer focus. The QFD process should reflect the business needs of the organization. No two QFDs are alike.

CUSTOM TAILORING YOUR QFD PROCESS

Dr. Akao never intended QFD to be a rigid boilerplate of required QFD tools and methods. Virtually every case published in Japan begins with an explanation of the business problem the company faced and how they improved their development process using QFD. When QFD came to the US however, the need for the automotive industry to quickly adopt it resulted in an oversimplification (dubbed kindergarten QFD by its American creators) that could be taught easily. This was based on a re-purposing of a four step reliability deployment study done at Fuji Xerox, and resulted in the often cited 4-Phase QFD model.

While easy to understand, it fit only businesses doing model upgrades of manufactured build-to-print components and parts. Companies in assembly, materials processing, consumer products, service, or software industries and companies that did system level design that attempted to adapt their development process to fit this 4-Phase model often ended up frustrated. Further, as US companies moved towards Lean Six Sigma and right-sized their development activities, the resources to do QFD were often unable to complete what they thought was the *required* set of charts.

Dr. Akao, concerned that QFD was being abandoned by companies in the US and elsewhere in the West, tasked the QFD Institute to modernize the QFD process for these companies, including tailoring the process, making the process faster and sustainable, developing training programs, and incorporating other improvements that he had been directing in Japan for some time. The result is the QFD Institute Belt program, in which the authors are directly involved.

The first step is to custom-tailor the QFD process to meet the needs of the organization. This is done by a QFD Master Black Belt® or QFD Red Belt® (highest level). It begins with in-depth interviews with key process owners and managers to understand the key objectives of the organization and what prevents them from being realized. Then, the QFD tools, methods, and process are tailored to address the most pressing issues.

The custom tailoring began in March, 2010 at Medtronic Diabetes headquarters in Northridge, California. Interviewees included Katie Szyman, Greg Meehan, Kevin Lee, John Mastrototaro, Fred Trimble, Jay Radovich and Cary Talbot.

From these interviews, several business objectives emerged including:

1. Identify critical success factors for a portfolio of product development projects
2. Improve early phase customer testing
3. Increase early understanding of how products will be used
4. Align internal priorities with what matters most to the customer
5. Minimize scope creep or feature de-scoping during product development
6. Quantify trade-offs between features in different products
7. Optimize customer value for each product development investment
8. Increase collaboration between cross functional teams
9. Incorporate competitive assessment in product pipeline planning
10. Establish a process that can be incorporated into the company culture
11. Improve resource assessment

Based on the business objectives from internal interviews and given the preponderance of proposed product solutions for multiple projects, a "Reverse" QFD process was tailored to include the following steps:

1. Brainstorming Solutions
2. Customer Segmentation Table
3. Customer Process Model
4. Gemba Visit Table

5. Customer Voice Table
6. Affinity Diagram
7. Hierarchy Diagram
8. Analytical Hierarchy Process

Multiple projects were conducted simultaneously. The examples contained in this paper are drawn from different projects intentionally to protect the confidentiality of the detailed information. Project teams ranged in size from 8 – 12 people and all the teams were cross-functional. Each team was initially led by a Marketing person, and each team included members from Research and Development, Operations, Human Factors, and Engineering.

Each team working on a Reverse QFD project was divided into teams of two (a Marketing person and a technical person) to capture all of the known ideas. Pairing a person from Marketing with a Technical person provided a dynamic relationship because each person had to explain the ideas in terms the other person could easily understand. This discussion led to a more full description of each idea. The ideas were captured in a spreadsheet, and an excerpt is shown in Figure 3.

STEP 1. BRAINSTORMING SOLUTIONS

Definition – We start with the proposed solutions that already exist in the organization. We derive Customer Needs from those solutions

Purpose

Reverse QFD is practiced for two reasons.

- Document all of the ideas that exist in the organization. This list of ideas will be used later in the QFD process
- Immediately engage the cross-functional team

The second point is more important to the success of the project. If an organization is new to QFD, participants are often put off by the amount of “process” and tasks that need to be accomplished prior to brainstorming ideas and discussing their chances for success. Participants may be used to a process where their ideas are immediately put into implementation, so the idea of a thorough design process seems like a waste of time. We can placate their doubts about QFD (if they exist) by immediately gaining input on solutions.

Technique

You can accomplish the task in at least two ways. First, you can try it as a group exercise with a moderator capturing ideas on a flip pad or white board. The main benefit of this technique is that the group meeting allows everyone to hear the other team members’ ideas, and they can build on them. The downside of a large meeting is it can be difficult to assemble the entire team for the length of time needed to hear from everyone.

The second way you can capture the ideas is to break people up into groups of two or three. The best combination is to team technical and non-technical people together. This combination allows each side to learn from the other, and different points of view can launch new ideas as well as strengthen other ideas by providing a different perspective. Typically the technical person has the greatest domain knowledge of the possible features or solutions and the non-technical customer-facing person has the greatest insights regarding the customer needs that the features may contribute to satisfying.

Example

In the example below, shown in Figure 1, a few ideas are listed. Some ideas may have much more depth of detail than others, but all ideas should be recorded.

<u>Feature</u>	<u>Details</u>	<u>Key Customer</u>	<u>Need</u>
Automated Linked Log Book	All or most significant events	Patient	Everything that can be automatic is so I don't have to hassle with it
		Patient	My logbook information is complete to help me and my care team understand
		CareGiver	Everything that can be automatic is so my loved one's life is easier, and I know the information is complete
Automated Upload to CareLink	Periodic, automatic	Patient, Caregiver	I don't have to worry about uploading before a doctor's visit.
		HCP	I don't have to worry about upload time in the office or reminding my patient to do it before their visit.
Automated Interventions	Detection and alert of predicted excursion (CGM only)	Patient	I am warned when I am going to going to have an excursion.
	Alert sent to caregiver	Caregiver	I get reliable notifications of status changes so I can stop worrying about it all the time.
	Alerts sent via SMS, email, IM	All	I know that the system is redundant and as reliable as it can be.

Figure 1: Medtronic Reverse QFD process to capture known solutions

The columns are inputs to the Customer Voice Table. This is the team's first attempt at defining the Customer Needs. The language of the needs will, in most cases, be a rough draft, and that is perfectly acceptable. It is more important to capture the basic needs, and move onto the next solution, rather than worrying about whether they are perfectly worded. Later the team will "word-smith" the needs during the Customer Voice Table and Affinity Diagramming phases of the project.

Outcome

The small team approach worked well in accomplishing the task of capturing all the ideas. Using the small teams did result in a large number of duplicate ideas that had to be purged later by the QFD team leader.

Each of the small teams shared a frustration in attempting to state the Customer Need. Oftentimes, the need included jargon, or the wording was long and vague, which is common "Corporate Speak" in large organizations. The frustration of the Customer Need naming portion of the exercise turned out to be a benefit because the team members began to see the benefit of thoughtful discussion of defining customer needs. It is important for the team to be able to effectively communicate their ideas with the teammates and the other members of the organization.

STEP 2. CUSTOMER SEGMENTS TABLE

Definition: Prioritization of different customers groups. The segmentation can be based on demographics, behavior, attitude, customer type, geography, problems they are trying to solve, where and when they use products, etc.

Purpose

The Customer Segments Table serves several purposes: 1) Clarifies the spectrum of customers that need to be considered, 2) exposes the key parameters that differentiate customers, 3) guides where research should be focused to better understand the customer. Organizations must focus on segments of the population to maximize the chances for success. No product meets the all the needs of every person, so it is inefficient to market one product to everyone. So, if we are not going to market to everyone, a company has to do the difficult work of selecting the segments it will market to. I say "difficult" because, by definition, if we select a group to market toward we are also choosing to not market to another group. Some individuals in organizations can feel that segmenting is akin to discrimination, and it makes them uncomfortable. It is incumbent upon the Marketing members of the team to adequately explain the benefits of segmentation to the other members of the team.

Selecting the proper customer segments was a key ongoing activity for Medtronic. It was an ongoing activity because we found it relevant to understand which customers we needed to access at each touch-point of the process. For example, the common use of the Customer Segment Table is to identify the situations in which we'd like to observe customers. In QFD we call these situations the "gemba", the place where work gets done. We will discuss gemba in-depth later in the paper.

Technique

Defining the segments for gemba visits is more involved than selecting segments for Goal Setting because we are attempting to understand our targeted segments’ “pain points,” and there are typically many pain points. A pain point is a step in the customer’s process where a particular customer is having trouble accomplishing a goal (with our without our product). For example, in the case of patients with diabetes, the pain points are situations such as exercise, sleeping at night, stress, and mealtimes.

We use the Customer Segments Table to identify and to prioritize the different segments by dissecting the segments into categories such as:

- Which combinations of devices do they use?
- User Type: Adult, Child, Care Partner, different body types
- Where do they use it?
- When do they use it?
- Why did they begin using the product?
- Why did they stop using the product?

Each category you would like to evaluate becomes a column in the Customer Segments Table. The best way to complete the table is to fill-in one column at a time listing all of the items you are interested in for each category (each column) first before moving to the next column. At this point of the process, the rows of the table are unrelated. Once the columns are populated you will select one item from each column to define a key customer segment.

Example

In the first column of the example Customer Segment Table, shown in Figure 2a below, we listed all of the different device combinations we were interested in before listing all of the Users. We loosely identified the target segments during this exercise as:

- Pumpers (insulin pump users) that have never tried CGM (continuous glucose monitoring)
- Pumpers that quit using CGM

We filled-in each column independently from the other columns.

Figure 2a. Medtronic Customer Segments Table.

Device Combinations	Users	Where	When	Why started CGM?	Why Quit CGM?	On-body events
Medtronic Pumpers never on CGM	Pediatric / Caregiver	Home	First time trained	Diagnostic	Too many alarms	hot & sweaty
MDT Pumpers on MDT CGM (2 sensor orders)	Adult	Office	Replace & startup of 2nd sensor	Improve Control	Not accurate (SG not BG)	End of sensor life
	Caregiver	Work	Morning	security	Comfort	sleeping
	Family Members	School	Meals	safety	Calibration	romance

Once the table was populated, we asked the team members to begin prioritizing the gemba visits they would like to do first, second, etc. The team selected one item from each column to identify a gemba. Blue ovals were used to select the first prioritized a gemba and red ovals were used for the second, as shown in Figure 2b below.

Figure 2b. Medtronic Customer Segments Table with Prioritizations.

Device Combinations	Users	Where	When	Why started CGM?	Why Quit CGM?	On-body events
Pumpers never on CGM	Pediatric / Caregiver	Home	First time trained	Diagnostic	Too many alarms	hot & sweaty
Pumpers on CGM	Adult	Office	Replace & startup of 2nd sensor	Improve Control	Not accurate (SG not BG)	End of sensor life
	Caregiver	Work	Morning	security	Comfort	sleeping
	Family Members	School	Meals	safety	Calibration	romance

Outcome

Since we had limited time and budget for research it was critical that we selected the customers and situations to observe that were most likely to expose new customer needs rather than selecting the most common situation or even the most important customer.

STEP 3. CUSTOMER PROCESS MODEL

Definition: A Flow Chart of a customer's steps while interacting with the product.

Purpose

Once the team determines the gemba situations they want to observe, the next step is to create a process flow chart of each gemba situation. The process flow chart represents the team's best "guess" at what they believe are the steps involved for the customer in the gemba. A question mark represents a step the team "thinks" may be a pain point for the customer. The team uses the question marks to remind them to pay special attention when observing these steps.

The Customer Process Model gives the team its first holistic view of the customer's world. The cross-functional QFD team constructs the model, so additions by members can often be new insights that other team members have not previously considered.

The Customer Process Model provides a head start on looking for opportunities when you visit the gemba. In this example, the Customer Process Model exercise showed the team that they not only had to observe people exercising, but they also had to observe them in the locker room. That opportunity may have been lost had they not discovered this issue in advance of the gemba visit.

Technique

The team created the flow charts in two meetings. The first meetings were done in small teams, and each team was assigned a gemba situation. The teams used a 3M Sticky Note for each step of the process, and the teams moved and added Sticky Notes until they were satisfied with the process.

In the second meeting, the small teams reconvened as a large group, and the large group critiqued each of the flows. Steps were added and subtracted. At the end of the meeting, the process flows were documented in Excel and distributed to the teams for use in the gembas.

Outcome

The Customer Process Model was another good opportunity for the cross-functional team members to learn from each other. The technical people challenged the non-technical people and vice-versa. The models are very detailed, and they brought up a number of pain-point opportunities for observation.

STEP 4. GEMBA VISIT TABLE – Capturing customer verbatim, observations and analysis

Definition

The Gemba Visit Table is a document used by the team to record the data gathered during a gemba visit. The Japanese have coined a word to describe the true source of information — the gemba. Gemba has a few other meanings when translated into English. Sometimes it is translated as "the scene of the crime," and sometimes it is translated as "the place where truth is known" or "the place where work gets done." In manufacturing, gemba refers to the shop floor. When there is a problem, the engineers go directly to the work area and use their own eyes to see, their own ears, to hear, their own hands to touch, etc. They rely on their own experience, not reported data, to understand the situation.

Purpose

The Gemba Visit Table takes the salient steps of your Customer Process Model and puts them into a format that reminds you to look for Observations, Verbatim, Data, and any other notes you may garner from your gemba visit. In QFD, the gemba is where the product or service becomes of value to the customer, that is, where the product really gets used and delivers real

value to the customer. It is in the gemba that we really see who our customers are, what their real problems are, how the product will really be used by them, etc. We go the gemba to see our customer’s problems and opportunities as they happen.

Unlike other customer information gathering techniques, such as focus groups and surveys, we do not ask questions about problems with our technology or marketing, we do not remove customers to an artificial site such as a meeting room (unless our product is tables and chairs), and we do not rely on customers’ memories to report problems to us. Rather, we employ all of our senses using contextual inquiry, videotaping, 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.

An analysis of what is observed in the gemba can clarify unspoken opportunities for new products and services. There is no substitute for a going to the gemba. It can be a life changing experience.

Technique

The team transfers the steps of the Customer Process Model into the first column of the Gemba Visit Table. Not all steps need to be recorded, but the key steps related to pain points should be included.

On the top of the page the team records the details of the day including the team members in attendance, the location, the circumstance, time of day, etc. The detail helps everyone better remember the event

After introducing yourself, have the customer walk you through his business processes under consideration. Observe him at work (or daily life for a consumer product) dealing with his problems or his customer’s problems. Use the Gemba Visit Table, shown in Figure 3, to document the customer’s actions, words, smiles, and curses. Do words, facial expressions, and actions agree? Quick movements may convey anxiety; angry, negative words may mean disagreement or fear; etc. Listen with your eyes, ears, and heart to get the complete message. Ask for clarification of problems and opportunities. Some customers may not see themselves as having problems. Encourage these to brag of their accomplishments and “invite” them to join you in the concept phase. Encourage the speaker to tell more by saying, “You seem concerned about...” or “You seem to disagree.” During the gemba visit, record any observations, verbatim, data gathered or other notes on the Gemba Visit Table.

While at the gemba ask yourself these questions: Where might the customer benefit from your product; where does the customer have the problems; what makes them feel good about themselves and what makes them look good to others??

Figure 3: Example Gemba Visit Table

Gemba Visit Table						
<i>What does the customer do? Tell us? Have data on?</i>						
Interviewee: Contact info:				Interviewer(s): Date and Time: Place:		
Interviewee Characteristics (memorable):						
Situation:						
#	Tasks	Observations	Verbatims	Data	Notes	Clarified Items <i>with measures</i>
T1						clarified item 1
T2						clarified item 2
T3						clarified item 3
T4						

Outcome

The Medtronic team doesn't currently make great use of this exact form during its gemba visits. Rather, the leaders tell each of their team members to record information with audio, photographs or with video. This technology allows the team to review the visits and capture items it may have missed as well as allowing the team members who were not in attendance to view the gemba. The audio, photos and video recordings are downloaded into files made available on network drives.

STEP 6. CUSTOMER VOICE TABLE – Translate observations and verbatim into customer needs

Definition: The Customer Voice Table is a document used by a team to convert the information in the Gemba Visit Table into Customer Needs.

Purpose

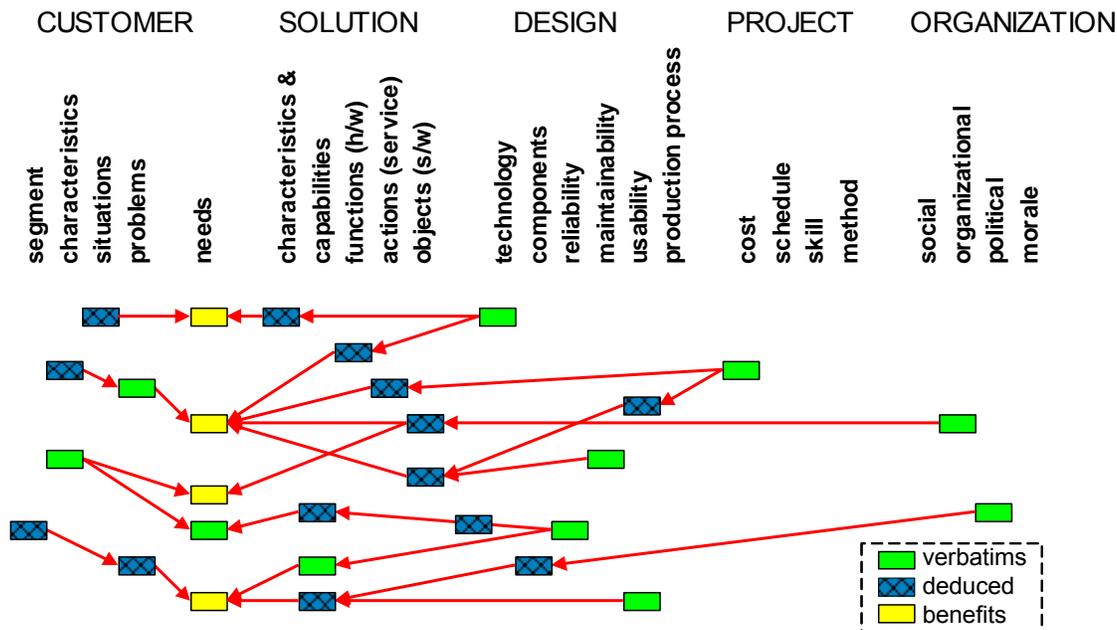
The verbatim, observations, data and notes gathered from the gemba are all clues that can be used to identify customer needs. We must understand the underlying customer needs to clearly define what our products and services can do for our customers. If we understand the root needs behind the customer's comments and actions, we can then explore the most effective way to satisfy the needs.

When customers speak they tend to express their frustrations, share potential solutions and define measurable parameters as well as they understand them. When customers act we can see what they are trying to do and how they are presently doing their tasks. With the customer voice table we can map the customer's comments and actions to their needs.

Technique

The Customer Voice Table includes column headings that represent the categories of information gathered from customers. The information may have come from gemba visits, the Customer Segments Table, the Customer Process Table, or other sources such as complaint reports, warranty data, sales reports, online videos, published studies, etc. Each piece of information should be singular. Complex statements should be decomposed into individual elements. Data should be placed in the appropriate column. Column headings typically include: solutions, design, project, and even organizational issues. After the information is entered into the table, each individual piece of information can be evaluated to identify a need. A sample Customer Voice Table is shown in Figure 4 below.

Figure 4: Customer Voice Table



When converting information into customer needs note there is not a one to one association between the pieces of information and the needs. Many pieces of information may point to one need or one piece of information may lead to several needs.

How do you know when you've identified a "need?"

Needs are benefits to the customer. There are four kinds of needs. Most of the needs tend to be related to the tasks the customer is trying to complete. These needs are related to solving a problem or creating an opportunity.

1. Solves a Problem. Problems are negative statements of what is wrong or what needs to be changed. We can define a need by rewording the negative problem into a positive statement of what needs to be done.
2. Creates an Opportunity. Opportunities are already positively stated. Opportunities are things the customer wishes they could do, not that they're complaining, but they are dreaming of doing something more than they can today.

Some needs are related to improving the customer's image:

3. Makes them feel good about themselves.
4. Makes them look good to others.

When creating the Customer Voice Table it is ok to error on the side of generating too many needs. There will be an opportunity later in the process to eliminate incorrect needs and combine needs that are too detailed.

Example

For example, a patient might say, "I'd like an insulin pump the size of a credit card so I can carry it in my pocket." This one verbatim provides several pieces of information to be placed into the customer voice table and suggests several possible needs. The "credit card," size is a characteristic (measurable parameter) of a solution. "Carry it in my pocket," is a function of the solution. The "pump" is a component of the design. If we asked the customer more questions we may learn that the degree of smallness is her way of measuring privacy. Her real need may be to feel private. Or she may simply want to be able to more easily move around, or she may have a credit card holder that she would like to keep the pump in so it makes her feel more attractive. If we capture each of these needs at this stage, we will be able to test their value to the customer later.

Outcome

Dissecting the information we gather from customers exposed a much larger list of potential needs than we would have expected if we simply tried to convert each verbatim into a need. More experienced team members learned to ask sufficient follow up questions of customers to home in on their actual needs rather than making educated guesses based on the verbatim and observations.

STEP 6. AFFINITY DIAGRAM - Affinity Diagramming is grouping "like" things together

Definition: A process of allowing customers to organizing needs into groups according to their perceptions and thought processes.

Purpose

Affinity Diagramming shows us the way customers think about the needs. Furthermore, the groups of needs created by this process will simplify the prioritization process, which follows.

Technique

The Affinity diagram is produced using the KJ Method™. This is a non-rational "right brain" method, as most people are not aware of what cognitive structure they use for their requirements. It was developed by cultural anthropologist Dr. Jiro Kawakita to surface the cognitive structure in a culture. This method is unique because items are grouped together before the categories are defined. This eliminates the paradigms generated by using pre-existing categories for organizing the data.

Consider, whose cognitive structure do you want to explore? They should create the Affinity Diagram. Here we want to understand how customers think about their needs.

1. **Take the needs from the Customer Voice Table and rewrite them until they are at the same level of detail.** For example, "Apple" and "Orange" are on the same level, but "Fruit" is a header that is more general than apples and oranges, and "Granny Smith," and "Honeybell" are detailed types of apples. So "fruit" should be replaced with "apple"

and “orange” and “Granny Smith” and “Honeybell” should be eliminated since they are not at the same level as “apple” and “orange”.

Having the needs at the same level makes for logical comparisons when we have the needs prioritized by the customers in a later phase of QFD called Analytic Hierarchy Processing (AHP). In the AHP phase, we determine the relative importance of the needs.

2. **Clarify the wording.** It is critical that the needs be worded in a way that is familiar to the customers as opposed to the business. Avoid acronyms and business jargon. Review the needs statements with customers. If the customer has a quizzical look on her face, ask her what she thinks the need means, and use the more consumer-friendly version of the wording.
3. **Eliminate duplicate needs.** Oftentimes, needs overlap one another. The affinity diagramming phase is a good time to join together or eliminate needs that are very similar.
4. **Find participants that represent the customer segment you care to understand.** Make sure each participant is qualified. This is an activity that requires your participants to be subject-matter experts. We found it necessary to make sure the members of the group were highly familiar with our products. It is also important that the participants are from a homogeneous group. For example it would not be appropriate to have patients and doctors participate in this exercise at the same time together. Their perceptions are likely to be dramatically different (different cultures), so they will have trouble finding common ground.
5. **Print a single need on an index card.** Randomly number them. The numbering makes it easier to record which group is associated with each need later. Have plenty of pens for making changes and different colored note cards for Headers and newly-found needs.
6. **Spread the cards out on a table so all participants can read and touch the cards.**
7. **Explain to the participant the purpose of the activity.** Most participants will have never done this activity, but they pick it up quickly. The purpose is to group the cards as they see fit. Start by finding two cards that seem associated with each other and build from there.
8. **Tell them they are not allowed to speak for at least the first part of the activity.** Not speaking allows for the less-vocal members of the group to participate. It also causes people to think more rather than speaking up to challenge or defend a grouping.
9. **Once activity slows down, ask the participants to name the groups (Headers).** Challenge their thinking to look for other ways to think about the grouping. Include other people who may not have formed the grouping. If the participants struggle with naming (they often do), ask them to take the card that most exemplifies the grouping and place it at the top of the group. This card may act as a Header card, or it may be a thought-starter for a Header name.
10. **Challenge the participants to divide large groups of cards into smaller subgroups.** Is there a sub-criterion they can identify that will allow them to group needs into smaller groups. In general, having more than six needs in a group will significantly lengthen the time required for prioritization in a later phase.
11. **Ask for “Unspoken Needs”.** Identify smaller groups of needs. Ask the participants if there are needs that are missing from the group. This is a unique opportunity to discover needs that were not discovered from observations, verbatim or research.

Example

In the example shown in Figure 5 below, we can see a grouping of 10 or so cards. Most of the cards have had changes made to the original wording either for clarification or to put the needs into the customer’s language. The yellow sticky-note has the name of the Header the participants came up with. The pink card represents a new “unspoken” need that was not previously captured.

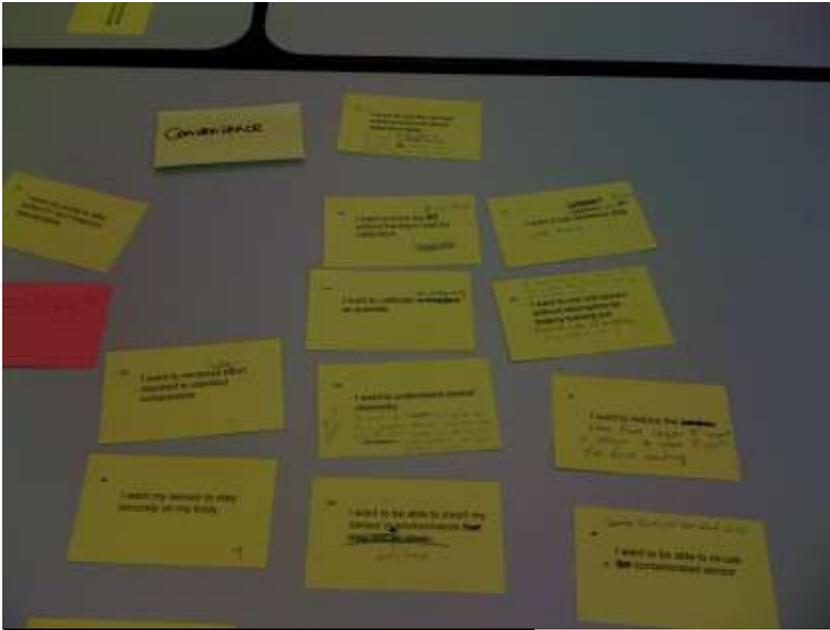


Figure 5: Affinity Diagramming

Depending on the number of needs you have, the activity can take place in as little as 10 minutes or take the better part of an hour. The activity requires a good bit of thinking on behalf of your participants, and they'll fatigue after being challenged for a while. Make the best use of your time by focusing on the groups that matter most.

If you're working with a group of folks that do not know each other, they will tend to be overly polite. Do some ice-breaking activities before the affinity work to get them to loosen up. Once the affinity work begins, move people around the room to give every person a chance to look at each card. Otherwise, people will tend to stay in one spot and avoid conflict. Once you allow people to speak, be careful that a few people don't dominate the conversation. Call on the quiet people to get their

Once you have a solid grouping and people have lost their enthusiasm for moving cards around, ask the customers which group matters most to them. One technique that works well is to give them each three stickers and have them place a sticker on the groups of needs they see as most important. If there is great consensus on a particular group, you can reduce the number of participants required for your AHP work.

Outcome

Affinity Diagramming was highly effective for all of the Medtronic QFD projects. It allowed us to tackle several tasks at the same time. The teams were able to:

- Reduce duplicate needs
- Clarify wording of the needs
- Discover "Unspoken" Needs
- Get input on naming headers
- Get input on sample size
- Begin to understand which categories of needs are more important

STEP 7. HIERARCHY DIAGRAM – VERIFY NEEDS ARE AT THE SAME LEVEL

Definition: The Hierarchy Diagram is the structure of needs (headers, needs and details). In short, we formalize and finalize the affinity diagram to make sure that each item is at the proper level. The Hierarchy Diagram is a QFD team activity as opposed to a Customer touch-point. The team uses the info it has heard from the customers and from their domain knowledge to work through the task.

Purpose

- **Correct the levels of detail** – This is the last opportunity to correct the wording of the needs and the level of the needs prior to surveying a large number of people.
- **Find missing data** - We look for hidden / unspoken needs that are implied by the structure of the data

Technique

1. **Synthesize multiple affinity diagrams** – It's normal for a team to have more than affinity diagrams as output from multiple focus groups. It's expected that the focus groups did not arrange the cards in the same manner. The QFD team

must look at all of the affinity diagrams produced and decide on a common structure. This can produce a lively debate, but there is usually enough commonality.

2. **Reduce the size of the hierarchy where possible** – This point may seem counter-intuitive. If there are needs that are clearly of little value they should be removed at this time. This will reduce the effort of prioritizing the needs later. Let us explain that point in more detail.
 - In the next step (Analytic Hierarchy Processing or AHP), we ask our customers to prioritize needs. This prioritization is done in a pairwise comparison by asking if Need 1 is more important or less important than Need 2 – and by how much. If we had unlimited time and resources, we would rank each need, one at a time, against every other need. This would take an enormous amount of time.
 - By using a hierarchy, we only have to compare the needs within each node of the hierarchy which is about half the effort. Still, we want to reduce the needs down to the essential amount to reduce the burden on the team and on the customers.
 - By this point in the process, you will have had two touch-points with customers. The first was in the gemba, and the second was with Affinity Diagramming. In each touch-point, you will have gained on insights on the needs that matter most to the customer. Use those insights to help you decide which needs should remain in the hierarchy without doubt and which needs are expendable. This is a team discussion, but guard against having all needs remain or you risk inducing fatigue on your customers and on your team.
3. **Confirm levels of detail** – Check the headers to make sure they are at the same level of abstraction compared to each other. Similarly, check the needs. They too must be at the same level of detail. If a need is too broad and encompasses other needs consider whether it should be a header or reworded more narrowly. If the need is too detailed consider whether it is represented by another need and if so, then remove the detailed need. Or if it is not represented by an existing need, reword the need so that its level of detail matches the other needs.

Example

In the example shown in Figure 6 below, we have hierarchy diagram designed by customers. The wording is simple, brief, and avoids jargon and acronyms. One way to look for hidden needs is to pick a header and ask if there are other needs that should be listed under the header. Taking the header “Minimize Lows” we might ask if there are any other activities that cause a diabetic person to go low. There are four listed here. Are there any others?

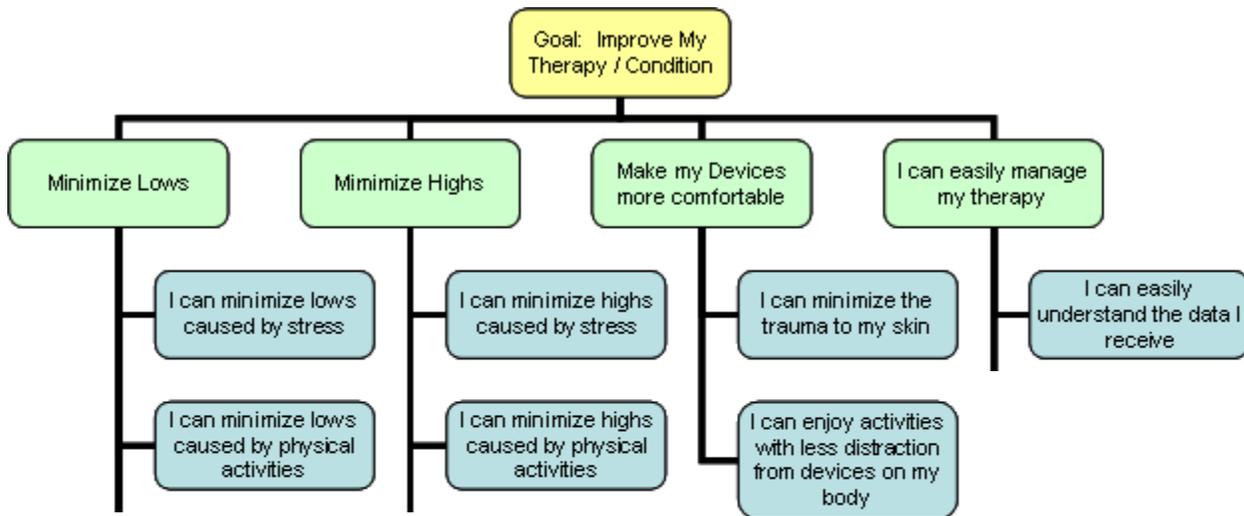


Figure 6: Hierarchy Diagram

Outcome

For the most part, the process worked well even if it was a bit painful at times. The reason it was painful, is it is the first step in the process where the team has to start making hard decisions.

Teams make decisions earlier in the process, such as customer segments, but for the most part, the steps involve gathering information, the idea is “more is better.” During this step in the process, the team began to winnow down the needs that will be considered by the customers.

The teams had had several opportunities to observe customers in gemba and the affinity diagramming phase. In some cases, prioritization of needs had taken place after affinity diagramming but before the customer hierarchy. These customer touch-point opportunities gave the team insight onto which needs matter most. Since opinions can differ on such things, there was debate on which needs should be included and which needs should be left out.

It was also a challenge for teams to view needs through the lens of the customer and not from a Medtronic point of view. As in most companies, people inside the corporate walls tend to overvalue parts of the business. For example, Customer Service managers generally tend to overvalue their function in the minds of customers. This is normal, but it can lead to less-important needs related to customer service being left in a structure.

It's not important that subject matter experts can know the difference between needs; the difference has to be readily apparent to customers.

Step 8 – ANALYTIC HIERARCHY PROCESS – Prioritizing needs

Definition: Analytic Hierarchy Process (AHP) is a prioritization methodology used in QFD to prioritize customer needs, customer segments, product features, or other key decisions. AHP can be used in a collaborative manner with a group of people in a room, or it can be used remotely, and the results can be aggregated.

The main benefit of AHP over other measurement systems is that it provides a ratio scale as opposed to an ordinal scale. The ratio scale provides a finer and statistically-sound distinction of differences between alternatives.

Purpose

The primary purpose for using AHP at this point in the process is to determine which needs are most important to the customer.

Technique

1. Each group of needs includes at least two needs. Customers are asked to compare two needs at a time and determine which is more important and by how much: Extremely more important, very strongly more important, strongly more important, moderately more important or equal. Every possible pair of needs within a group are compared to each other and their relative importance assessed. The number of comparisons the customer must make can be calculated by this formula:
2. After comparing all the needs in one group the customer will then compare all the needs in the next group and so on until all of the needs have been compared.
3. Finally the customer will compare each group to all the other groups.
4. Once the comparisons are collected from the customers the relative importance of the needs can be calculated using the AHP algorithm, which is not discussed in this document.

There are sophisticated software applications designed to help with applying AHP. One example is Expert Choice. Figure 7 below shows an example of two needs being compared using Expert Choice.



Figure 7: Comparing two needs using Expert Choice software, which employs AHP algorithms

CONCLUSIONS

Outcomes for several projects varied based three key factors:

- Scope or the project - As a rule of thumb, projects with a larger scope will have more needs.
- Individuals' willingness to compromise within a group
- Corporate culture

Compromise – Some individuals were more willing to compromise on which needs should be included than others, so, as in any negotiation, this leads to a skewing of the data. Sometimes it was skewed so that more needs were included, and sometimes it was skewed so that fewer needs were included. Part of this skewing is due to the newness of the QFD at Medtronic. Since people were new to QFD, and had not been the whole process, they may have overly relied upon the QFD Black Belts for direction. In the future, as people become more proficient in the QFD discipline, we should expect discourse to increase.

Culture – Culture is closely related to the topic of Compromise. The willingness to compromise is often affected by the culture. For example, in a military environment, orders are followed, and opportunities for discussion and compromise are limited. In most corporate cultures, however, discussion and discourse is encouraged.

In Medtronic's case, the most influential factor on the depth of discussion was the level of QFD expertise. QFD was new to almost everyone in the company, and most participants were working on their first project. Oftentimes, QFD was viewed as a linear process where one step was done at a time. When the group has more experience, they will learn that QFD is an iterative process where some steps can be done independent of each other. They will also have a greater sense of how each of the beginning steps affects the later steps, and they will make better decisions at the beginning of the process that will cause better results in a shorter time frame.

ABOUT THE AUTHORS

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Hepler is helping to develop. Hepler consulted with Medtronic in Los Angeles, CA during 2010-2011 on New Product Development for Insulin Pumps and Sensors for Type 1 Diabetics. Hepler joined Blue Cross Blue Shield of Florida in 2002 and served as the Innovation Director. He focused on “disruptive innovation” and looking for the new “Wellness” business model to supplant the current health insurance model. Prior to joining BCBSF Mr. Hepler spent twelve years in the credit card business with AT&T Universal Card and with Citibank. He has written four white papers on the topic of Innovation and Delighting Customers. He is a past member of the Conference Board’s Council on Innovation, a network of leaders across multiple industries in the area of innovation. www.LinkedIn.com/in/CareyHeplerInnovation

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