TRANSACTIONS FROM
THE 23rd SYMPOSIUM ON
QUALITY FUNCTION DEPLOYMENT

QFD®

December 3, 2011
San Diego CA

Using QFD to Design a Multi-Disciplinary Clinic

Jim Grimm, Quality Program Manager, Center For Clinical Effectiveness, The Children's Mercy Hospital, Kansas City MO

Deb Denavs, QFD Green Belt®, consultant/ instructor, Johnson County Community College, Overland Park KS

Glenn Mazur, QFD Red Belt®, QFD Institute, Ann Arbor MI

Abstract: Pediatric patients and families have become discriminating shoppers for healthcare. Hospitals must improve quality and attract and retain patients. This paper proposes Quality Function Deployment (QFD) as a way to ensure focus on the vital few requirements, creating a structured planning and decision making methodology for capturing and translating stakeholder requirements into useful clinic language for the building of the Virtual Clinic. The QFD tools used include Customer Segments Table, Customer Process Model, Customer Voice Table, Customer Needs Hierarchy Diagram, Analytical Hierarchy Process, and Maximum Value table. This paper is part 1 of the on-going study, part 2 is to be presented in 2012 to flow the results into an agile software development process by providing Voice of Customer driven focus to a SCRUM team.

Keywords: QFD, AHP, Multi-Disciplinary Clinic, Patient and Family Centered Care, Virtual Clinic, VOB, VOC

1. Healthcare and Quality

Donald M. Berwick, MD ,current Administrator for The Centers For Medicare and Medicaid Services in his former capacity of President and CEO of the Institute for Healthcare Improvement (IHI)of Cambridge MA, was asked by the Institute of Medicine (IOM), one of the three bodies that makeup the U.S. National Academy of Sciences, to architect a study and report on quality in healthcare titled "Crossing the Quality Chasm." Dr. Berwick followed up the study with a "User's Manual for the IOM's 'Quality Chasm' Report" that was aptly subtitled "Patients' experiences should be the fundamental source of the definition of quality.[i] Among the fundamental changes recommended was that improvement should be bold, explicit, uniformly espoused, comprehensive, and patient centered. For healthcare organizations, suggested redesigns in six areas can be summarized as:

1. Finding and standardizing best practices to replace historically protected or habitual ones.

2. Using information technology to improve access to information and to support clinical decision making.
3. Improving workforce knowledge and skills.
4. Consistent development of effective teams.
5. Better coordination of care among services and settings, both within and among organizations, especially with respect to the care of people with chronic illnesses.
6. More informative measurement of performance and outcomes.

This paper proposes using Quality Function Deployment (QFD) to address numbers 2-6 with regards to patient-centered development of software solutions to improving the coordination of medical information in a multidisciplinary clinic at Children's Mercy Hospital (CMH) in Kansas City MO to provide rehabilitation services to children with spina bifida, mild traumatic brain injury, and muscle and nerve injuries. The paper also proposes the use of QFD to address the needs of two other customers of CMH organization - the visiting physician providers and the professional nursing staff.

2. Caring for People with Multiple Health and Social Needs

The IHI recently published in its 2011 Care Coordination Model that "People with multiple health and social needs are high consumers of health care services, and are thus drivers of high health care costs. The elevated cost of care in this population offers a tremendous opportunity to understand the individuals and their priorities and needs, and to craft a service delivery plan that meets their needs more effectively at a significantly lower cost."[ii]

The concept of coordinating healthcare delivery emerged in the health maintenance organizations (HMO) in the 1990s as part of an overall plan to promote health (not just prevent or treat disease) and thereby lower costs. Additional pilot studies by Centers for Medicare and Medicaid Services (CMS) showed that health outcomes improved when the case manager developed a personal, trusting, and caring relationship with the patient.

The IHI model for care coordination for people with multiple health and social needs contains the following elements:

- Leverage the individual and family assets that support the patient.
- Identification of candidate patients.
- Care coordinator to identify health goals and coordinate appropriate services and providers. This includes highlighting responsibilities and collaboration of all involved. For individuals with medical frailties, a nursing skill set is recommended to build partner relationships among primary care providers and specialists.

The report concludes that a "medical home" be created to create a coherent plan to align supports for a meaningful engagement of health treatments and activities.

3. Children's Mercy Hospital

The Children's Mercy Hospital is ranked among the leading places to work by the Kansas City, Missouri Business Journal, is accredited through The Joint Commission, has Magnet designation for excellence in nursing and is recognized as a leading hospital by the US News and World Report (http://health.usnews.com/best-hospitals/children's-mercy-hospitals-and-clinics-6630340). The Children's Mercy Hospital network has a combined total of 314 beds in two free standing hospitals and has three offsite primary care clinics.

The pillars of the Children's Hospital in Kansas City, Missouri include: increased access for patients, training for medical students, residents and fellows, and effective use of hospital resources while maintaining high quality patient care and cash flow. There is a need to provide superb pediatric care while accommodating the parents and maximizing the utilization and efficiency of providers of medical care.

Today's ponderous multidisciplinary clinics are inefficient, time-consuming and present logistic problems in integrated care across medical disciplines. Availability of technologies such as the Electronic Medical Record coupled with Clinical Practical Guidelines could link visits separated by distance or time resulting in the Primary Care Physician and family receiving an integrated plan resulting in better care and access with fewer constraints for parents, physicians and providers. The proposed result is a virtual clinic that does not depend on physical locality, but leverages the use of information technology to link the patient and provider. The challenge to this is what to do first with limited resources such as space, time and money. What is most important to the stakeholders?

The authors propose Quality Function Deployment (QFD) as a way to ensure focus on the vital few requirements, creating a structured planning and decision making methodology for capturing and translating stakeholder requirements into useful clinic language for the building of the Virtual Clinic.   This paper strives to demonstrate how QFD can work in a clinical setting with a standardized QFD process to clarify and prioritize requirements, to maintain integrity and accuracy of requirements and minimize changes in building the Virtual Clinic.

4.   Quality Function Deployment (QFD) and Healthcare

QFD was developed in Japan during the 1960s (during its period of modernizing traditional approaches to quality management) to assure that not only was negative quality (customer dissatisfaction) addressed in the design and development of new products and services, but that positive quality (customer satisfaction) become the hallmark of competitiveness. In other words, a lack of dissatisfaction does not guarantee satisfaction; i.e. nothing ≠ anything right. **Figure 1.**
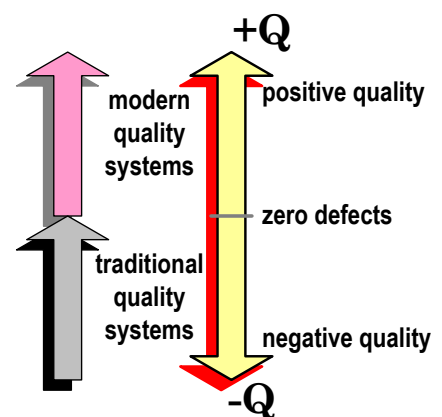

Figure 1 Nothing wrong ≠ anything right.

The concept was extraordinary at the time. Traditional approaches to product design were typically driven by technical advancements that often failed in usability or made downstream manufacturability or service delivery a nightmare. The QFD approach recommended that:

- Assuring product quality required a multi-functional team approach. Quality engineers typically engage too late in the process to truly affect customer satisfaction and value.

- For customer-focused design, it is critical to involve the users, buyers, and other stakeholders who can make or influence a purchase decision. QFD recommends that marketing play a leading role in acquiring and analyzing the Voice of the Customer (VOC) to determine what matters most to these stakeholders.
- Different stakeholders have different needs with different strengths. It is important to get an accurate priority from them *before* detailed development and implementation begin. This will improve quality, acceptance, and timing, and lower costs due to waste and rework.

QFD journeyed to the U.S. in the early 1980s at the behest of the automotive industry. Faced with market and sales erosion to Japanese car makers like Toyota, Honda, and Nissan (then Datsun), Detroit's Big Three (General Motors, Ford, and Chrysler) as well as their first- and second-tier suppliers invited Japanese academics and quality specialists to assist in improving their operations. A unusually collaborative spirit emerged with the adage that a rising tide lifts all ships – meaning that strong competitors were mutually beneficial for the Japanese automakers. The real winner, we have learned, is the consumer who can now enjoy more attractive, reliable, safer, and fuel efficient cars than ever before.

Early QFD efforts through the 1990s focused on creating elaborate charts to help the multi-functional teams visualize the complex cause-and-effect relationships among users, developers, builders, and deliverers of products and services. Mathematical models were incorporated so that market priorities could be maintained and tracked as they drove priorities for engineering and manufacturing.

The Japanese automotive quality experience continues its influence in the 21st century. Customer focus has been joined with process efficiency called Lean Thinking, which demands that product makers and service providers examine all activities to remove wasted materials and effort. QFD, appropriately, has become more lean. The idea emerged in the mid-1990s among software developers facing rapid development pressures in an environment of fast changing technology. The premise was that insufficient staffing and many unknown risks forced engineers to focus on a few critical requirements first, before pursuing the more mundane requirements. In other words, a product that delivered greater value to users would have the opportunity for later upgrades to minor complaints, while a product that failed to deliver on what mattered most to customers would never have a second chance.

QFD essentially means that to deliver a quality product or service to customers that adds value to their lives (solves their problems, enables their opportunities, or enhances their image), efforts must begin early in the product planning stages before decisions have been made. These early efforts include identifying key customers and stakeholders, determining their most important spoken and unspoken needs, and then delivering game-changing solutions that make the new product or service the most desired alternative customers can choose. While QFD has its origins in chemical processes and automobiles (the first published case study was by Bridgestone Tire in 1966[iii]), its applicability to other business sectors was quickly recognized. These included services such as financial, hospitality, healthcare, and education; manufacturing such as aerospace, electronics, appliances, transportation; software such as communications, databases, web sites; and business processes such as strategic planning, corporate governance.

The healthcare community was quick to pick up on QFD. GOAL/QPC, a leading quality training and research organization in the U.S. formed a Heath Care Applications Research Committee to explore how Total Quality Management and process improvement methods and tools could be used in the health care sector. Their QFD Research Committee proposed conducting pilots at several hospitals and sent instructors to train and facilitate them. These included Bethesda with Cincinnati OH physicians practicing there, Bryn Mawr Hospital in their Philadelphia PA emergency room, New England Memorial Hospital on their Stoneham MA rehab center, and the University of Michigan Hospitals and Health Centers on their new medical procedures unit. Glenn Mazur was designated as the QFD expert for UMHHC. The first pilot project was for an ambulatory multi-disciplinary procedures unit (MPU) with an ad hoc team formed from representatives from planning, marketing, administration, finance, and clinical professionals from Internal Medicine Gastroenterology, Surgical Gastroenterology, Pediatric Gastroenterology, Abdominal Radiology, Gastrointestinal Pathology, Adult Pulmonary Medicine, and Adult Cardiology.[iv] The result of the pilot studies were reported as

- Nursing issues addressed prior to unit's opening
- Changes in CME courses led to 300% increase in attendance
- Changes in marketing communications saved $20,000 and produced 14% increase in referrals.

Ongoing QFD projects in the healthcare field include both clinical and operational staff, medical devices, and pharmaceutical studies.

The healthcare industry has unique characteristics. Unlike a manufactured good, healthcare products are difficult to standardize because each patient presents a different profile of physical, emotional and social issues. This makes choosing providers difficult for patients. Healthcare decisions profoundly affect people's lives – they are usually unplanned and unwelcomed events that require immediate responses by all involved and bad decisions by anyone can be difficult and expensive to reverse. We can't go "test drive" a kidney transplant from different doctors or hospitals and select the one that works best. Healthcare costs are currently based on treatments rather than outcomes, meaning that they remain unpredictable due to many unknowns. Yet, the trend to control costs should not force patients to accept minimal levels of care or rush providers into grueling, insufficient scheduling.

These characteristics can cloud the planning process with inconsistencies, conflicts, and confusion. QFD can help clarify this process, as this paper will show. Readers should keep in mind that their particular facility may have challenges that would benefit from custom tailoring the QFD to their circumstances.

5. The Multidisciplinary Clinic Project at Children's Mercy Hospital

In order to match provider efficiency to customer satisfaction (patients, family, primary care physicians-PCP), Children's Mercy Hospital would like to design a virtual clinic in which patients would visit individual specialty clinics during the day and the provider evaluations and recommendations would be linked electronically in order to quickly update the care plan and communicate it to parents and PCPs. This would be a more efficient use of constrained provider resources than having the doctors travel to a single clinical setting. Patient travel and wait times between independent clinics on the same campus can be improved with side visits such as a planned aquarium and Legoland.

As mentioned above, each institution should use a QFD process that is custom tailored for their management and quality systems, clinical specialties, and patient segments. Presented here in **Figure 2** is a generalized process used in QFD Green Belt® training courses.
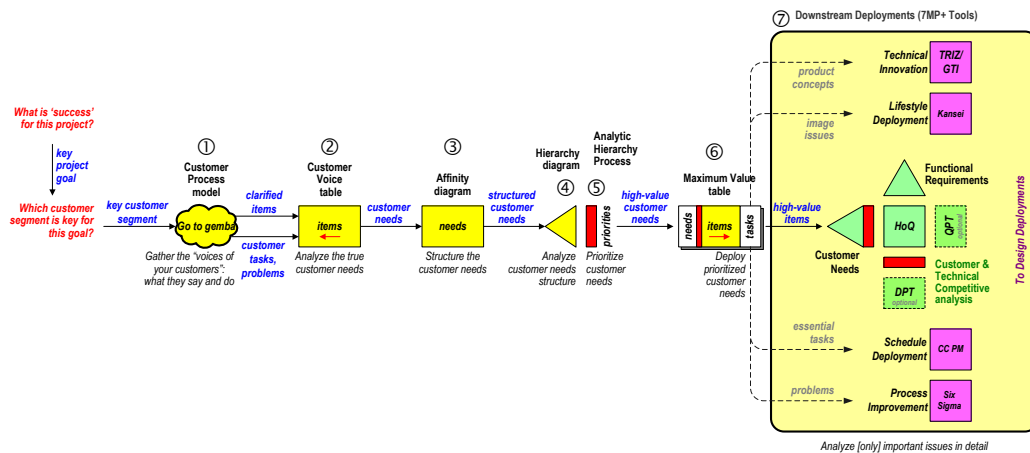

Figure 2 Generic QFD process model

QFD Flow and Tasks

5.1 What is in/out of scope for the project? A common concern of all process, service, and product planners is scope drift and creep. Once a project has been chartered with a budget, resources, deliverables, and time schedule, any change in scope can be significant. Thus, it was important at the project start to clarify what part of the process is to be redesigned – where does the process to be created start and where does it end. This is shown in the process beginning and end table in **Table 1**.

Table 1 Process beginning and end table (partial)

Begin	Process	End	Customers & Stakeholders
Begin rehabilitation services on main campus for spinabifida, mild traumatic brain injury, muscle and nerve.	Make appointment	Patient exits facility	Patients, family, caregivers, doctors, nurses, providers, check in staff, payers, HIPPA compliance office.
	Check in		
	Take vital signs		
	Exam		
	Place orders		
	Schedule next appointment		
	Entering clinic notes into patient records		

5.2. What are the desired objectives or outcomes of the project? "If this project is successful, our institution and stakeholders will benefit how?" This helps the team focus on the "voice of the hospital." Management invests in certain projects over others and must make this selection according to some

criteria related to benefits to the institution. Frequently, these are not explained thoroughly to project team members, whose disagreement can cause confusion later in development process. The project goals table in **Table 2** is often used to summarize the project charter but with a quality twist that asks how these goals will be measured, where they are today and need to go and by when, and who will judge whether they have actually been met. This last column can be important if the judge of success has a different set of metrics.

Table 2 Project goals table (partial)

#	Goal Statement	How measured?	Current level	Target level	By when?	Who judges success?
PG1	Improve patient satisfaction	Pt satisfaction scores				
PG2	Retain patients	Pt satisfaction scores				
PG3	Increase Access	available appointment	5th available appointment	3rd available appointment		
PG4	Single source summary across pt encounters	Leverage of electronic records.	multiple sources	single source	Phase 2	
PG5	Increase employee satisfaction	Employee satisfaction scores				
PG6	Reduce the number of patients who do not keep their appointment	Appointment no show rates				

5.3. Who are our internal stakeholders? It is important to identify all who have a hand in the project because their buy-in will be necessary for success. A hospital is a complex organization with many constituents who may have different and sometimes conflicting needs. In order for the team to focus its work, it is useful to identify who are the key stakeholders and customers of the process to be developed. Generally, among these are providers (students, residents, fellows, and ancillary staff), clinical staff (nurses, appointment and check-in staff, etc.), HIPPA and other compliance offices, and others.

5.4. Who are our customers (external stakeholders)? What is the value chain of customers from the facility to the provider to the end beneficiary? These may include payers, family, caregivers, and others. It may also be useful to create personae - a brief narrative relating to a customer's attitudes, behaviors, with sufficient specificity rather than generalities and can even include pictures, as shown in **Figure 3**. Customers should also be defined, based on their interactions with the proposed product, process, or service. Characteristics such as disease, when and where the interactions are most critical, help keep the team focused on what is most critical. The Customer Segments table shown in **Table 3** should be customized for each healthcare facility but will typically describe these kinds of customer attributes.

	Fish diner	Dinner host	Waiter
Persona	I grew up near the sea but I live inland now. I miss the fresh fish.	It's my date's birthday and I want her to enjoy a "taste of home."	I take pride informing my guests about where our fish comes from.

Figure 3 Example of persona for restaurant (partial)

Table 3 Customer segments table (partial)

Customer Segment	Who uses process	What disease condition	What is process used for	Where	When	Why	How
Pediatric pt	Pt and family	spinabifida	improve interaction between visting physicians	CMH main campus	daytime ambulatory clinic	visiting physicians do not have sufficient time to interact	develop new tools to better evaluate treatment options
Visiting physicians	Provider	mild traumatic brain injury				Share medical records from urban to rural facility members	
Nursing staff		muscle and nerve					

5.**5. How can we best collect the Voice of the Customer?** Marketing groups use many instruments to capture the voice of the customer. Surveys, interviews with staff, caregivers, patients, focus groups, direct observation are all powerful ways of learning about our customers. In surveys and focus groups, we write the script that tends to focus mostly on what the hospital cares about most – its products and services. Their purpose is to learn the **known unknowns**. QFD offers an additional observational technique which can help uncover unspoken needs. Using the Japanese word *gemba* meaning a "place of truth" or a crime scene on cop shows, this is a method of observing the customer in action with our own eyes and ears to gather both spoken and behavioral data that enriches our understanding. This is to focus on what the customer cares about most – themselves or their family. *Gemba's* purpose is to learn the **unknown unknowns**.

This can be very enlightening in a healthcare setting where patients and families often feel overwhelmed and even intimidated. As recipients of life-saving care, who are they, they may think, to criticize or ask for something more. Yet, without their insight, how else can the organization improve?

Since many hospital processes are complex, it is often easier to get customer input if we can parse the activities into discrete steps and get feedback about them. We can also ask the customer which step in the process is most in need of improvement from their perspective as well as what is working well and should be continued. Thus, we are asking the customer to give us process, content, and value in one diagram. This is called the annotated Customer Process model shown in **Table 4**.

Table 4 Annotated customer process model (partial)

t and must be continued?
"Reduce stress for my child."

"Provider's are prepared for my child."

"Ensure a timely and correct diagnosis."

"Providers have enough time for my child."

"Leave appointment with a plan that works."

"Give me education relative to my child's care plan. For example, teach me how to start an IV, give an injection, reconstitute a drug, mix formula etc."

"Appointments available outside of school hours."

5.6. What are the customers' needs? Voice of the customer starts our analysis of true customer needs, which QFD defines as the benefits to the customer of their problem solved, their opportunity enabled, or their image enhanced, *independent* of the solution. This is absolutely critical because customers, trying to be helpful, may suggest ways in which we can do things better. This presents two problems: 1) for the customer, "better" means "better for me" and may create conflict with "better" for another customer or the staff, and 2) customer suggestions are based on their past experience – hardly the fodder for developing new and potentially game-changing solutions based on emerging technology.

So, the QFD process encourages us to ask the customers what benefit they seeking. For example, in the above customer process model in the last step on the right, the customer narrative states "Appointments available outside of school hours." Appointment times are not a customer needs but a characteristic of the hospital's scheduling. So we ask the customer, if appointment times were available outside of school hours, what benefit would you get? They might answer, "My child won't fall behind in their lessons" because of so many doctor's appointments. So their need is not the availability of after school hours, but that their children are not falling behind in school. This kind of questioning helps us avoid making assumptions about what customers need.

This helps us in two ways. First, it allows us to think outside the box for solutions (if the need later turns out to have high priority. Don't waste precious team time on solutions to low priority needs.) For example, to not fall behind, could the school provide a video link the child could watch while waiting? Could the clinic provide volunteer tutors to help kids with their lessons and homework that were missed? The second way this helps is by making us think before we give the customer exactly what they ask for. For example, 2-3am appointments are certainly outside school hours, but not very conducive to the parents or child having much a normal day afterwards.

Another point about customer needs is trying to phrase them in positive language. Often the raw expression is negative or a complaint. In a process improvement effort, we can certainly try to address their problem. But QFD is really more for building new systems and process, and so positive statements help us understand more of what is needed rather than what is to be avoided.

This translation of VOC into customer needs is done in the Customer Voice table (CVT), as shown in **Table 5**. In this case, the customer is the visiting physician conducting follow-up exams during a weekly clinic. Patients who fail to attend or show up late create chaos in the schedule by throwing off times other patients expect to be seen and dismissed, as well as preventing another patient from filling hard-to-get appointments. The provider's VOC includes "I need patients to attend the appointments they make" which implies that the clinic appointment scheduler should take some action to assure appointments are attended. This means that the customer, the visiting physician, is telling the scheduler how to do their job and what capabilities the clinic should have. The QFD team then steps back and asks why this is important, i.e. what are the true needs. The analysis yielded statements such as "my valuable time is respected," "the number of appointments equals the number of patients," etc. Of course, these will be confirmed with the physicians, but they can open up new ways of thinking for us.

Table 5 Provider as customer voice table (partial)

Customer						Analysis
segment	situation	task	problems/ narratives	needs		functional requirements
Visiting Physician	Weekly clinic	Follow-up Examination	I need patients to attend the appointments they make.	My valuable time is resepected.		Patients are kept in schedule
			I only have a set number of appointments to see patients.	The number of appointments equals the number of patients.		Number of appointments
			I have guidance that I must see a certain number of patients per week.	I see the "guidance" recommended number of patients per week.		guidance
			I need to generate reveue to support my clinic operations.	I need to generate reveue to support my clinic operations.		
			I have to ask a social worker to follow-up as to why the patient did not keep their appointment	I need to know what I can do to help patients keep their appointments.		social worker

5.7. Structuring and prioritizing customer needs. Once the customer needs are identified, the next step is to determine which need to address first. It is not uncommon that the time, budget, or staff assigned to a project will change (usually reduced) during the course of a project. Thus, the most important customer needs should be addressed first. Prioritization in multi-criteria decision making was advanced by the research of Dr. Thomas Saaty in the 1970s at the U.S. Department of Defense and later at the Wharton School of Business at the University of Pennsylvania. Saaty found that decision makers facing a multitude of elements in a complex situation innately organized them into group sharing common properties, and then organized those groups into higher level groups, and so on until a top element or goal was identified. This is called a hierarchy and when making informed judgments to estimate importance, preference, or likelihood, both tangible and intangible factors must be included and measured. A properly organized and prioritized hierarchy can tell us if we have sufficient needs to satisfy the customers. In other words, do we have enough needs that the customer would be satisfied with the product, if we delivered them?
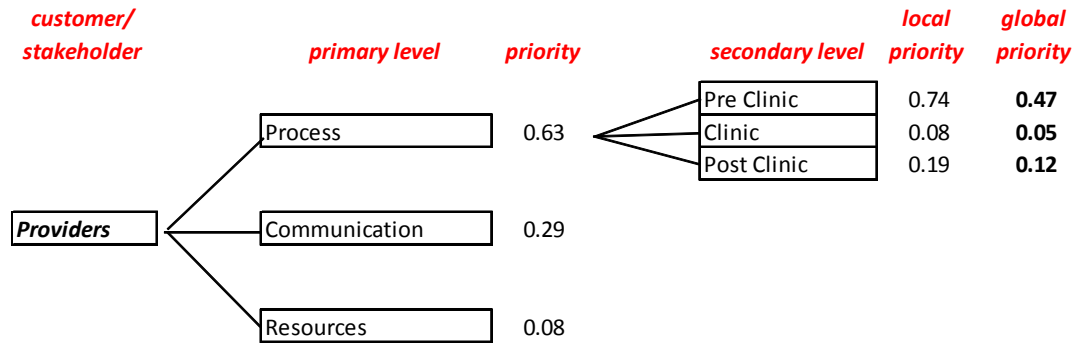
Modern QFD, uses Saaty's Analytic Hierarchy Process (AHP)[v] technique to manage this process in a manner that captures the intuitive understanding of the participants and also yields mathematically stable results expressed in a numerical, ratio scale. A numerical, ratio scale is preferred for the following reasons:

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

The resulting prioritized customer needs hierarchy for the physician provider is shown in **Table 6**. Hierarchies should be deployed to the tertiary level (not shown) for sufficient detail to guide developers in later project phases. Priorities were derived by having the providers do an AHP pair-wise comparison (not shown) first at the primary level (non-rounded results will total 100%). Resource constrained teams

looking only to identify the few needs that they the people, time, and funds to act on are recommended to only pursue priorities of the high priority branches. Since "Process" captured 63% of the priority at the primary level, and "Pre Clinic" captured 74% of "Process" at the secondary level, it is most likely that the most critical tertiary level needs (not shown) are nested within "Pre Clinic." The global priority is calculated by multiplying the local priority by the parent level priority.

Table 6 Prioritized customer needs hierarchy for provider (partial)

customer/ stakeholder	primary level	priority	secondary level	local priority	global priority
	Process	0.63	Pre Clinic	0.74	**0.47**
			Clinic	0.08	**0.05**
			Post Clinic	0.19	**0.12**
Providers	Communication	0.29			
	Resources	0.08			

5.8 Translate key customer needs or benefits into prioritized solution requirements. Once the QFD team has identified the top customer needs for each segment (parents/patients, providers, and nurses), they can focus their solution development efforts in few manageable areas rather than trying to tackle everything at once. The Maximum Value (MVT) table takes key customer needs and drives them forward to the various dimensions of design that must be aligned end-to-end in order to assure quality and customer value. The MVT does not of itself kick-off the whole project, but illustrates where we need to do our best in the design and delivery of the product. At this point it is permissible to "over explore" as we can cut back later depending on time, availability of resources, and budget. The columns start with the same set used in the CVT, but new columns may be added to assure coherent end-to-end activity to deliver value to the customer. The MVT may show us areas that have greater complexity or uncertainty, and where more complex matrices need to be done between two design dimensions and at what level of detail. The outputs are specific tasks and staff actions.

Table 7 Maximum value table (concept)
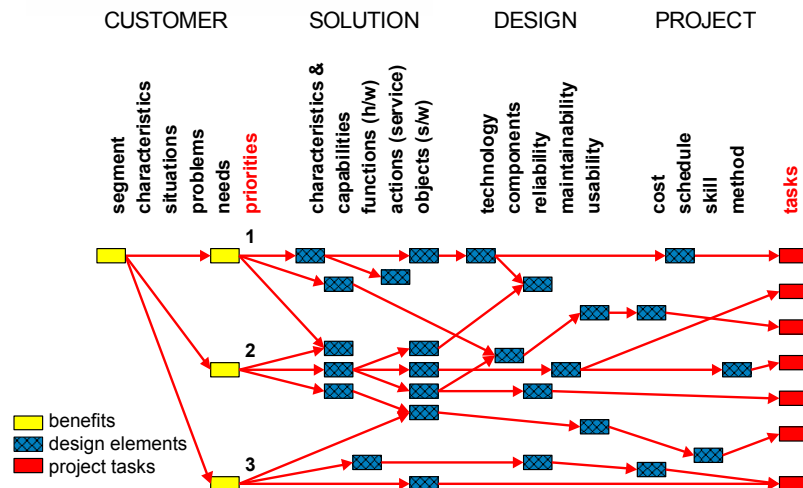
The principle of the MVT is a cause-and-effect diagram where the desired effect or outcome is a key customer need, and then how does the new product, service, or process cause the need to be met. Traditional quality tools will often use what is called a "fishbone" diagram (resembling a fish skeleton) where the "head" is the effect or outcome and the "bones" are the causal factors that must be designed and controlled in development and implementation of a solution. When using spreadsheets to organize the analysis, it is easier to "filet" the fish skeleton into rows and columns as depicted in **Table 7**.

The most important tertiary level Provider need (not shown, but to the right of Pre-clinic in table 6) is "Patients and parents need to participate in their care." The Maximum Value table in **Table 8** helps begin the process of developing a solution by defining what critical functional requirements the product must have. This can be expressed in terms of capabilities (what the product must do) or characteristics (what the product must be) independent of the enabling technology that might be used. Of course, as the team defines the functional requirements, any enabling technologies that come up may be parked in the "solution technology" column for later consideration. By being technology agnostic at this point in the analysis, the team is able to keep from jumping to solutions prematurely and thus preserving the opportunity for innovative, game-changing concepts to emerge.

Table 8 Maximum Value table for providers

Customer			Analysis	Design	
			Functional Requirements	Design Requirer	
task	problems	needs	characteristics & capabilities	solution technology	
Pre clinic	Parents may or may not provide goals for their child	Patients and parents need to participate in their care	Capability to help parents to set goals for their child. Capability to help parents communicate goals to provider prior to clinic.	Selectable modality of communication: email, written, verbal; signing, and on line. Goals should be entered electronically prior to the clinic visit. Ability to communicate goals in family's native language.	
			Capability to help parents understand care requirements for their child, i.e. how to feed, how to give meds, monitoring of equipment, troubleshooting equipment.	Telemetry for equipment to communicate directly to hospital.	
			Capability to help parents	Follow up nurse	

5.9. Developing the solution. As soon as the key customer needs and high level functional requirements are defined in the MVT, the detailed development process can begin. The authors propose that the medical records software use an agile environment with SCRUM. This will be covered in greater detail in part 2 of this paper to be presented in 2012. This will entail additional steps such as:

- Use MVT data as the requirements backlog.
- Identify owner and Scrum Master .
- Use QFD data to write epic, themes, stories.
- Create budget and schedule estimates.
- Deploy sprints.

- Develop a release plan.
- Documentation.

6. QFD for Software Development

The dominant reason for failure of any software development is the same it has always been: poor execution of the early stages in the project. By definition this includes defining project scope and eliciting and validating the business requirements.

These two principles are completely intertwined; the Project scope cannot be known until requirements are fully elicited. Projects that begin with changing or unclear requirements make it difficult to even establish initial project expectations. This manifests itself throughout the life of the project and results in project failure.

Large-scale projects fail with regularity. The Standish Group reports[vi]:

- Typical project over-ran its budget 189% and its schedule by 222%.

- Over 70% of project failures are caused by poor requirements

- Poor requirements practice wastes 34% of a typical organization's IT budget

- 74% of companies have a low level of requirements maturity

- Organizations with high requirements maturity deliver successful projects 92% of the time

- Only 15% of companies report having excellent requirements software

Given these facts, the need for a consistent, simple, proactively methodology to discover requirements is needed. Customers typically have an abstract idea of an end result, but not what is required of the software to complete this, thus incomplete, ambiguous, or even contradictory requirements may result. Quality Function Deployment (QFD) addresses clear, complete customer needs or requirements, in the initial stage of the project finding a consistent method to obtain the desired needs and the design strategy to turn those needs into actionable, useable requirements.

The software development life cycle (SDLC) is a structured process for the development of a software product. There are several models for software development including, Waterfall, Rational Unified Process (RUP), Agile, Scrum, Lean, and Extreme Programming. Each model embraces a variety of activities; however, at the heart, all must have business requirements clearly executed to be valuable to the owner.

This paper will focus on Agile Software Development with an emphasis on Scrum Development. Scrum projects evolve rapidly with changing priorities, expectations, and requirements. Scrum is an agile method or framework for completing complex software projects, yet the Scrum framework is deceptively simple.

Scrum is a framework that contains sets of practices and predefined roles. The main roles in Scrum are:

1. the "ScrumMaster", who maintains the processes and is accountable for removing impediments to the ability of the team to deliver the sprint goal/deliverables. The ScrumMaster is not the team leader but acts as a buffer between the team and any distracting influences.
2. the "Product Owner", who represents the stakeholders and the business. The Product Owner is the voice of the customer who writes customer-centric items ; referred to as user stories; prioritizes them, and adds them to the product backlog.
3. the "Team" is a cross-functional group who do the actual analysis, design, implementation, testing, and so on.

A sprint is a one-week to one month iteration of work in the development of the software product. This work is a "time boxed" (i.e. restricted to a specific duration) effort of a constant length.

Each sprint is preceded by a planning meeting where tasks are identified and estimated for the sprint goal. Each sprint is followed by a review or retrospective meeting where the progress is reviewed and lessons learned are identified for the next sprint. During each sprint, the team creates a potentially deliverable product increment that is working and tested software. The set of features that go into a sprint come from the product "backlog", a set of high-level requirements of work to be done. Which backlog items go into the sprint is determined during the scheduled and defined Planning Meeting. During this meeting, the Product Owner determines the items in the product backlog that needs completion. The team then determines how much of these items they can commit to complete during the next sprint, and records this in the sprint backlog. Development is time boxed such that the sprint must end on time; if requirements are not completed for any reason they are left out and returned to the product backlog. After a sprint is completed, the team demonstrates how to use the software at the retrospective meeting.[vii]

Graphically, Scrum looks something like this:
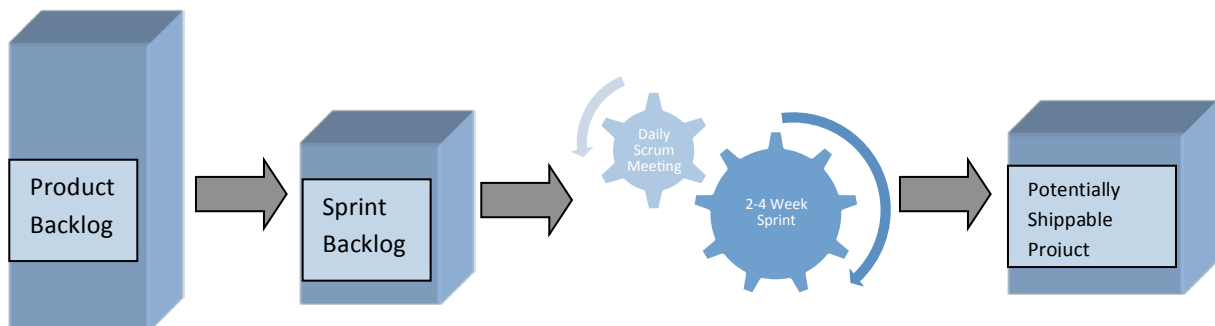
It is this paper's hypothesis that this Scrum approach coupled with QFD will yield a successful manner in which to produce requirements for a product. That product will have clearly defined scope related to the business causing a timely and cost effective use of resources for the company.

7. Conclusion and Future Study

QFD proved to be an invaluable methodology for creating, capturing and translating stakeholder requirements into useful clinic language for analyzing the multidisciplinary clinic. QFD is systematic and accountable, because functional requirements, designs and projects can be retraced to specific custom-

er verbatim statements. Comparing the interim results of this project with the project goals attest to a measure of success. QFD methodology, including *gemba* visits, captures a real time-time snap shot of patient and employee satisfaction. The current process at CMH of evaluating patient and employee satisfaction is through the use of a questionnaire, which neither provides a timely picture of the current state nor an evaluation of success after implementing an improvement intervention. Not all people respond to questionnaires and even those who do may not reflect a broad range of opinions. A real-time ability to capture and assess patient and employee satisfaction facilitates rapid cycle improvement. Over time, increased patient satisfaction can have a synergistic effect in reducing the number of patients who do not keep appointments. The use of QFD enables us to simultaneously work on short-term projects such as improving *Communication* (the primary level of hierarchy identified by both the parent and nursing/access representative customer groups), as well as longer-term projects involving *Process* (the primary level of hierarchy identified by the provider customer group). Such process improvements can have a positive impact toward providing a single source summary across all patient encounters. The authors of this paper propose an IT solution to improve clinic *Process,* using QFD to provide functional design requirements leading to a product that provides the basis of a virtual clinic that does not depend on physical locality, but leverages the use of information technology to link the patient and provider. This phase of the QFD methodology will be documented in part 2 of the project.

8. About the authors

Jim Grimm, BS, MA, MT (ASCP) is a Quality Program Manager with the Center of Clinical Effectiveness at The Children's Mercy hospital, Kansas City. He has 11 years of quality experience as a project improvement facilitator for the hospital. Jim is a retired Army officer with 27 years of service in the active duty and National Guard, U.S. Army Corps of Engineers.

Deb Denavs, BS, MA, PMP, CSSBB, CCC-A, Certified Scrum Master, QFD Green Belt® is a consultant and instructor with Johnson County Community College. She has 20 years working she has worked with industries ranging from dog food to aerospace. Her background in medical, business and software puts her in a unique position to look at problems from many angles. She considers her husband, two adorable dogs and her family her strongest attributes.

Glenn H. Mazur, BA, MBA, QFD Red Belt® has been active in QFD since its inception in North America, and has worked extensively with the founders of QFD on their teaching and consulting visits from Japan. He is a leader in the application of QFD to service industries and consumer products, conducts advanced QFD research, and is the Conference Chair for the annual North American Symposium on Quality Function Deployment. Glenn is the Executive Director of the QFD Institute and International Council for QFD, Adjunct Lecturer on TQM at the University Of Michigan College Of Engineering (ret.), President of Japan Business Consultants Ltd., and is a senior member of the American Society for Quality (ASQ), and the Japanese Society for Quality Control (JSQC). He is a certified QFD Red Belt® (highest level), one of two in North America. He is a certified QFD-Architekt #A21907 by QFD Institut Deutschland. He is convenor of

the ISO Technical Committee 69 Subcommittee 8 Working Group 2 to write an international standard for QFD. He is an academician of the International Academy for Quality. Glenn@Mazur.net

Notes

[i] Berwick, Donald M. Health Affairs, 21, no.3 (2002):80-90 A User's Manual For The IOM's 'Quality Chasm' Report. http://content.healthaffairs.org/content/21/3/80.full.html
[ii] Craig C, Eby D, Whittington J. *Care Coordination Model: Better Care at Lower Cost for People with Multiple Health and Social Needs*. IHI Innovation Series white paper. Cambridge, Massachusetts: Institute for Healthcare Improvement; 2011. (Available on www.IHI.org)
[iii] Oshiumi Kiyotaka. 1966. "Perfecting Quality Assurance System in Plants," (Japanese) *Quality Control* Vol. 17 (May 1966): 62-67 (supp.).
[iv] Ehrlich, Deborah and Glenn Mazur. 1993. "QFD for Service Industries: A Case Study at the University of Michigan Medical Center." *Proceedings of the Sixth Annual National Forum on Health Care Quality, Performance Measurement Track.* Joint Commission on Accreditation of Healthcare Organizations (JCAHO).
Ehrlich, Deborah M. and Dennis J. Hertz. 1993. "Applying QFD to Health Care Services: A Case Study at the University of Michigan Medical Center." *Transactions of the Fifth Symposium on QFD*. QFD Institute. ISBN 1-889477-05-2
Ehrlich, Deborah M. and Eric W. Kratochwill. 1994. "QFD in Health Care: Identifying Methods to Tailor QFD to a Service Industry." *Transactions of the Sixth Symposium on QFD*. QFD Institute. ISBN 1-889477-06-0
[v] Saaty, Thomas L. 1990. *The Analytic Hierarchy Process.* Pittsburg:RWS Publications. p. x., 1. ISBN 0-9620317-2-0
[vi] Standish Group, (2005) CHAOS Report.
[vii] The Scrum Alliance, http://www.scrumalliance.org/pages/whatisscrum, accessed November 7,2011.