Developing the Voice of Customer to Support Systematic Innovation

Brian Weiss, MBA, SKF Product Development Manager
Donald P. Lynch, Ph.D., SKF Master Black Belt

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Systematic Innovation is the use of a facilitated, structured process to identify customer needs, develop creative ideas and invent a solution which fulfills the need [Weiss & Lynch, 2013]. When applied within the context of product development, the basic premise is that facilitators can apply a process leveraging creativity techniques to develop innovative concepts. The success of this method requires that product and application engineering knowledge is present, and customer requirements (wants and needs) are well understood.

The key to successful Systematic Innovation is to first develop the voice of the customer (VOC). If the needs of the customer are not first understood, the result is often developing products and solutions that do not hit the target market. Every year, many product development resources are committed to developing products that deliver what engineers think the customer wants rather than what they are willing to purchase.

Developing the VOC is taken in two phases. First, the voice of the customer must be captured from the potential customers. Then, the VOC must be translated into a form that can be used by the development team. These phases are discussed below.

Capturing the voice of the customer, especially for a large or complex market, is not a trivial task. Customers are spread out around the globe. Complex supply chains create many different customers or even confusion regarding who the customer is. Think about the typical situation. Have the product designers spoken with everyone who touches the product? When was the last time they visited the 3rd party warehouse where the end customer stores the product? That warehouse may not be the manufacturer or product designers' responsibility, but their storage and handling practices may affect how well the product ultimately performs for the customer. In order to make the process of capturing the voice of the customer effective and efficient, as well as integrating it into the innovation process, four steps can be taken:

1. scoping the innovation,
2. customer identification,
3. capturing customer wants and needs, and
4. data organization.

The 19th century American philosopher John Dewey once said, "A problem well put is half solved" [Garrison, 1999]. Scoping the innovation forces the innovators to clearly define the boundaries within which their solution will exist, as well as begin to describe what it is that their product or service must deliver. Without a common understanding and agreement about the challenge, the innovators may be working on different issues or have a different vision.

Many tools and techniques exist to facilitate scoping. The boundary diagram has proven effective for product innovation, and it fits within the systematic innovation framework. Typically, the boundary diagram is a block diagram, or schematic, which describes the pieces of the system. Outside of the box are the sub-systems or components with which the innovative solution must interact. Also outside of the box are some indications of the desired and undesired outputs expected by the customer. At this point, limited

information may be populated. In the case of breakthrough innovation, the inside of the center block may be empty to indicate that a solution does not exist. For incremental innovation, the existing solution may be shown. A simple example is shown below to fulfill a customer need to create a hole in a piece of material.

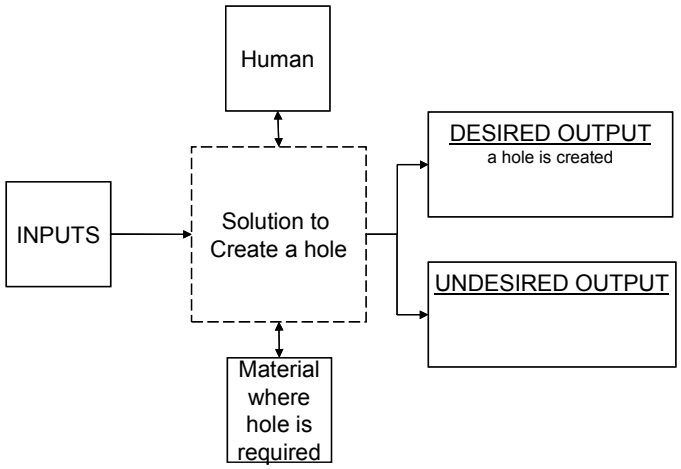

Figure 1. Boundary diagram example for a product innovation

This example may seem insignificant, but apply this technique to a complex system such as an automobile and the result will be more noteworthy. Also, as the solution requirements become clearer, the boundary diagram can be populated with additional information. The boundary diagram also aids communication by requiring all inputs and outputs to be measurable with tolerances. For example, outputs for the hole may be diameter and roundness.

As the scope of innovation becomes less ambiguous, the need arises to identify who the customer actually is, the second step in the process. The question seems easy to answer, right? If 10 different people are polled in an organization regarding who is their customer, 10 different answers may result. The reason relates back to the complexity of supply chains in today's world. Many suppliers are part of the value chain created to deliver a solution to an end user. As a result, innovators must agree on the customer for which the solution will be developed. Without this agreement, the voice of the customer capturing becomes a chaotic and ineffective exercise.

In Systematic Innovation, the focus should be on the end user or final consumer of the product or service. The working assumption is that all features or characteristics added to a product or service are done so with the intention of meeting an end user need, even if the feature is used at an intermediary point in the supply chain. The diagram in Figure 1 above shows the boundary for a solution to create a hole. However, the material in which the hole is created likely fits into a higher order component or sub-system. The system boundary diagram my be used to cascade system requirements down to lower levels.

Starting voice of customer capturing at the end user (system level) is easier as well. As an example, an automobile purchaser knows what they want from a car, but could not tell

you what that means for the tire or transmission. Starting at the system level forces the developers to understand how requirements flow down to sub-systems and components. The process of flowing down requirements lets the developers understand how the sub-parts of a solution work together. In addition, starting at the system level opens the possibilities for innovation since a certain combination of components or sub-parts is not already assumed. This thinking process promotes breakthrough, rather than incremental innovation.

With the customer clearly identified, the voice of the customer can be captured. Three expectations of a customer must be considered: outcome expectation, performance expectation and perception expectation [Christensen & Raynor, 2003]. The outcome expectation is the desired outcome a customer is looking to achieve. For example, a person who buys a drill and bit desires to have a hole. Therefore, creating a hole is the desired outcome, while the drill and bit is the solution that fulfills the needs. The performance expectation describes how the customer would like the solution to perform or behave. In the case of creating a hole, the customer may state how quickly they want the hole to be created. The perception expectation describes how a customer wants a solution to make them feel. This could imply shape, color, size or other characteristics that give the customer a certain emotional reaction.

Uncovering and understanding the details of these expectations can be accomplished through direct contact with customers. Three methods have proven effective to extract relevant information:

- interviews,
- focus groups, and
- analytical surveys.

Interviews, in the form of a phone call or face-to-face discussion, are the most intimate way to extract information from a customer. They typically involve a one to one discussion between two persons. Interviews are typically used when a great level of detail is desired on a specific subject. Interviews are also used when clarifying detail is required. The main benefit of an interview is the opportunity for back and forth dialogue. Both the interviewer and interviewee have the opportunity to ask questions or probe specific areas of interest. Two main drawbacks are the time commitment and limited scope. To have an effective interview, time is required not only during the interview, but also before hand to prepare appropriate questions and logistics, as well as afterwards to process the results. With all of the effort comes a deep understanding of customer needs, but only for a limited number of customers, potentially as few as one. The risk is that this understanding does not directly translate to the broader needs of a market. An extension of the interview is customer visits. To overcome the inertia of sharing details in a short interview, visits lasting a full day, or even weeks may be used to gain a detailed understanding of the customer's situation.

Focus groups are interviews held with a small group of persons who represent a sample of customers. The sample could be arranged in multiple ways including: different job functions from the same customer, multiple customers from the same industry or a

demographic or geographic cross section. Typically, focus groups are executed in the form of face-to-face interviews with the collective sample group. As a result, the level of intimacy remains quite high, but the risk of a single view point is lessened. Much like one to one interviews, focus groups can be used when a detailed understanding of a topic is required. The benefit of the focus group approach is the ability to leverage the diverse viewpoints within the group to gain insight into the broader needs of a market or industry. However, a drawback is shared with interviews in the amount of time required to execute.

Analytical surveys are question and answer exchanges completed via electronic or paper forms and in some cases by phone. In these exchanges, many customers are contacted regarding their specific wants and needs of a product or service solution. They represent the least intimate method to capture the voice of the customer. In most cases, there is no back and forth dialogue with customers. The benefit of the survey technique is the ability to reach a very large audience, thereby collecting information from a large sample within a market or industry. The main drawbacks of the survey method are the lack of human interaction, potential for low response rate and the time required to complete the process. Although surveys purposely limit human interaction, the lack of dialogue raises the risk that the person taking the survey will misunderstand the questions and inadvertently answer in an unintended way. To minimize the risk of confusion, time and experience is required to create and execute a quality survey. In addition, with the opportunity for a large sample size, often the post processing analysis can be time consuming.

For a practical, yet thorough capturing of voice of customer, each of the techniques should be used. First, a limited number of focus groups can be held to gain insight into the needs in the market. Then, a survey can be used to correlate and confirm what was learned in the focus groups to the broader market. Lastly, interviews will help to clarify any areas of question or concern. Although this approach may seem time consuming, the scope and breadth of application can be modified to suit individual needs.

For those situations where market knowledge is more mature, an alternative method may be considered. The *Express VOC* is a quick and intuitive method to capture customer wants and needs. In this method, employees of the company who are intimately familiar with the customer or market are assembled in a small working session, a VOC kaizen event, to collect current knowledge of the voice of customer. In the working session, the group of persons takes on the role of the customer and explains their wants and needs. Once the voice of customer is understood using internal persons, a small survey or focus group is used to confirm the results with external customers. The survey or focus group is a critical step in using the *Express VOC* method. Systematic Innovation requires that the voice of customer originates from the end customer, regardless of how confident an organization feels about their market understanding.

Regardless of the method, capturing the customer requirements will yield a significant amount of data to sort through. Thus, the next step in developing the voice of customer is presented, organizing the data.

The challenge of organizing the data is two fold. First, the quantity of data may be overwhelming. Secondly, customers express the VOC in their language. That itself may not seem like an issue until 10 or more customers are polled and the realization is that they all said something a bit different. In this situation, a tool is needed to document a consolidated voice of customer. The tool presented here is the Quality Functional Deployment (QFD) House of Quality 1 (HOQ 1) [Hauser & Clausing, 1998].

The HOQ 1, shown below, offers several benefits to Systematic Innovation. First, the tool is well known in industrial and retail communities. As a result, ample sources exist for knowledge regarding templates and use. Second, the HOQ 1 will document a wealth of information regarding customer requirements and competitor benchmarking. Third, the tool can be used as part of a system engineering process. And finally, the HOQ 1 will serve as a kickoff point for creativity and innovation.

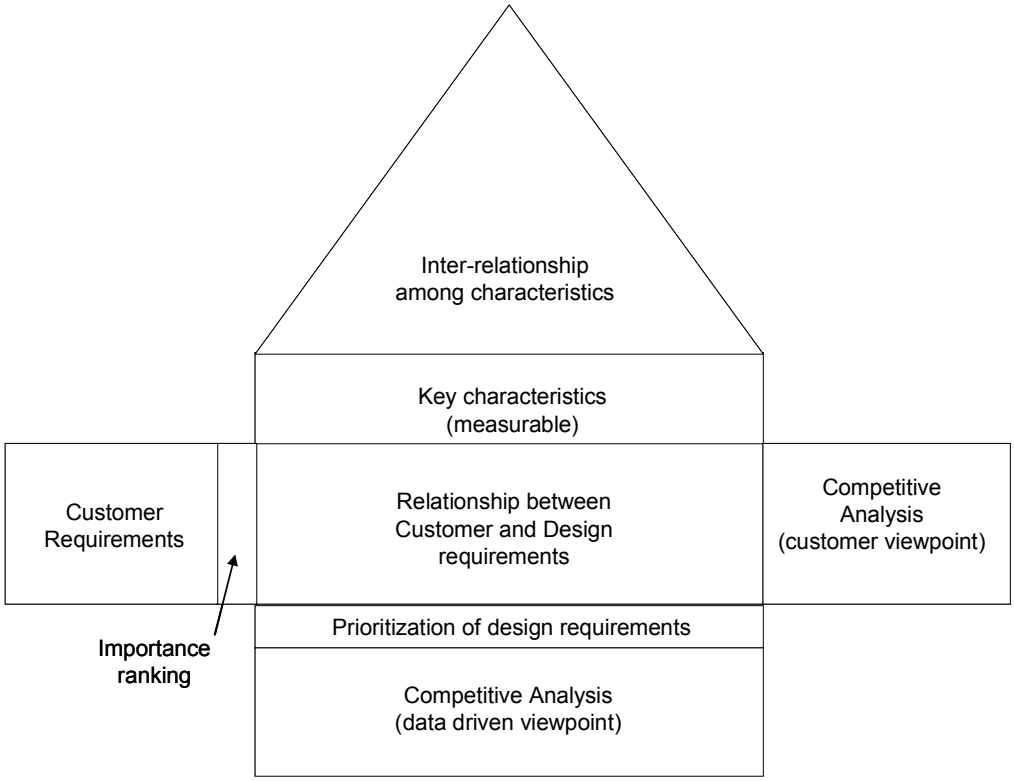

Figure 2. QFD House of Quality 1

The House of Quality is effectively a template that captures and compares different pieces of information. In line with the "house" analogy, the HOQ 1 is divided into several rooms. Each room contains a different piece of information. The customer requirements are the starting point and contained in the left-most room. Then, the rightmost and lower rooms are used to document competitive analysis information. The center room is where we translate the voice of customer into measurable key characteristics. The last room, the roof, is where information is captured to understand the relationship between different key characteristics.

For VOC organization, the focus should be in four areas of the HOQ 1: 1) customer requirements, 2) importance rating, 3) competitive analysis and 4) measurable key characteristics. The customer requirements room is where we document the results of our VOC capturing work.

As noted earlier, the customer will state their wants and needs, without a filter. To help start the data organization process, the following categories may be useful to consider:

- functional requirement,
- non-functional requirement,
- product or service constraints, and
- project consideration.

A functional requirement specifies a function that a system, component or service must be able to perform. In the eyes of the customer, it is their outcome expectation, as introduced earlier. Simply put, a functional requirement specifies what the system should do. In the case of the drill and bit, this could be to "create a hole". Whereas, a non-functional requirement specifies how the system should behave and represents the customers' performance and perception expectations. Non-functional requirements specify all the remaining requirements not covered by the functional requirements. They specify criteria that judge the operation of a system, rather than specific behaviors. For the drill bit, this could be the heat or vibration produced when the hole is drilled. The functional and non-functional requirements represent the "standard" to which a product or service shall be measured.

In some cases, the customer has constrains in addition to functional requirements. Examples of a constraint could include industry standard tests, regulatory requirements or even the size or shape of an object. These type of requirements are called must haves because if the offer fails to fulfill the requirement (such as passing a test or meeting a standard), then the customer will not even consider the product. Often constraints have underlying functional or non-functional requirements within them, such as durability or safety measures. So, these constraints must be considered carefully.

The last useful category to consider when organizing VOC data is project considerations. Project considerations are requirements that the customer may have on how the product or service solution is delivered to the market. These could include items such as delivery lead-time, project completion time, cost, or market price. Best practices suggest that these considerations are not captured in the HOQ 1, but rather in project management documents such as a project charter or project scorecard.

Affinity grouping of the wants and needs serves to organize the information into common groups or sub-groups. The four groups of customer requirements discussed above may represent the primary heading in an affinity grouping exercise. The data under the headings represent the content which will be documented in the leftmost room of HOQ 1, remembering that project considerations shall be omitted. Typically, the results are a

listed as wants and needs shown in the words of the customer. A populated customer requirements room may look something like the figure below.

		Voice of Customer	Importance Rating
Requirements	Functional requirements	create a hole	
	Non-functional requirements	make the hole quickly	
		last a long time	
		lightweight	
		will not rust during storage	
		minimal training required to use	
Constraints	Must haves	no hazardous materials formed while creating hole	
		must fit in a 3m x 3m x 1m cabinet	

Figure 3 - House of quality with customer requirements

Up until this point, no insight has been recorded into how the customer prioritizes requirements. Solution developers should understand priorities, and use them to their advantage during the design optimization phase of a solution. As noted earlier, there is no room for trade-offs in constraints. They must be there for the solution to have any value. However, in the functional and non-functional requirements some "wiggle room" may exist. Think about a passenger vehicle. A customer may accept that the vehicle has less opulent features in the interior, but delivers very low fuel consumption. To capture the customers' preferences, an importance rating should be given to the functional and non-functional requirements. Many techniques are available to understand the prioritization of customer requirements. Tools such as a Kano analysis, if/if not survey or pairwise comparison have all proven effective. The specifics of each technique shall not be covered here. Regardless of the technique, the objective is the same: try to understand how the customer would make trade-off decisions if necessary. As an outcome of the analysis, an importance rating can be given to each functional and non-functional requirement. The rating should be adjusted to a 1 to 5 scale, with 5 being the most important. For simplicity sake, typically only whole integers are used. With the importance rating added, the leftmost room of the house of quality may looks as follows for our solution to create a hole.

		Voice of Customer	Importance Rating
Requirements	Functional requirements	create a hole	5
	Non-functional requirements	make the hole quickly	3
		last a long time	2
		lightweight	2
		will not rust during storage	1
		minimal training required to use	1
Constraints	Must haves	no hazardous materials formed while creating hole	
		must fit in a 3m x 3m x 1m cabinet	

Figure 4. HOQ 1 with customer requirements and importance rating

As part of the voice of customer capturing process, an assessment of how the competition is performing can be made and then recorded in the HOQ 1. The right most room records information regarding how the customer perceives a competitor is performing against their requirements.

The word "perceives" should be highlighted, as the interest lies not in the actual, measured performance, but rather how the customer believes a competitor is performing. How can perception and actual performance be different? An example may clarify the point. In the luxury car market, image is known to play an important role in buying decisions. In this case, the customer may have a requirement for comfortable seats and easily accessible interior controls. One manufacturer may build a marketing campaign around how luxurious their cars are and how the operator will feel the car "wrap around them". Their interior is equipped with basic leather seats and some controls on the steering wheel. Meanwhile, the second manufacturer may focus on the interior design and provide leather heated and cooled seats with more the controls located on the steering wheel. But, the second manufacturer didn't invest in a successful marketing campaign. As a result, the customer has the perception that the first manufacturer offers more luxury. But, when actually measuring against customer requirements (comfortable seat, easily accessible controls), the second manufacturer outperforms the first.

The right room records the customer perception. In this room, each functional and non-functional requirement is given a score on scale of 1 to 5, with 5 representing a very good

perception. These scores must come from the customer. They can be assessed during the direct contact with the customer. For example, we could include survey questions on the topic or inquire during focus group sessions. The results are then recorded in the HOQ 1. Often, symbols can be used to make the information more visually legible. A completed room with customer perception may look like the figure below.

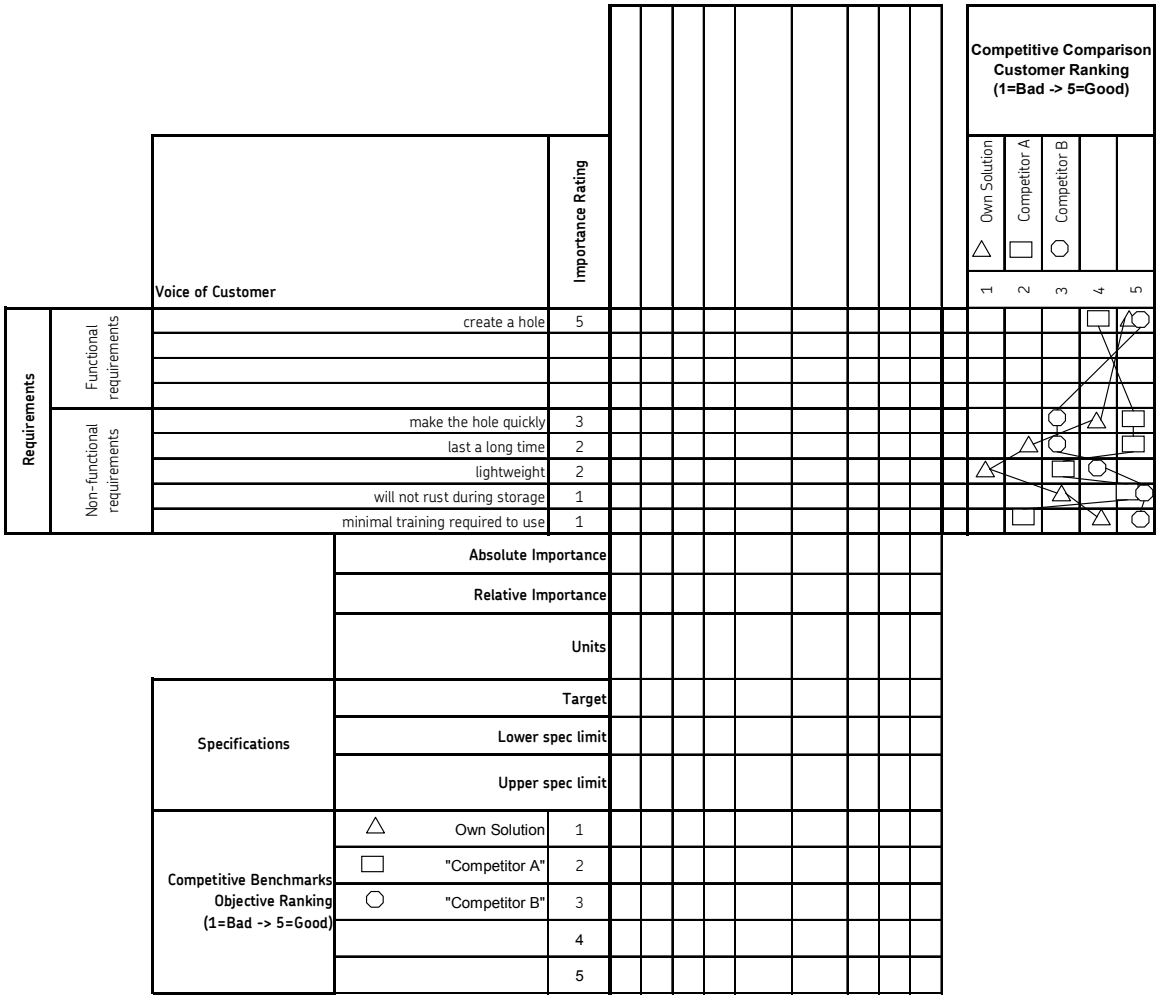

Figure 5. HOQ 1 with customer perception rating

The actual measured performance data can be recorded as well. The lower room of the HOQ 1 is the place where measured benchmark data is captured. As with the customer perception rating, a rating score from 1 to 5 is given, with 5 representing the best performance. Symbols are used to show how each solution alternative performs. However, before a solution can be measured against customer requirements, the measurement system must be defined.

The measurement system is created by a defining a set of solution neutral key characteristics. These key characteristics are measurable attributes representing the Voice of the Developer. Effectively, the Voice of Customer is translated into terms that the developer can better understand and use in the solution development process. The characteristics can be used to assess how well a solution is meeting customer requirements. The earlier example of creating a hole will provide a suitable example. The customer indicated a need to "make the hole quickly". No doubt that this requirement somehow relates to the speed at which the hole is made, but "quickly" and "make the hole" are non-descript words. The customer may be referring to many different possibilities such as: total time required to drill the hole including setup and break down or just the time create a hole not including setup. Similar challenges could occur with the requirement to "last a long time". What does the word "last" mean to the customer? To avoid confusion, the key characteristics are created using descript and measurable statements. Caution must be taken to ensure the characteristics correctly measure the requirement of the customer. For creating a hole, the key characteristics could be describes as in Figure 6.

			Key characteristic
Requirements	Functional requirements	create a hole	circular diameter
			maximum out of round (any circular plane)
			cylindricity
			taper
	Non-functional requirements	make the hole quickly	time to drill hole (not including setup/breakdown)
		last a long time	number of holes created before time to create drops by 50% from new
		lightweight	mass
		will not rust during storage	does rust appear after 24 hours storage
		minimal training required to use	number of hours training before first use

Figure 6. Key characteristics

In addition to being measurable, the characteristics must remain "solution neutral". Solution neutral denotes that the measurable characteristic does not imply a specific solution, such as a drill bit. If the characteristic measuring "make the hole quickly" was stated as "time to drill the hole", a specific solution is implied. The result of defining characteristics that are not solution neutral is to stifle creativity in later phases of development.

The key characteristics are recorded in the HOQ 1 just below the roof. To show the relationship between the customer requirements and the key characteristics, an inter-relationship score is recorded in the center. The score reflects the strength (or weakness) of the relationship between the customer requirements and the key characteristics. Typically, a 1, 3 or 9 score is used and interpreted according to the following scale:

Blank (no score) – no relationship
1 – weak relationship
3 – medium relationship
9 – strong relationship

A score of 9 indicates that the key characteristic was defined specifically for customer requirement to which it is related. To help understand the relationship, the following question may be useful to ask: "Does [*insert name of key characteristic*] help me assess my solutions ability to deliver *[insert name of customer requirement*]?". In the case of the hole solution, the question may be "Does the mass of the solution help me deliver a solution with minimal training requirements?". In this case, the answer is likely no and so the inter-relationship does not exist, yielding a score of "blank".

Once the inter-relationships are developed, an importance score can be calculated for the key characteristics. The score is computed by multiplying the customer requirement importance score with the inter-relationship score. Then, the scores are summed for each key characteristic. The purpose of this importance score is that it helps the developer understand which characteristics deliver the most value to the customer. Such knowledge can be very valuable during a design phase, especially where trade-off or optimization decisions are required.

As an additional step, specifications for the key characteristics can be documented. The customer may likely have target values or limits for their requirements. For example, they may know how quickly they would like to make the hole or how lightweight a solution should be. This type of information is recorded just below the key characteristic importance scores.

With a reliable and effective measurement system defined, the actual performance data can be recorded. The data driven competitor analysis section (lowermost room) is where benchmarking data can be recorded. Using the key characteristics as metrics, benchmarking can be performed to see how a competitor is performing against customer requirements. Then, once a solution is developed, it too can be measured and compared against the competition.

For the solution used to create a hole, the HOQ with key characteristics, inter-relationship scoring, specifications and data driven competitive analysis may look like Figure 7.

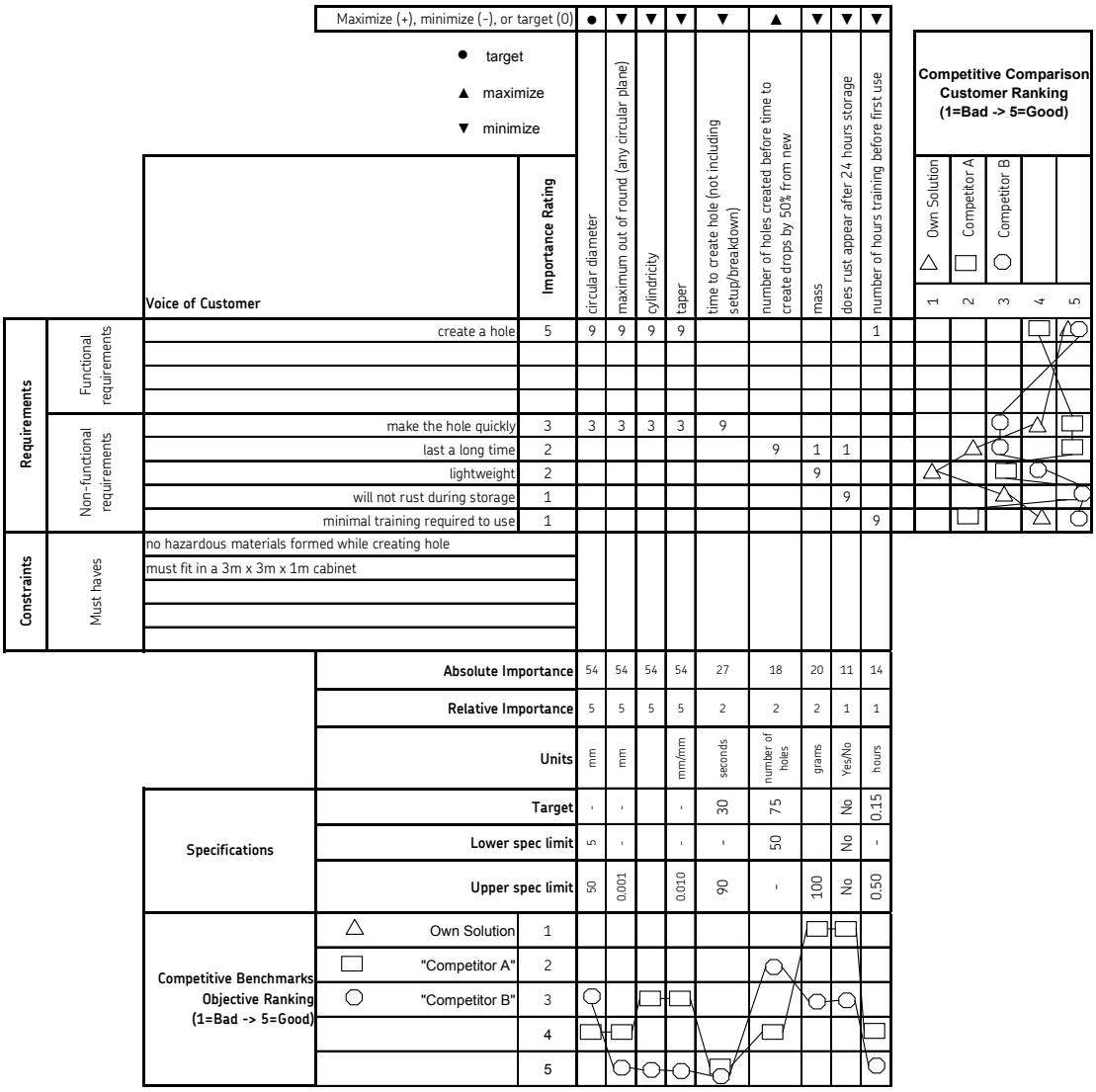

Figure 7. HOQ 1 with voice of customer information

The last area of the HOQ 1 remaining is the "roof" or uppermost room. The roof is used to understand the relationship between key characteristics. For example, as hole diameter size requirements grow, holding low out of round may become more difficult in typical situations. To visualize the relationships, a symbolic scale can be used, as shown in Figure 8.

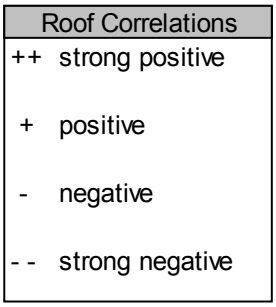

Figure 8. symbols used for roof correlations

Information contained in the roof becomes valuable during innovation work. Strong positive or negative correlations provide great opportunities to innovate. For example, in the case of a strong negative correlation, innovation methods may be used to disassociate the system behavior and give the customer greater control and flexibility in performance. A HOQ 1 with all of the key information recorded is shown in Figure 9.

The four step process for capturing the voice of the customer has provided a means to gather and organize a large amount of data. The House of Quality 1, as the main deliverable, serves as the tool to capture all of the knowledge gained. In order to obtain all of the information, the developer likely has to become intimately familiar with the customer and their needs. In addition, this tool provides an understanding of the design challenge. The design challenge is the foundation on which innovative solutions can be developed as part of the Systematic Innovation process.

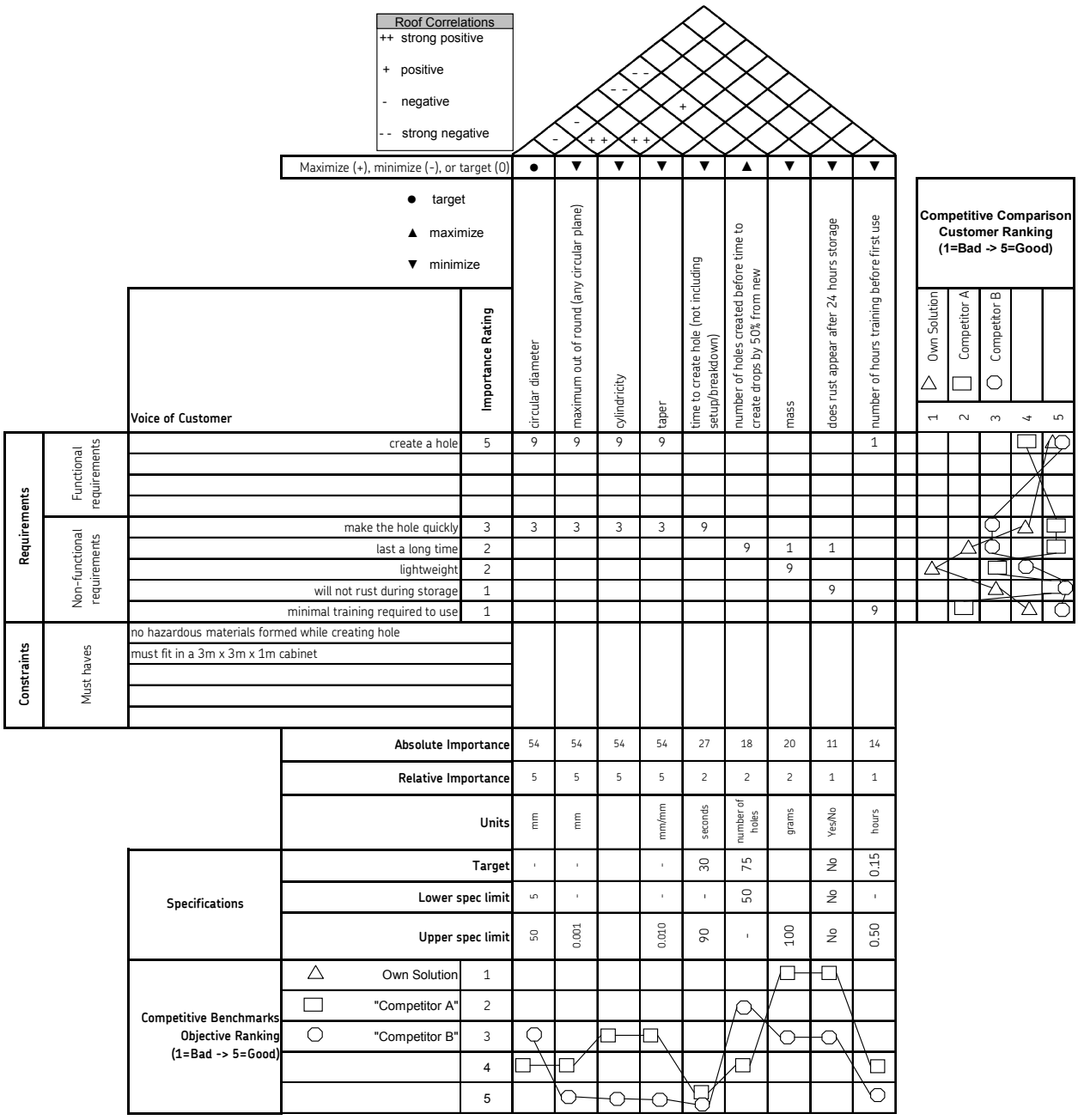

Figure 9. completed QFD House of Quality 1

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Brian Weiss is the manager of an advanced development team focusing on creating new to market products and services for industrial and automotive equipment. He is employed by SKF, a leading supplier of rolling bearings, seals, mechatronics, services and lubrication systems. Mr. Weiss held positions in applications engineering and project management at SKF prior to his current role. He also worked in sales at The Timken Company. Brian holds a Bachelors of Science in Mechanical Engineering from Penn State University and a Masters of Business with a concentration in Corporate Entrepreneurship from Lehigh University. He is certified in Lean Six Sigma and Design for Six Sigma as a Black Belt Specialist in Innovation and Requirements Management.

Donald P. Lynch, Ph.D. received his BS in Mechanical Engineering from Michigan Technological University, MBA from Eastern Michigan University, Ph.D. in Mechanical (Industrial) Engineering from Colorado State University and a post Graduate Certificate in Lean Six Sigma from the University of Michigan. His professional career includes positions in engineering, quality, design, management and consulting at Ford Motor Company, Diamond Electric Mfg., Visteon Corporation, SKF USA, The University of Michigan and University of Detroit-Mercy. He holds (6) American Society for Quality certifications including Six Sigma Black Belt (CSSBB) and is an ASQ Fellow. He is also a University of Michigan Certified Black Belt and Lean Specialist (manufacturing and office) and an International Quality Federation (IQF), Visteon Corporation, International Society of Six Sigma Professionals (ISSSP) and SKF Certified Master Black Belt (MBB). Don also holds certifications from the Institute for Lean Innovation as well as Kepner-Fourie in Critical Thinking. As a four-time Lean Six Sigma MBB Don has completed projects, developed programs, consulted and instructed in all areas of Design for Six Sigma, Traditional Six Sigma and Lean including manufacturing, office, transactional, product and process design, systematic innovation as well as critical thinking. He has deployed continuous improvement programs for organizations in Asia, Europe, South America and the U.S. in a number of industries. He has certified over 150 Black Belts, has led over 20 Black Belt waves, has mentored over 15 Master Black Belts and has facilitated over 20 kaizen events in a 14+ year career in Lean Six Sigma. Has completed projects numerous projects in a wide variety of process areas in (4) continents. He has authored over twenty-five papers, magazine articles, journal entries and presentations on Design for Six Sigma Traditional Six Sigma, Lean Continuous Improvement and other related areas. In his current position he is a Senior Lean Six Sigma Master Black Belt and Deployment Champion with SKF USA. Don is also an Adjunct Professor at the University of Detroit-Mercy and a guest Lecturer and Conference Leader, Consultant and Co-Director of Lean Six Sigma programs for the University of Michigan College of Engineering and Integrative Systems and Design.