

Managers at Motorola and Philips describe their use of several technology roadmapping methods for integrating the planning of technology development and product development.

Willyard, Charles H., and Cheryl W. McClees, "Motorola's Technology Roadmap Process," *Research Management*, Vol. 30, No. 5, Sep./Oct. 1987, pp. 13-19.

Groenveld, Pieter, "Roadmapping Integrates Business and Technology," *Research-Technology Management*, Vol. 40, No. 5, Sep./Oct. 1997, pp. 48-55.

Christensen provides evidence that firms must invest in fundamentally new products, technologies, and markets in order to remain at the leading edge of their industries.

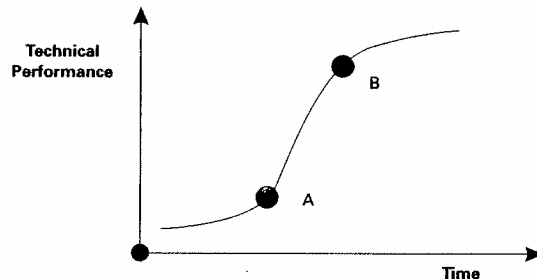
Christensen, Clayton M., *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail*, Harvard Business School Press, Boston, 1997.

Exercises

1. Conduct a search using the Internet or published corporate annual reports to identify the corporate strategy of a company in which you might be interested in investing. Learn about the firm's product lines and its newest products. How do these products support the corporate strategy? What types of projects would you expect to see in the product plan?
2. Create a product-technology roadmap illustrating the availability of technologies for a class of products you understand well, such as personal computers.

Thought Questions

1. How might a portfolio of development projects differ if the firm believes a particular product technology is currently at position A or B on the technology S-curve shown below?



2. How might Xerox be able to address the shortage of mechanical design engineers identified by the aggregate project planning analysis shown in Exhibit 3-9? List five ways Xerox could increase the capacity and five ways to reduce the demand for mechanical design engineers.

CHAPTER FOUR

Identifying Customer Needs

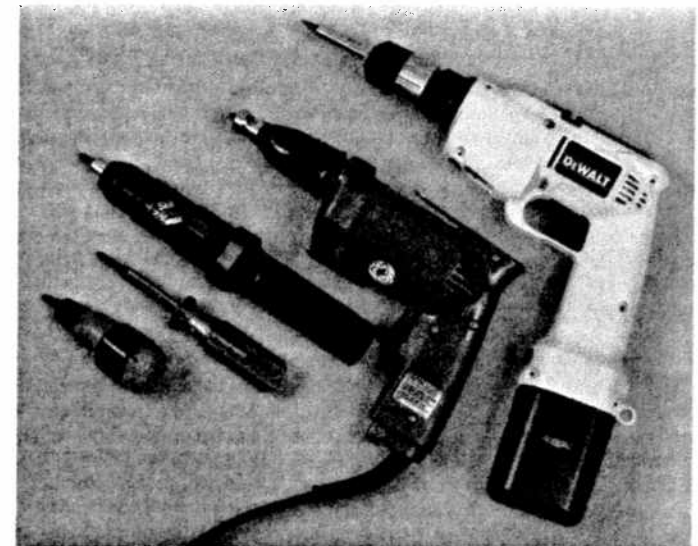


Photo by Stuart Cohen

EXHIBIT 4-1

Existing products used to drive screws: manual screwdrivers, cordless screwdriver, screw gun, cordless drill with driver bit.

This chapter was developed in collaboration with Jonathan Sterrett.

A successful hand tool manufacturer was exploring the growing market for hand-held power tools. After performing initial research, the firm decided to enter the market with a cordless screwdriver. Exhibit 4-1 shows several existing products used to drive screws. After some initial concept work, the manufacturer's development team fabricated and field-tested several prototypes. The results were discouraging. Although some of the products were liked better than others, each one had some feature that customers objected to in one way or another. The results were quite mystifying since the company had been successful in related consumer products for years. After much discussion, the team decided that its process for identifying customer needs was inadequate.

This chapter presents a method for comprehensively identifying a set of customer needs. The goals of the method are to:

- Ensure that the product is focused on customer needs.
- Identify latent or hidden needs as well as explicit needs.
- Provide a fact base for justifying the product specifications.
- Create an archival record of the needs activity of the development process.
- Ensure that no critical customer need is missed or forgotten.
- Develop a common understanding of customer needs among members of the development team.

The philosophy behind the method is to create a high-quality information channel that runs directly between customers in the target market and the developers of the product. This philosophy is built on the premise that those who directly control the details of the product, including the engineers and industrial designers, must interact with customers and experience the *use environment* of the product. Without this direct experience, technical trade-offs are not likely to be made correctly, innovative solutions to customer needs may never be discovered, and the development team may never develop a deep commitment to meeting customer needs.

The process of identifying customer needs is an integral part of the larger product development process and is most closely related to concept generation, concept selection, competitive benchmarking, and the establishment of product specifications. The customer-needs activity is shown in Exhibit 4-2 in relation to these other front-end product development activities, which collectively can be thought of as the *concept development* phase.

The concept development process illustrated in Exhibit 4-2 implies a distinction between customer needs and product specifications. This distinction is subtle but important.

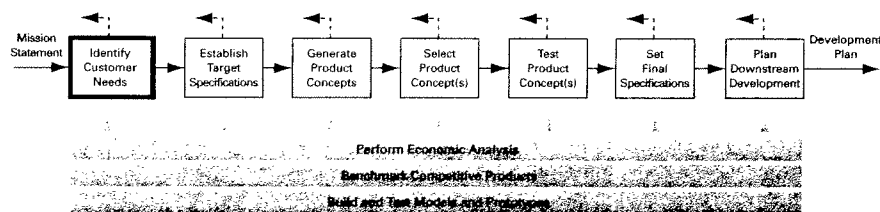


EXHIBIT 4-2 The customer-needs activity in relation to other concept development activities.

Needs are largely independent of any particular product we might develop; they are not specific to the concept we eventually choose to pursue. A team should be able to identify customer needs without knowing if or how it will eventually address those needs. On the other hand, *specifications* do depend on the concept we select. The specifications for the product we finally choose to develop will depend on what is technically and economically feasible and on what our competitors offer in the marketplace, as well as on customer needs. (See Chapter 5, Product Specifications, for a more detailed discussion of this distinction.) Also note that we choose to use the word *need* to label any attribute of a potential product that is desired by the customer; we do not distinguish here between a want and a need. Other terms used in industrial practice to refer to customer needs include *customer attributes* and *customer requirements*.

Identifying customer needs is itself a process, for which we present a five-step method. We believe that a little structure goes a long way in facilitating effective product development practices, and we hope and expect that this method will be viewed by those who employ it not as a rigid process but rather as a starting point for continuous improvement and refinement. The five steps are:

1. Gather raw data from customers.
2. Interpret the raw data in terms of customer needs.
3. Organize the needs into a hierarchy of primary, secondary, and (if necessary) tertiary needs.
4. Establish the relative importance of the needs.
5. Reflect on the results and the process.

We treat each of the five steps in turn and illustrate the key points with the cordless screwdriver example. We chose the screwdriver because it is simple enough that the method is not hidden by the complexity of the example. However, note that the same method, with minor adaptation, has been successfully applied to hundreds of products ranging from kitchen utensils costing less than \$10 to machine tools costing hundreds of thousands of dollars.

Before beginning the development project, the firm typically specifies a particular market opportunity and lays out the broad constraints and objectives for the project. This information is frequently formalized as a *mission statement* (also sometimes called a *charter* or a *design brief*). The mission statement specifies which direction to go in but generally does not specify a precise destination or a particular way to proceed. The mission statement is the result of the product planning activities described in Chapter 3, Product Planning. The mission statement for the cordless screwdriver is shown in Exhibit 4-3.

The cordless screwdriver category of products is already relatively well developed. Such products are particularly well suited to a structured process for gathering customer needs. One could reasonably ask whether a structured method is effective for completely new categories of products with which customers have no experience. Satisfying needs is just as important in revolutionary products as in incremental products. A necessary condition for product success is that a product offer perceived benefits to the customer. Products offer benefits when they satisfy needs. This is true whether the product is an incremental variation on an existing product or whether it is a completely new product based on a revolutionary invention. Developing an entirely new category of product is a risky undertaking, and to some extent the only real indication of whether customer needs have

EXHIBIT 4-3

Mission statement for the cordless screwdriver.

| Mission Statement: Screwdriver Project | |
|--|--|
| Product Description | <ul style="list-style-type: none"> • A hand-held, power-assisted device for installing threaded fasteners |
| Key Business Goals | <ul style="list-style-type: none"> • Product introduced in fourth quarter of 2006 • 50% gross margin • 10% share of cordless screwdriver market by 2008 |
| Primary Market | <ul style="list-style-type: none"> • Do-it-yourself consumer |
| Secondary Markets | <ul style="list-style-type: none"> • Casual consumer • Light-duty professional |
| Assumptions | <ul style="list-style-type: none"> • Hand-held • Power-assisted • Nickel-metal-hydride rechargeable battery technology |
| Stakeholders | <ul style="list-style-type: none"> • User • Retailer • Sales force • Service center • Production • Legal department |

been identified correctly is whether customers like the team's first prototypes. Nevertheless, in our opinion, a structured method for gathering data from customers remains useful and can lower the inherent risk in developing a radically new product. Whether or not customers are able to fully articulate their latent needs, interaction with customers in the target market will help the development team build a personal understanding of the user's environment and point of view. This information is always useful, even if it does not result in the identification of every need the new product will address.

Step 1: Gather Raw Data from Customers

Consistent with our basic philosophy of creating a high-quality information channel directly from the customer, gathering data involves contact with customers and experience with the use environment of the product. Three methods are commonly used:

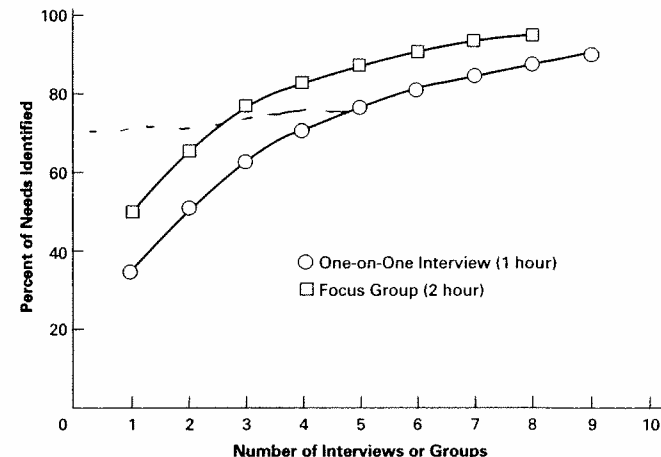
1. Interviews: One or more development team members discuss needs with a single customer. Interviews are usually conducted in the customer's environment and typically last one to two hours.

2. Focus groups: A moderator facilitates a two-hour discussion with a group of 8 to 12 customers. Focus groups are typically conducted in a special room equipped with a two-way mirror allowing several members of the development team to observe the group. In most cases, the moderator is a professional market researcher, but a member of the development team sometimes moderates. The proceedings are usually videotaped. Participants are usually paid a modest fee (\$50 to \$100 each) for their attendance. The total cost of a focus group, including rental of the room, participant fees, videotaping, and refreshments, is about \$2,500. In most U.S. cities, firms that recruit participants, moderate focus groups, and/or rent facilities are listed in directories under "Market Research."

EXHIBIT 4-4

Comparison of the percentages of customer needs that are revealed for focus groups and interviews as a function of the number of sessions. Note that a focus group lasts two hours, while an interview lasts one hour.

Source: Griffin and Hauser, 1993



3. Observing the product in use: Watching customers use an existing product or perform a task for which a new product is intended can reveal important details about customer needs. For example, a customer painting a house may use a screwdriver to open paint cans in addition to driving screws. Observation may be completely passive, without any direct interaction with the customer, or may involve working side by side with a customer, allowing members of the development team to develop firsthand experience using the product. Ideally, team members observe the product in the actual use environment. For some products, such as do-it-yourself tools, actually using the products is simple and natural; for others, such as surgical instruments, the team may have to use the products on surrogate tasks (e.g., cutting fruit instead of human tissue when developing a new scalpel).

Some practitioners also rely on written surveys for gathering raw data. While a mail or web-based survey is quite useful later in the process, we cannot recommend this approach for initial efforts to identify customer needs; written surveys simply do not provide enough information about the use environment of the product, and they are generally ineffective in revealing unanticipated needs.

Research by Griffin and Hauser shows that one 2-hour focus group reveals about the same number of needs as two 1-hour interviews (Griffin and Hauser, 1993). (See Exhibit 4-4.) Because interviews are usually less costly (per hour) than focus groups and because an interview often allows the product development team to experience the use environment of the product, we recommend that interviews be the primary data collection method. Interviews may be supplemented with one or two focus groups as a way to allow top management to observe a group of customers or as a mechanism for sharing a common customer experience (via video) with the members of a larger team. Some practitioners believe that for certain products and customer groups, the interactions among the participants of focus groups can elicit more varied needs than are revealed through interviews, although this belief is not strongly supported by research findings.

Choosing Customers

Griffin and Hauser also addressed the question of how many customers to interview in order to reveal most of the customer needs. In one study, they estimated that 90 percent of the customer needs for picnic coolers were revealed after 30 interviews. In another study, they estimated that 98 percent of the customer needs for a piece of office equipment were revealed after 25 hours of data collection in both focus groups and interviews. As a practical guideline for most products, conducting fewer than 10 interviews is probably inadequate and 50 interviews are probably too many. However, interviews can be conducted sequentially and the process can be terminated when no new needs are revealed by additional interviews. These guidelines apply to cases in which the development team is addressing a single market segment. If the team wishes to gather customer needs from multiple distinct segments, then the team may need to conduct 10 or more interviews in each segment. Concept development teams consisting of more than 10 people usually collect data from plenty of customers simply by involving much of the team in the process. For example, if a 10-person team is divided into five pairs and each pair conducts 6 interviews, the team conducts 30 interviews in total.

Needs can be identified more efficiently by interviewing a class of customers called *lead users*. According to von Hippel, lead users are customers who experience needs months or years ahead of the majority of the market and stand to benefit substantially from product innovations (von Hippel, 1988). These customers are particularly useful sources of data for two reasons: (1) they are often able to articulate their emerging needs, because they have had to struggle with the inadequacies of existing products, and (2) they may have already invented solutions to meet their needs. By focusing a portion of the data collection efforts on lead users, the team may be able to identify needs which, although explicit for lead users, are still latent for the majority of the market. Developing products to meet these latent needs allows a firm to anticipate trends and to leapfrog competitive products.

The choice of which customers to interview is complicated when several different groups of people can be considered "the customer." For many products, one person (the buyer) makes the buying decision and another person (the user) actually uses the product. A good approach is to gather data from the end user of the product in all situations, and in cases where other types of customers and stakeholders are clearly important, to gather data from these people as well.

A customer selection matrix is useful for planning exploration of both market and customer variety. Burchill suggests that market segments be listed on the left side of the matrix while the different types of customers are listed across the top (Burchill et al., 1997), as shown in Exhibit 4-5. The number of intended customer contacts is entered in each cell to indicate the depth of coverage.

For industrial and commercial products, actually locating customers is usually a matter of making telephone calls. In developing such products within an existing firm, a field sales force can often provide names of customers, although the team must be careful about biasing the selection of customers toward those with allegiances to a particular manufacturer. The web or the telephone book can be used to identify names of some types of customers for some classes of products (e.g., building contractors or insurance agents). For products that are integral to a customer's job, getting someone to agree to an interview is usually simple; these customers are eager to discuss their needs. For con-

EXHIBIT 4-5

Customer selection matrix for the cordless screwdriver project.

| | Lead Users | Users | Retailer or Sales Outlet | Service Centers |
|-------------------------------|------------|-------|--------------------------|-----------------|
| Homeowner (occasional use) | 0 | 5 | 2 | 3 |
| Handy person (frequent use) | 3 | 10 | | |
| Professional (heavy-duty use) | 3 | 2 | 2 | |

sumer products, customers can also be located by making telephone calls. However, arranging a set of interviews for consumer products generally requires more inquiries than for industrial or commercial products because the benefit of participating in an interview is less direct for these customers.

The Art of Eliciting Customer Needs Data

The techniques we present here are aimed primarily at interviewing end users, but these methods do apply to all of the three data-gathering modes and to all types of stakeholders. The basic approach is to be receptive to information provided by customers and to avoid confrontations or defensive posturing. Gathering needs data is very different from a sales call: the goal is to elicit an honest expression of needs, not to convince a customer of what he or she needs. In most cases customer interactions will be verbal; interviewers ask questions and the customer responds. A prepared interview guide is valuable for structuring this dialogue. Some helpful questions and prompts for use after the interviewers introduce themselves and explain the purpose of the interview are:

- When and why do you use this type of product?
- Walk us through a typical session using the product.
- What do you like about the existing products?
- What do you dislike about the existing products?
- What issues do you consider when purchasing the product?
- What improvements would you make to the product?

Here are some general hints for effective interaction with customers:

- **Go with the flow.** If the customer is providing useful information, do not worry about conforming to the interview guide. The goal is to gather important data on customer needs, not to complete the interview guide in the allotted time.
- **Use visual stimuli and props.** Bring a collection of existing and competitors' products, or even products that are tangentially related to the product under development. At the end of a session, the interviewers might even show some preliminary product concepts to get customers' early reactions to various approaches.
- **Suppress preconceived hypotheses about the product technology.** Frequently customers will make assumptions about the product concept they expect would meet their

needs. In these situations, the interviewers should avoid biasing the discussion with assumptions about how the product will eventually be designed or produced. When customers mention specific technologies or product features, the interviewer should probe for the underlying need the customer believes the suggested solution would satisfy.

- **Have the customer demonstrate the product and/or typical tasks related to the product.** If the interview is conducted in the use environment, a demonstration is usually convenient and invariably reveals new information.
- **Be alert for surprises and the expression of latent needs.** If a customer mentions something surprising, pursue the lead with follow-up questions. Frequently, an unexpected line of questioning will reveal *latent needs*—important dimensions of the customers' needs that are neither fulfilled nor commonly articulated and understood.
- **Watch for nonverbal information.** The process described in the chapter is aimed at developing better physical products. Unfortunately, words are not always the best way to communicate needs related to the physical world. This is particularly true of needs involving the human dimensions of the product, such as comfort, image, or style. The development team must be constantly aware of the nonverbal messages provided by customers. What are their facial expressions? How do they hold competitors' products?

Note that many of our suggested questions and guidelines assume that the customer has some familiarity with products similar to the new product under development. This is almost always true. For example, even before the first cordless screwdriver became available, people installed fasteners. Developing an understanding of customer needs as they relate to the general fastening task would still have been beneficial in developing the first cordless tool. Similarly, understanding the needs of customers using other types of cordless appliances, such as electric razors, would also have been useful. We can think of no product so revolutionary that there would be no analogous products or tasks from which the development team could learn. However, in gathering needs relating to truly revolutionary products with which customers have no experience, the interview questions should be focused on the task or situation in which the new product will be applied, rather than on the product itself.

Documenting Interactions with Customers

Four methods are commonly used for documenting interactions with customers:

1. **Audio recording:** Making an audio recording of the interview is very easy. Unfortunately, transcribing the recording into text is very time consuming, and hiring someone to do it can be expensive. Also, audio recording has the disadvantage of being intimidating to some customers.

2. **Notes:** Handwritten notes are the most common method of documenting an interview. Designating one person as the primary notetaker allows the other person to concentrate on effective questioning. The notetaker should strive to capture some of the wording of every customer statement verbatim. These notes, if transcribed immediately after the interview, can be used to create a description of the interview that is very close to an actual transcript. This debriefing immediately after the interview also facilitates sharing of insights between the interviewers.

3. **Video recording:** Video recording is almost always used to document a focus group session. It is also very useful for documenting observations of the customer in the

use environment and/or using existing products. The video recording is useful for bringing new team members "up to speed" and is also useful as raw material for presentations to upper management. Multiple viewings of video recordings of customers in action often facilitate the identification of latent customer needs. Video recording is also useful for capturing many aspects of the end user's environment.

4. **Still photography:** Taking photographs provides many of the benefits of video recording. The primary advantages of still photography are ease of display of the photos, excellent image quality, and readily available equipment. The primary disadvantage is the relative inability to record dynamic information.

The final result of the data-gathering phase of the process is a set of raw data, usually in the form of *customer statements* but frequently supplemented by video recordings or photographs. A data template implemented in a spreadsheet is useful for organizing these raw data. Exhibit 4-6 is an example of a portion of such a template. We recommend that the template be filled in as soon as possible after the interaction with the customer and edited by the other development team members present during the interaction. The first column in the main body of the template indicates the question or prompt that elicited the customer data. The second column is a list of verbatim statements the customer made or an observation of a customer action (from a video recording or from direct observation). The third column contains the customer needs implied by the raw data. Some emphasis should be placed on investigating clues that may identify potential latent needs. Such clues may be in the form of humorous remarks, less serious suggestions, frustrations, nonverbal information, or observations and descriptions of the use environment. The symbol (!) is used in Exhibit 4-6 to flag potential latent needs. Techniques for interpreting the raw data in terms of customer needs are given in the next section.

The final task in step 1 is to write thank-you notes to the customers involved in the process. Invariably, the team will need to solicit further customer information, so developing and maintaining a good rapport with a set of users is important.

Step 2: Interpret Raw Data in Terms of Customer Needs

Customer needs are expressed as written statements and are the result of interpreting the need underlying the raw data gathered from the customers. Each statement or observation (as listed in the second column of the data template) may be translated into any number of customer needs. Griffin and Hauser found that multiple analysts may translate the same interview notes into different needs, so it is useful to have more than one team member conducting the translation process. Below we provide five guidelines for writing need statements. The first two guidelines are fundamental and are critical to effective translation; the remaining three guidelines ensure consistency of phrasing and style across all team members. Exhibit 4-7 provides examples to illustrate each guideline.

- **Express the need in terms of what the product has to do, not in terms of how it might do it.** Customers often express their preferences by describing a solution concept or an implementation approach; however, the need statement should be expressed in terms independent of a particular technological solution.

| | | | |
|---------------------------------|---|---|----------------------|
| Customer: | Bill Esposito | Interviewer(s): | Jonathan and Lisa |
| Address: | 100 Memorial Drive Cambridge, MA 02139 | Date: | 19 December 2002 |
| Telephone: | 617-864-1274 | Currently uses: | Craftsman Model A3 |
| Willing to do follow-up? | Yes | Type of user: | Building maintenance |
| Question/Prompt | Customer Statement | Interpreted Need | |
| Typical uses | I need to drive screws fast, faster than by hand. | The SD drives screws faster than by hand. | |
| | I sometimes do duct work; use sheet metal screws. | The SD drives sheet metal screws into metal duct work. | |
| | A lot of electrical; switch covers, outlets, fans, kitchen appliances. | The SD can be used for screws on electrical devices. | |
| Likes—current tool | I like the pistol grip; it feels the best. | The SD is comfortable to grip. | |
| | I like the magnetized tip. | The SD tip retains the screw before it is driven. | |
| Dislikes—current tool | I don't like it when the tip slips off the screw. | The SD tip remains aligned with the screw head without slipping. | |
| | I would like to be able to lock it so I can use it with a dead battery. | The user can apply torque manually to the SD to drive a screw. (!) | |
| | Can't drive screws into hard wood. | The SD can drive screws into hard wood. | |
| | Sometimes I strip tough screws. | The SD does not strip screw heads. | |
| Suggested improvements | An attachment to allow me to reach down skinny holes. | The SD can access screws at the end of deep, narrow holes. | |
| | A point so I can scrape paint off of screws. | The SD allows the user to work with screws that have been painted over. | |
| | Would be nice if it could punch a pilot hole. | The SD can be used to create a pilot hole. (!) | |

EXHIBIT 4-6 Customer data template filled in with sample customer statements and interpreted needs. SD is an abbreviation for screwdriver. (Note that this template represents a partial list from a single interview. A typical interview session may elicit more than 50 customer statements and interpreted needs.)

- **Express the need as specifically as the raw data.** Needs can be expressed at many different levels of detail. To avoid loss of information, express the need at the same level of detail as the raw data.
- **Use positive, not negative, phrasing.** Subsequent translation of a need into a product specification is easier if the need is expressed as a positive statement. This is not a rigid guideline, because sometimes positive phrasing is difficult and awkward. For example, one of the need statements in Exhibit 4-6 is “the screwdriver does not strip screw heads.” This need is more naturally expressed in a negative form.
- **Express the need as an attribute of the product.** Wording needs as statements about the product ensures consistency and facilitates subsequent translation into product specifications. Not all needs can be cleanly expressed as attributes of the product, however, and in most of these cases the needs can be expressed as attributes of the

| Guideline | Customer Statement | Need Statement—Right | Need Statement—Wrong |
|-----------------------------|---|--|--|
| “What” not “how” | “Why don’t you put protective shields around the battery contacts?” | The screwdriver battery is protected from accidental shorting. | The screwdriver battery contacts are covered by a plastic sliding door. |
| Specificity | “I drop my screwdriver all the time.” | The screwdriver operates normally after repeated dropping. | The screwdriver is rugged. |
| Positive not negative | “It doesn’t matter if it’s raining; I still need to work outside on Saturdays.” | The screwdriver operates normally in the rain. | The screwdriver is not disabled by the rain. |
| An attribute of the product | “I’d like to charge my battery from my cigarette lighter.” | The screwdriver battery can be charged from an automobile cigarette lighter. | An automobile cigarette lighter adapter can charge the screwdriver battery. |
| Avoid “must” and “should” | “I hate it when I don’t know how much juice is left in the batteries of my cordless tools.” | The screwdriver provides an indication of the energy level of the battery. | The screwdriver should provide an indication of the energy level of the battery. |

EXHIBIT 4-7 Examples illustrating the guidelines for writing need statements.

user of the product (e.g., “the user can apply torque manually to the screwdriver to drive a screw”).

- **Avoid the words *must* and *should*.** The words *must* and *should* imply a level of importance for the need. Rather than casually assigning a binary importance rating (*must* versus *should*) to the needs at this point, we recommend deferring the assessment of the importance of each need until step 4.

The list of customer needs is the superset of all the needs elicited from all the interviewed customers in the target market. Some needs may not be technologically realizable. The constraints of technical and economic feasibility are incorporated into the process of establishing product specifications in subsequent development steps. (See Chapter 5, Product Specifications.) In some cases customers will have expressed conflicting needs. At this point in the process the team does not attempt to resolve such conflicts, but simply documents both needs. Deciding how to address conflicting needs is one of the challenges of the subsequent concept development activities.

Step 3: Organize the Needs into a Hierarchy

The result of steps 1 and 2 should be a list of 50 to 300 *need statements*. Such a large number of detailed needs is awkward to work with and difficult to summarize for use in subsequent development activities. The goal of step 3 is to organize these needs into a hierarchical list. The list will typically consist of a set of *primary needs*, each one of which will be further characterized by a set of *secondary needs*. In cases of very complex products, the secondary needs may be broken down into tertiary needs as well. The primary needs are the most general needs, while the secondary and tertiary needs express needs in more detail. Exhibit 4-8 shows the resulting hierarchical list of needs for the screwdriver

The SD provides plenty of power to drive screws.

- * The SD maintains power for several hours of heavy use.
- ** The SD can drive screws into hardwood. The SD drives sheet metal screws into metal ductwork.
- *** The SD drives screws faster than by hand.

The SD makes it easy to start a screw.

- * The SD retains the screw before it is driven.
- *! The SD can be used to create a pilot hole.

The SD works with a variety of screws.

- ** The SD can turn Phillips, Torx, socket, and hex head screws.
- ** The SD can turn many sizes of screws.

The SD can access most screws.

- ** The SD can be maneuvered in tight areas.
- ** The SD can access screws at the end of deep, narrow holes.

The SD turns screws that are in poor condition.

- ** The SD can be used to remove grease and dirt from screws.
- ** The SD allows the user to work with painted screws.

The SD feels good in the user's hand.

- *** The SD is comfortable when the user pushes on it.
- *** The SD is comfortable when the user resists twisting.
- * The SD is balanced in the user's hand.
- ! The SD is equally easy to use in right or left hands. The SD weight is just right.
- ** The SD is warm to touch in cold weather. The SD remains comfortable when left in the sun.

The SD is easy to control while turning screws.

- *** The user can easily push on the SD.
- *** The user can easily resist the SD twisting. The SD can be locked "on."
- *! The SD speed can be controlled by the user while turning a screw.
- * The SD remains aligned with the screw head without slipping.
- ** The user can easily see where the screw is.
- * The SD does not strip screw heads.
- * The SD is easily reversible.

The SD is easy to set up and use.

- * The SD is easy to turn on.
- * The SD prevents inadvertent switching off.
- * The user can set the maximum torque of the SD.
- *! The SD provides ready access to bits or accessories.
- * The SD can be attached to the user for temporary storage.

The SD power is convenient.

- * The SD is easy to recharge. The SD can be used while recharging.
- *** The SD recharges quickly. The SD batteries are ready to use when new.
- *! The user can apply torque manually to the SD to drive a screw.

The SD lasts a long time.

- ** The SD tip survives heavy use. The SD can be hammered.
- * The SD can be dropped from a ladder without damage.

The SD is easy to store.

- * The SD fits in a toolbox easily.
- ** The SD can be charged while in storage. The SD resists corrosion when left outside or in damp places.
- *! The SD maintains its charge after long periods of storage. The SD maintains its charge when wet.

The SD prevents damage to the work.

- * The SD prevents damage to the screw head. The SD prevents scratching of finished surfaces.

The SD has a pleasant sound when in use.

The SD looks like a professional quality tool.

The SD is safe.

- ** The SD can be used on electrical devices.
- *** The SD does not cut the user's hands.

EXHIBIT 4-8 Hierarchical list of primary and secondary customer needs for the cordless screwdriver. Importance ratings for the secondary needs are indicated by the number of *'s, with *** denoting critically important needs. Latent needs are denoted by !.

example. For the screwdriver, there are 15 primary needs and 49 secondary needs. Note that two of the primary needs have no associated secondary needs.

The procedure for organizing the needs into a hierarchical list is intuitive, and many teams can successfully complete the task without detailed instructions. For completeness, we provide a step-by-step procedure here. This activity is best performed on a wall or a large table by a small group of team members.

1. Print or write each need statement on a separate card or self-stick note. A print macro can be easily written to print the need statements directly from the data template. A nice feature of this approach is that the need can be printed in a large font in the center of the card and then the original customer statement and other relevant information can be printed in a small font at the bottom of the card for easy reference. Four cards can be cut from a standard printed sheet.

2. Eliminate redundant statements. Those cards expressing redundant need statements can be stapled together and treated as a single card. Be careful to consolidate only those statements that are identical in meaning.

3. Group the cards according to the similarity of the needs they express. At this point, the team should attempt to create groups of roughly three to seven cards that express similar needs. The logic by which groups are created deserves special attention. Novice development teams often create groups according to a technological perspective, clustering needs relating to, for example, materials, packaging, or power. Or they create groups according to assumed physical components such as enclosure, bits, switch, and battery. Both of these approaches are dangerous. Recall that the goal of the process is to create a description of the needs of the customer. For this reason, the groupings should be consistent with the way customers think about their needs and not with the way the development team thinks about the product. The groups should correspond to needs customers would view as similar. In fact, some practitioners use a process in which customers actually organize the need statements.

4. For each group, choose a label. The label is itself a statement of need that generalizes all of the needs in the group. It can be selected from one of the needs in the group, or the team can write a new need statement.

5. Consider creating supergroups consisting of two to five groups. If there are fewer than 20 groups, then a two-level hierarchy is probably sufficient to organize the data. In this case, the group labels are primary needs and the group members are secondary needs. However, if there are more than 20 groups, the team may consider creating supergroups, and therefore a third level in the hierarchy. The process of creating supergroups is identical to the process of creating groups. As with the previous step, cluster groups according to similarity of the need they express and then create or select a supergroup label. These supergroup labels become the primary needs, the group labels become the secondary needs, and the members of the groups become tertiary needs.

6. Review and edit the organized needs statements. The arrangement of needs in a hierarchy is not unique in terms of being correct. At this point, the team may wish to consider alternative groupings or labels and may engage another group to suggest alternative arrangements.

The process is more complicated when the team attempts to reflect the needs of two or more distinct market segments. There are at least two approaches that can be taken to address this challenge. First, the team can label each need with the segment (and possibly

the name) of the customer from whom the need was elicited. This way, differences in needs across segments can be observed directly. One practical visual technique for this labeling is to use different colors of paper for the cards on which the needs statements are written, with each color corresponding to a different market segment. The other approach to multiple market segments is to perform the clustering process separately for each market segment. Using this approach, the team can observe differences both in the needs themselves and in the ways in which these needs are best organized. We recommend that the team adopt this parallel, independent approach when the segments are very different in their needs and when there is some doubt about the ability of the team to address the different segments with the same product.

Step 4: Establish the Relative Importance of the Needs

The hierarchical list alone does not provide any information on the relative importance that customers place on different needs. Yet the development team will have to make trade-offs and allocate resources in designing the product. A sense of the relative importance of the various needs is essential to making these trade-offs correctly. Step 4 in the needs process establishes the relative importance of the customer needs identified in steps 1 through 3. The outcome of this step is a numerical importance weighting for a subset of the needs. There are two basic approaches to the task: (1) relying on the consensus of the team members based on their experience with customers, or (2) basing the importance assessment on further customer surveys. The obvious trade-off between the two approaches is cost and speed versus accuracy: the team can make an educated assessment of the relative importance of the needs in one meeting, while a customer survey generally takes a minimum of two weeks. In most cases we believe the customer survey is important and worth the time required to complete it. Other development tasks, such as concept generation and analysis of competitive products, can begin before the relative importance surveys are complete.

The team should at this point have developed a rapport with a group of customers. These same customers can be surveyed to rate the relative importance of the needs that have been identified. The survey can be done in person, by telephone, via the Internet, or by mail. Few customers will respond to a survey asking them to evaluate the importance of 100 needs, so typically the team will work with only a subset of the needs. A practical limit on how many needs can be addressed in a customer survey is about 50. This limit is not too severe, however, because many of the needs are either obviously important (e.g., the screwdriver fits in a toolbox easily) or are easy to implement (e.g., the screwdriver prevents inadvertent switching off). The team can therefore limit the scope of the survey by querying customers only about needs that are likely to give rise to difficult technical trade-offs or costly features in the product design. Such needs would include the need to vary speed, the need to drive screws into hardwood, and the need to have the screwdriver emit a pleasant sound. Alternatively the team could develop a set of surveys to ask a variety of customers each about different subsets of the needs list. There are many survey designs for establishing the relative importance of customer needs. One good design is illustrated by the portion of the cordless screwdriver survey shown in Exhibit 4-9. In addition to asking for importance ratings, this survey asks the respondent to explicitly identify the needs that are unique or unexpected. This information can be used to help the team identify latent needs.

The survey responses for each need statement can be characterized in a variety of ways: by the mean, by the standard deviation, or by the number of responses in each cate-

Cordless Screwdriver Survey

For each of the following cordless screwdriver features, please indicate on a scale of 1 to 5 how important the feature is to you. Please use the following scale:

1. Feature is undesirable. I would not consider a product with this feature.
2. Feature is not important, but I would not mind having it.
3. Feature would be nice to have, but is not necessary.
4. Feature is highly desirable, but I would consider a product without it.
5. Feature is critical. I would not consider a product without this feature.

Also indicate by checking the box to the right if you feel that the feature is unique, exciting, and/or unexpected.

Importance of feature
on scale of 1 to 5

Check box if feature is unique,
exciting, and/or unexpected.

- | | |
|--|--------------------------|
| _____ The screwdriver maintains power for several hours of heavy use. | <input type="checkbox"/> |
| _____ The screwdriver can drive screws into hardwood. | <input type="checkbox"/> |
| _____ The screwdriver speed can be controlled by the user while turning a screw. | <input type="checkbox"/> |
| _____ The screwdriver has a pleasant sound when in use. | <input type="checkbox"/> |

And so forth.

EXHIBIT 4-9 Example importance survey (partial).

gory. The responses can then be used to assign an importance weighting to the need statements. The same scale of 1 to 5 can be used to summarize the importance data. The needs in Exhibit 4-8 are rated according to the survey data, with the importance ratings denoted by the number of *'s next to each need statement and the latent needs denoted by !. Note that no critical needs are also latent needs. This is because if a need were critical, customers would not be surprised or excited by it; they would expect it to be met.

Step 5: Reflect on the Results and the Process

The final step in the method is to reflect on the results and the process. While the process of identifying customer needs can be usefully structured, it is not an exact science. The team must challenge its results to verify that they are consistent with the knowledge and intuition the team has developed through many hours of interaction with customers. Some questions to ask include:

- Have we interacted with all of the important types of customers in our target market?
- Are we able to see beyond needs related only to existing products in order to capture the latent needs of our target customers?
- Are there areas of inquiry we should pursue in follow-up interviews or surveys?
- Which of the customers we spoke to would be good participants in our ongoing development efforts?
- What do we know now that we didn't know when we started? Are we surprised by any of the needs?
- Did we involve everyone within our own organization who needs to deeply understand customer needs?
- How might we improve the process in future efforts?

Summary

Identifying customer needs is an integral part of the concept development phase of the product development process. The resulting customer needs are used to guide the team in establishing product specifications, generating product concepts, and selecting a product concept for further development.

- The process of identifying customer needs includes five steps:
 1. Gather raw data from customers.
 2. Interpret the raw data in terms of customer needs.
 3. Organize the needs into a hierarchy.
 4. Establish the relative importance of the needs.
 5. Reflect on the results and the process.
- Creating a high-quality information channel from customers to the product developers ensures that those who directly control the details of the product, including the product designers, fully understand the needs of the customer.
- Lead users are a good source of customer needs because they experience new needs months or years ahead of most customers and because they stand to benefit substantially from new product innovations. Furthermore, they are frequently able to articulate their needs more clearly than typical customers.
- Latent needs may be even more important than explicit needs in determining customer satisfaction. Latent needs are those that many customers recognize as important in a final product but do not or cannot articulate in advance.
- Customer needs should be expressed in terms of what the product has to do, not in terms of how the product might be implemented. Adherence to this principle leaves the development team with maximum flexibility to generate and select product concepts.
- The key benefits of the method are: ensuring that the product is focused on customer needs and that no critical customer need is forgotten; developing a clear understanding among members of the development team of the needs of the customers in the target market; developing a fact base to be used in generating concepts, selecting a product concept, and establishing product specifications; and creating an archival record of the needs phase of the development process.

References and Bibliography

Many current resources are available on the Internet via www.ulrich-eppinger.net

Concept engineering is a method developed by Burchill at MIT in collaboration with the Center for Quality of Management. This chapter benefits from our observations of the development and application of concept engineering. For a complete and detailed description of concept engineering, see:

Burchill, Gary, et al., *Concept Engineering*, Center for Quality of Management, Cambridge, MA, Document No. ML0080, 1997.

The research by Griffin and Hauser is one of the only rigorous efforts to validate different methods for extracting needs from interview data. Their study of the fraction of needs identified as a function of the number of customers interviewed is particularly interesting.

Griffin, Abbie, and John R. Hauser, "The Voice of the Customer," *Marketing Science*, Vol. 12, No. 1, Winter 1993, pp. 1–27.

Kinney and Taylor thoroughly discuss data collection methods and survey design. Kinney, Thomas C., and James R. Taylor, *Marketing Research: An Applied Approach*, fifth edition, McGraw-Hill, New York, 1995.

Norman has written extensively on user needs, especially as related to the cognitive challenges of using products.

Norman, Donald A., *The Design of Everyday Things*, Doubleday, New York, 1990.

Payne's book is a detailed and interesting discussion of how to pose questions in surveys. Payne, Stanley L., *The Art of Asking Questions*, Princeton University Press, Princeton, NJ, 1980.

Total quality management (TQM) provides a valuable perspective on how identifying customer needs fits into an overall effort to improve the quality of goods and services.

Shiba, Shoji, Alan Graham, and David Walden, *A New American TQM: Four Practical Revolutions in Management*, Productivity Press, Cambridge, MA, and The Center for Quality of Management, Cambridge, MA, 1993.

Urban and Hauser provide a thorough discussion of how to create hierarchies of needs (along with many other topics).

Urban, Glen L., and John R. Hauser, *Design and Marketing of New Products*, second edition, Prentice Hall, Englewood Cliffs, NJ, 1993.

Von Hippel describes many years of research on the role of lead users in innovation. He provides useful guidelines for identifying lead users.

von Hippel, Eric, *The Sources of Innovation*, Oxford University Press, New York, 1988.

Exercises

1. Translate the following customer statements about a student book bag into proper needs statements:
 - a. "See how the leather on the bottom of the bag is all scratched; it's ugly."
 - b. "When I'm standing in line at the cashier trying to find my checkbook while balancing my bag on my knee, I feel like a stork."
 - c. "This bag is my life; if I lose it I'm in big trouble."
 - d. "There's nothing worse than a banana that's been squished by the edge of a textbook."
 - e. "I never use both straps on my knapsack; I just sling it over one shoulder."
2. Observe someone performing an everyday task. (Ideally, you should choose a task for which you can observe different users performing the task repeatedly.) Identify frustrations and difficulties encountered by these people. Identify the latent customer needs.

3. Choose a product that continually annoys you. Identify the needs the developers of this product missed. Why do you think these needs were not met? Do you think the developers deliberately ignored these needs?

Thought Questions

1. One of the reasons the method is effective is that it involves the entire development team. Unfortunately, the method can become unwieldy with a team of more than 10 people. How might you modify the method to maximize involvement yet maintain a focused and decisive effort given a large development team?
2. Can the process of identifying customer needs lead to the creation of innovative product concepts? In what ways? Could a structured process of identifying customer needs lead to a fundamentally new product concept like the Post-it Note?

CHAPTER FIVE

Product Specifications

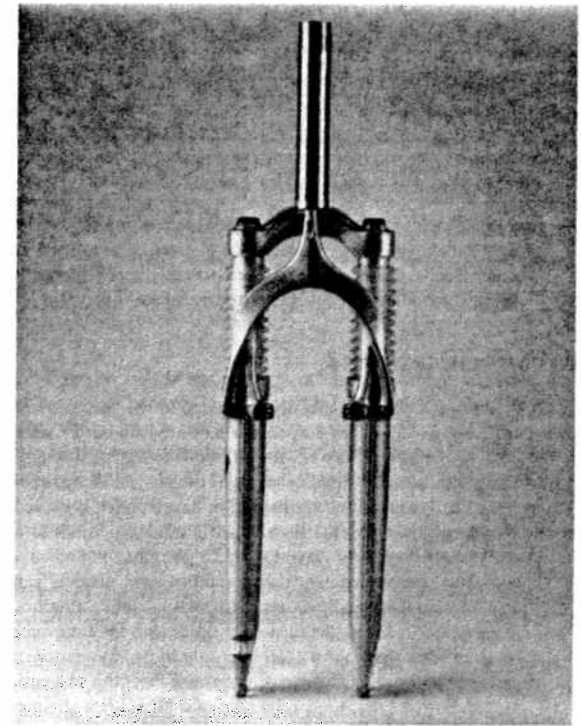


Photo by Stuart Cohen

EXHIBIT 5-1

One of Specialized's existing suspension forks.