

Stimulating Creative Design Alternatives Using Customer Values

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Abstract—This paper presents and illustrates an approach and procedures to stimulate the creation of design alternatives. The purpose is to generate many very good alternatives for a specific new product. Subsequently, a comparative evaluation of these alternatives and honing the designs of the most promising ones can proceed. To create potential alternatives with high customer appeal, the approach first elicits and organizes customer values to comprehensively define customer appeal. Several procedures are then defined and illustrated that use these customer values to stimulate the creation of alternative new product designs and design features. Applications concerning one tangible product, cellular telephones, and one intangible product, cellular telephone plans, illustrate the approach.

Index Terms—Creating alternatives, design decisions, objectives, product design, values.

I. INTRODUCTION

A COMPANY designs and sells products to achieve its objectives. These objectives include maximizing profits and market share, which pleases stockholders and allows better financial reward for employees. The company is also interested in pleasing customers, which enhances sales, and in providing a stimulating, enjoyable workplace that pleases employees.

Visualize an iterative process that begins with the question of “what could we design” and ends with “our degree of success”. Fig. 1 illustrates this process on a high level and indicates that it is a process driven by decisions [8], [15], [22]. Many decisions affect how successful a company is. At the very beginning, decisions must be made to provide the conceptual design for the product. The decisions specify the product properties and benefits as well as many aspects of its production and delivery to customers. The process usually begins with the creative generation of a rough conceptual design based on perceived customer needs [7]. This design is then honed through decisions and appraisal cycles to produce a more detailed conceptual design.

Subsequent to selecting a conceptual design, there are many design decisions that eventually lead to a product. For an extensive review of research on product development decisions, see [14]. At the same time, many other company management decisions about pricing, marketing, advertising, and strategy influence both the product design and its availability for prospective customers to consider. Each prospective customer then makes

the decision on whether or not to purchase the product. Finally, the degree of company success is determined by the profits and market share resulting from the collective customer response and all previous company decisions.

Since a chosen alternative can be no better than the best in the set from which it is chosen, we would often be in a better position if we had many alternative potential conceptual designs to choose among. Thus, it is important to generate a set of worthwhile alternatives for conceptual designs. Creating these alternatives is the topic of this paper.

Given several conceptual design alternatives, they should be systematically compared to select the best one. Many approaches have been suggested to evaluate such alternatives. They range from informal to structured mathematical evaluation [4], [5], [9], [18], [21], [23], [24] and include several new web-based methods [3]. However selected, if the chosen alternative is better than any other existing designs, you have made a significant contribution.

The literature of design, and other decision processes, gives less attention to the creation of alternatives than to the evaluation of those created alternatives. Existing literature suggests general procedures to create alternatives such as brainstorming, neglecting constraints, or using analogies [1], [2], [12]. However, some literature has been more specific in suggesting and illustrating that identifying customers concerns or needs can aid the alternative creation process [6], [10], [11], [17], [25]. For custom products needed to meet very specialized needs, much of the design process can be turned over to actual customers [26], [27].

This paper focuses on the very beginning of the design process, going from “no ideas” to “some ideas”, which hopefully include “some potentially great design concepts”. The approach first identifies customer values as broadly and deeply as we can, using in-depth personal discussions. Then, these values are organized and structured to provide a basis to stimulate the creation of design alternatives. Several procedures are described to facilitate such creative thought processes. The approach is illustrated with two cases.

II. DESIGN DECISIONS

What constitutes an excellent design process? Answer: one that results in higher quality products that are cheaper to design and produce and are available sooner. The less a product costs to develop and produce, the better from the viewpoint of the company. This allows it to be more competitive and to make more money. Also, other things equal, it is preferred to have the product available sooner. If for some reason it was desirable to hold back introduction, this could be done. On the other hand,

Manuscript received June 9, 2003; revised January 20, 2004 and January 26, 2004. This work was supported in part by the National Science Foundation under Grant DMI-0003298. This paper was recommended by Associate Editor K. W. Hipel.

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Digital Object Identifier 10.1109/TSMCC.2004.829255

you cannot go ahead with production or implementation when the product is not ready.

Quality of a design is difficult to define, as quality is naturally in the eyes of the beholder. From the designer's prospective, quality should mean those features and aspects of the product that are more highly valued by potential customers. Hence, it is the customers' concept of quality that is fundamental, and from this we derive the implications for quality in the design process.

So how can one obtain the definition of "quality" for a specific potential product? The answer is simple: you ask prospective customers what is important to them about the product. Product quality is determined using the values of your prospective customers. It is their values that count, because their values are the basis for their choice to purchase or not. To have a quality product, you need a great design. Design quality is determined by balancing design objectives, but these objectives must be recognized as means to a great product.

The responses that an individual gives to indicate what is important about a conceptual product represent his or her values for such a product. In this sense, values refer to any aspects of a potential product that could influence the likelihood that customers would purchase that product. These values may be stated as features, characteristics, needs, wants, concerns, criteria, or unwanted aspects. What is critical is that the designers can understand the meaning of each of the values.

To adequately define quality in a specific case, you should interview a number of prospective customers, say between one and one thousand depending on the product, to determine values. You want to stimulate customers to think hard about their responses with probing questions. These questions might be as simple as "How?" and "Why?". For instance, if you are designing a cellular phone, one prospective customer may say that safety of phone use is important. You might inquire about how safety is influenced by the design. The prospective customer may respond that the necessity to look at the telephone to enter a phone number is a distraction. This suggests that another value is to minimize distraction in using the phone.

Another value for a wireless phone might be that it has voice-mail. You should ask, "Why does this matter?", and the response may be "for convenience". This would suggest that there might be other important aspects of convenience. One value might be that the ringing of the phone should not interrupt some event. An implication is, of course, that a design feature that can turn off the ringer might be desirable. On the other hand, since one may not want to miss phone calls, it might be useful to offer a vibration alert for an incoming call and have caller identification, so one could see if they wish to answer it.

The intent of the interview process is to come up with as complete a list of customer values to define quality as one can. Then one goes through a logical process of examining these values to suggest possible design features that influence quality. This process hopefully creates a rich (i.e., large and diverse) set of potential design alternatives to choose among. The design process of selecting which of these design alternatives to develop is separate and should follow only after a rich set of alternatives is established. If the creative process of coming up with designs is combined with the evaluative process of

eliminating the less desirable ones, the process of creating alternatives is stymied.

This paper develops an explicit approach, grounded in common sense, to elicit values from customers and use them to create design alternatives. Two illustrations are first presented to provide a background for the general approach and procedures that follow. Section III presents a case involving cellular telephones, and Section IV presents a case involving wireless communication plans. With these cases as background, Section V then presents the procedures for eliciting, understanding, and organizing customer values, while Section VI presents the procedures for creating innovative design alternatives based on those values. Conclusions follow in Section VII.

III. CELLULAR TELEPHONES—A CASE STUDY

The cellular telephone market is dynamic and competitive. It is a fast changing field with new designs being introduced regularly. By eliciting and structuring customer values, one can provide useful insights to guide the process of creating potentially successful designs.

In early 2000, I elicited values of six very experienced cellular telephone customers. These six were extremely knowledgeable about the desires of cell phone customers in general. At the time of the elicitations, they were the founders, chief technical officer, and sales staff of IceWireless.com, a small Internet firm that provided small and medium sized companies a software product to help each of their employees select a cell phone and wireless plan consistent with the company's policies and individual needs. At the time, I was the Vice President of Decision Sciences at IceWireless.

Separate discussions of thirty minutes to an hour were held with each individual. I first asked each individual to write down everything that prospective customers might value about a cellular phone. When finished, usually after about ten minutes, I used the initial responses to expand their list of values and to better understand each stated value. For each stated value, such as button size, form factor, durability, popularity, and number of characteristics displayed, I probed the individual's thinking with questions such as: What do you mean by this? Why is it important? How might it be measured? How might you achieve it? The responses often suggested additional values that were subsequently probed in detail. The result of each discussion was a list of all the values that the individual could think of that might be relevant to a customer wanting a cellular telephone.

I then created a combined list of values. The individuals' lists naturally had much in common, but each individual also had some values not on other lists. The next step was to organize the combined list of values into categories (i.e., major values) and to identify the means-ends relationships among them. This facilitates the identification of possibly missing values and enhances the foundation to stimulate the identification of creative design alternatives.

The major values of cellular phones are shown in Fig. 2. The figure distinguishes between the values corresponding to customer objectives and the design objectives that were depicted in the general model of Fig. 1. Each of the major values in Fig. 2 is specified in much more detail in Table I, which lists component

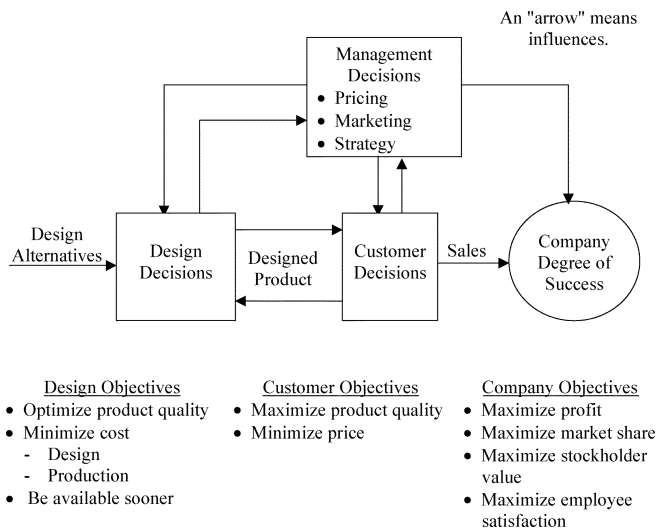


Fig. 1. General model of the design decision process.

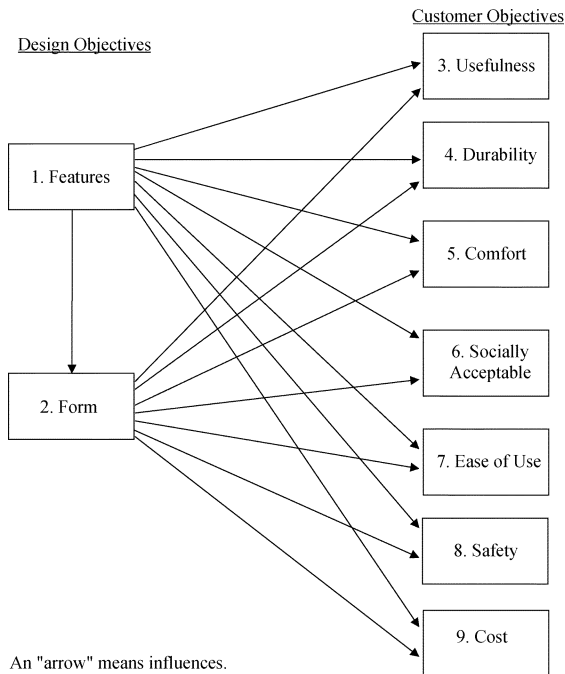


Fig. 2. Relationships among major values for cellular telephones.

values. It is the information in Fig. 2 and Table I that provides the basis for creating design alternatives.

A. Creating Cellular Telephone Design Alternatives

A potentially better design is one that achieves at least one of the values in Table I better than existing alternatives. Hence, to stimulate the creation of design alternatives, we ask for each value, "How can we better achieve this?". As simple as this sounds, it is often subtle to implement in practice and, of course, getting the set of values corresponding to Table I is not necessarily easy. Let us illustrate the creative process with some examples.

TABLE I
CUSTOMER VALUES FOR CELLULAR TELEPHONES

- Features**
 - Has a screen
 - Has easily readable text
 - Has a memory
 - Has a directory
 - Can connect to a computer
 - Is data capable
 - Size
 - Weight
 - Talk time
 - Stand by time
 - Battery life
 - Button size
 - Mode (single, double, or triple band)
 - Has flip top
 - Screen size
 - Memory size
 - Directory size
 - Number of characters displayed on screen
 - Has a working antennae
- Form** (These are often referred to as form factors.)
 - Is fashionable
 - Is slick
 - Is thin
 - Is shiny
 - Comes with colored face plates
 - Looks good
- Usefulness** (This concerns what functions you want your wireless telephone to be able to perform. The use of having a telephone conversation is assumed and not included.)
 - Enhance Voice Communication
 - Voice mail
 - Two-way radio
 - Allows group calls
 - Has caller-ID
 - Has vibration alert
 - Has a speaker phone
 - Has speed dialing
 - Can adjust volume dynamically
 - Has a phone directory
 - Stores recently used phone numbers
 - Stores recent incoming phone numbers
 - Missed call indicator
 - Has voice recorder
 - Enhance Text Communication
 - E-mail
 - Has alphanumeric paging
 - Facilitate Cost Management
 - Indicate cost of completed call
 - Monitor monthly usage (i.e., minutes in different cost categories)
 - Enhance Personal Organization
 - Personal calendar
 - Put address information in PDA
 - Provide reminders to users
 - Indicates time
 - Has an alarm
 - Has a clock
 - Has a calculator
 - Provide for Internet Use
 - Internet access
 - Web access
 - Has games
- Durability** (This is mainly an item for people in professions like construction.)
 - Be rugged
 - Be reliable
 - Not easy to break
- Comfort**
 - Feels good
 - Fits face
 - Fits hand
- Socially Acceptable**
 - Popular
 - Consistent with your profession
 - Consistent with your position
 - Consistent with your peers
- Ease of Use**
 - Simple to program
 - Easy to maintain the telephone (i.e. recharging battery)
 - Easy to use the telephone
 - Regular use
 - Outgoing calls only
 - Emergency calls
 - Special occasions
 - Easy dialing
 - Easy Access
 - Belt clip
 - Fits in pocket
 - Hard to Lose
- Safety**
 - While driving a vehicle
 - From regular use
 - In emergencies
- Cost**
 - Cost of phone
 - Cost of accessories

The value “durable—not easy to break” clearly suggests a range of design options to build a telephone out of stronger materials. These stronger materials may of course affect the weight of the telephone and its cost. All of this is important at the evaluation stage of potential designs, but here we are trying to generate creative design alternatives.

Consider the value under “usefulness—enhance voice communication” that refers to storing recent incoming phone numbers. One may ask why this is important. Some customers may state that it is important to have numbers available for return calls. This would suggest a design alternative that kept track of incoming phone numbers. As most phone calls are likely from friends and associates, a device that keeps track only of phone numbers not already in the directory might be smaller and lighter than a device that kept track of all recently used phone numbers.

Ask why vibration alert under the “usefulness” value is important and we find that one value is not to disturb people in situations such as concerts or business meetings. We can ask whether there are other ways to signal incoming calls that do not disturb others. One way might be to have a light on a pen or finger ring that would signal the call. Another question might pursue other situations where it is important not to disturb people. We have all been in an airport lounge or elevator where someone is speaking loudly and seemingly unaware that he or she is disturbing others. This suggests design alternatives that allow the person to talk less loudly and yet be heard. For those who do not perceive that they are disturbing others, a sophisticated phone could signal the speaker with a beep when the decibel level got higher than some level that was chosen by the user.

The e-mail value under “usefulness” implies that the feature of a screen is needed and suggests that the screen size is important. Bigger screens may increase the size of the telephone, but are better for e-mail. In pursuing why bigger screens are better, one reason is that it is easier to read the text. This suggests design alternatives that provide larger text on a smaller screen and allow the user to adjust the text size.

Consider the feature of button size. Large buttons further from each other facilitate ease of use, whereas smaller buttons placed closer together allow one to have a smaller telephone, which is easier to carry. Accounting for both concerns, you could design a phone with six larger buttons, each button used for two numbers. Push the first button on the top to indicate 1; push it on the bottom to indicate 2. Alternatively, one might ask, “Why have buttons at all?”, since they are means for ease of use and size of the cellular telephone. One could have voice input for telephone numbers and eliminate the buttons altogether, or just have a couple buttons programmed for special purposes.

Customer values concerning comfort and social acceptability suggest potentially useful research. Research on comfort would investigate what feels good and appropriately fits the hand and face of different classes of potential customers. This research could directly be used to guide the design of alternatives. Regarding social acceptability, research could focus on classes of potential customers, such as lawyers, and pursue their complete set of values. This might lead to a telephone that could better meet their specific needs. For instance, given that many lawyers bill their time in segments involving minutes, a telephone that

kept track of the talking time with specified phone numbers might be useful for billing purposes.

Consider “usefulness” at a high level. One might focus on the basic reason for a telephone, namely to talk to another person, and delete many of the other potential features, such as text communication, personal organization, Internet use, and games. At the extreme, one might have a telephone similar to an old home telephone. You could make a call or receive a call when you are available, and that is it. Such a phone might be cheaper than existing phones and much simpler to operate.

Values concerning “convenience” and “safety” are relevant to using cellular telephones in emergency situations. Some people may only be interested in a cellular telephone for such purposes. A design could allow only outgoing phone calls, or only outgoing calls to some numbers. Indeed, one could create a simple phone with, for instance, five buttons that corresponded to five important emergency numbers. For special circumstances, such as a two-week hike in the wilderness, one might create a disposable cellular telephone analogous to the disposable cameras that are regularly used for special purposes.

Many cellular customers would like to manage (i.e., minimize) their monthly bills. The value of “usefulness—facilitates cost management” suggests many design alternatives. If certain features of your cellular telephone plan were programmed into your phone, it could indicate the cost of a call and its cost components just after completing it. If programmed, it could indicate the full cost of a proposed call before placing it. Then a user could begin to internalize the costs of calls. Also, the phone could keep track of monthly minutes used and/or minutes left in time periods that had additional expenses after the plan minutes (e.g., 300 primetime minutes per month) were used.

IV. WIRELESS COMMUNICATION PLANS—A CASE STUDY

To use a cellular phone, a customer must select a company and a plan for telephone service. The plan specifies the services provided and the price of those services. It is a design decision that leads to each plan. We are concerned with the process of creating potential alternative plans to consider in that design decision.

Wireless communication plans are generically different from cellular telephones in several respects. First, a plan is a service (i.e., an intangible product), whereas cellular phones are tangible physical products. Second, the customer purchases the cellular telephone, but typically signs up for a plan. Third, the customer then owns the telephone, but uses the plan. Even with these differences, the same concepts to stimulate design alternatives for cellular telephones are useful to stimulate design alternatives for wireless communication plans.

In the same time period that I elicited values for cellular telephones, I assessed customer values for wireless communication plans from the same six individuals. The same process as described in Section III was followed.

The major values of a communication plan are shown in Fig. 3, which distinguishes between values relevant to design objectives and customer objectives. Component values of those major values are listed in Table II. The structure in this figure and table indicates two interrelated decision contexts concerning the quality of

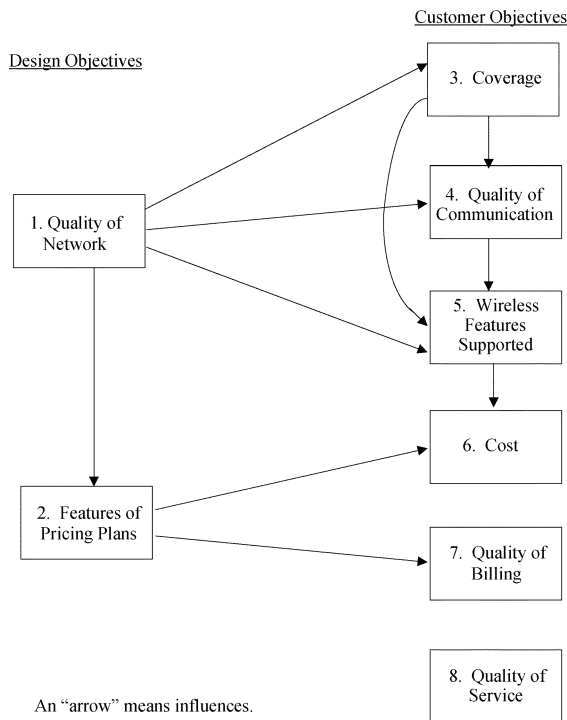


Fig. 3. Relationships among major values for wireless communications plans.

a wireless communication plan. One decision context involves building the network to support wireless communications. Decisions about the network affect what communication plans are technically feasible, the quality that customers receive, and the price that they pay for using those plans. The other decision context concerns the quality of nontelephone service provided in conjunction with various plans. Decisions about these services affect customers' choices about whether to sign up for a plan, as well as the company's bottom line.

A. Creating Wireless Communication Plan Alternatives

Using the values listed in Table II, we can stimulate the creation of numerous potential alternative plans. This is illustrated with several examples.

Consider the value "coverage". For a customer to use a cellular phone in a particular area, the company needs adequate capacity for the network in that area. Decisions about capacity concern the design of the network and not directly the design of specific plans. Related to coverage in an area is the issue of blocked calls, described under the "quality of communication" value. Blocked calls result from high demand above the ability of the network to provide for them. A simple analysis may indicate that the major blockage problems occur between the hours of 5:00 and 7:00 P.M. To reduce peak-load telephone traffic and thus blocked calls, a design feature of plans might include peak-load pricing: cheaper rates during off-peak hours and/or higher rates from 5:00 to 7:00 P.M.. Another alternative might try to promote short calls during that time period. For example, there could be a surcharge for each call over five minutes in high-capacity areas during peak hours.

Concerning "quality of billing", different customers may want their bills organized in different ways. A business person may have one cellular telephone used for both business and

personal use. It may be helpful to have the bill sorted by a predetermined list of phone numbers of business clients, personal friends, and other. Then only the category "other" would need to be examined for billing purposes, which may save the customer time and effort.

With the complexity of all of the pricing features of pricing plans, it is often difficult to decide on the best plan and to understand the complete bill each month. To simplify, a new plan could eliminate all special features and offer unlimited service in the United States for a fixed price of say \$150 per month. A different type of alternative would be to put several existing plans in a "basket" plan. Each month, the company would determine which of the plans in the basket would lead to a customer paying the lowest price and then bill them using that plan. This would alleviate the anxiety of individuals in choosing a plan and reduce the irritation of paying for something that they did not get if they underused the prescribed service, or paying very high prices if they used the service more than they had intended.

Consider the objective of the company to maximize profits. Components of this are to minimize billing expenses and disputed call costs, and to minimize un-collectable charges (i.e., customers that default). Associated with the \$150 per month fixed price, one might simply provide a bill with no details of individual calls, which should reduce billing costs and dispute costs. Another potential alternative might be to require prepayment in exchange for an overall cheaper communication plan rate. This should reduce the default rate significantly and would also avoid the time, hassle, and cost of pursuing nonpayment by customers.

V. ELICITING AND ORGANIZING CUSTOMER VALUES

There are systematic procedures to elicit customer values and use them to create design alternatives (for example, see [7] and [11]). This and the following section outline the procedures developed for use in the cases discussed in Sections III and IV. Here, we present procedures to elicit and organize values by considering four interrelated issues:

- who to gather customer values from;
- how and how many individuals to involve;
- what the substance of the interaction should be;
- how to organize the resulting information.

A. Who Should Provide Customer Values

To gather customer values, the general principle is to ask people knowledgeable about customer values. If customer values are provided by many people, each need not be knowledgeable about all customers or all values of some customers.

For existing products, the obvious people knowledgeable about customer values are customers. If you can question customers about their values, this is very useful. For these products, asking prospective customers about their values may provide different values than existing customers. If they had the same values, they could have become customers. For products that do not exist now, there are no current customers, so potential customers should be interviewed. For advanced technological products, von Hippel [25] pioneered the idea of using "lead users" of the product.

TABLE II
CUSTOMER VALUES FOR A WIRELESS COMMUNICATIONS PLAN

1. Quality of Network (There are relationships among listed values. For instance, the number and location of towers affects the capacity of and dead spots on the network.)
 - Number of towers
 - Location of towers
 - Capacity of the network
 - Dead spots on the network
2. Features of Pricing Plans (Features refer to all of the items that can have an effect on the overall cost of the wireless communications plan.)
 - Minutes included in access fee
 - Additional costs for peak-time minutes
 - Additional costs for off-peak minutes
 - Roaming charges
 - Long distance costs
 - Incoming minute charges
 - Round up policy for length of calls
 - Pooled minutes
 - Shared minutes
 - Corporate discounts
 - Volume discounts
 - Parameters (local, regional, or national plan)
 - Protected usage (not easy to misuse)
 - Contract length
 - Cost of changing plan
3. Coverage
 - Cover personal usage area
 - Where individual lives
 - Where individual works
 - Between individual's workplace and home
 - An individual's building
 - Areas traveled in by individual
4. Quality of Communication (The quality of communication felt by an individual is mainly a result of the quality of the network and coverage.)
 - Sound clarity
 - Blocked calls
 - Blurred calls
 - Dropped calls
5. Wireless Features Supported (These pertain to the functions that can be performed via the wireless telephone using the wireless communications network.)
 - Voice mail
 - E-mail
 - Internet access
 - Caller ID
 - Paging
 - Digital and analog applications
 - Two-way communication
6. Cost (These costs are those that relate to the customer's usage.)
 - Monthly cost of wireless communication usage (averaged over some appropriate period of time)
7. Quality of Billing (The bill should be functional for the company and categorize various costs in any way that's useful to the company.)
 - Ability to read bill
 - Ability to comprehend bill
 - Aggregate billing for employees in a company
 - Breakdown in billing
 - By users
 - By cost center
 - By region
 - By use (e.g. e-mail versus telephone communication)
8. Quality of Service (It should be noted that aspects of billing could be considered quality of service, but I dealt with it separately above.)
 - Minimize time to order
 - Minimize time to set up communications (i.e. have your wireless communications ready for use)
 - Reorder ease
 - Ease in changing the plan
 - Provides desired electronic reports

There are groups of individuals other than customers and prospective customers with very useful knowledge about customer values. These include people in the businesses that make and sell the general product of interest. Such people are in sales, marketing, management, and engineering. Individuals from each group may have a different perspective, which is useful for developing a comprehensive list of customer values.

B. How and How Many Individuals to Involve

Deciding how and how many people to involve in providing customer values are strongly related. The how part always involves asking individuals to develop a list of customer values and then asking them to expand their lists. The process can be carried out with or without a facilitator and done either individually or in groups. The intent is always to help each individual to develop a written list of all his or her knowledge about customer values.

Except for the fact that personal interviews take more time and are more expensive, the ideal is for a facilitator to interact personally with each individual. The facilitator can deeply probe an individual's knowledge and do the work of writing it down. This frees the individual to just think. The substance of such an interview, discussed in the next subsection, provides the model that less intensive approaches try to follow.

When personally interacting with a group, the facilitator asks many questions to help each individual separately record their ideas about customer values in written form. If one does not directly interact with individuals, paper or electronic questionnaires can guide participating individuals to provide a written list of customer values. Especially on the Internet, the questionnaire can be dynamic to pursue the thinking of a participant based on previous responses.

How many people to involve in providing customer values depends on the time and money available, the usefulness of the information, and how the individuals are interviewed. When the lists of values being provided by additional individuals do not include any new customer values, enough people have been interviewed.

In general, it is useful to interview at least five and up to fifty individuals to begin to understand the range of customer values (see [6]). This group should include people with potentially different perspectives to enhance the likelihood that your combined list of values will cover the full range of values.

With knowledge of this combined list, you can conduct any subsequent discussions with groups more intelligently. You can also design written and Internet questionnaires to productively gather more information about customer values. With an Internet questionnaire, you can ask a very large number of individuals about customer values and automatically update the combined list as new values are provided.

C. The Process of Gathering Customer Values

Generating the initial values from individuals is a creative process, as you are going from nothing to something. The general idea is to help an individual to think hard and express everything in his or her mind that matters about the product. You first explain that you want a list of everything that they care about regarding the potential product of interest (e.g., a cellular tele-

phone or wireless communication plan). You begin by simply asking them what it is they value or want or do not want in this context. After they have initially exhausted their thoughts, you begin to probe broader and deeper.

There are numerous devices from the marketing literature [3], [5], [24] and the decision literature [11] to facilitate thinking more broadly. If the individuals currently have the product, you ask them about problems and shortcomings they have experienced or features that they might like to have. You might ask individuals to identify as many situations as possible where they might use the product. For each situation, ask them what is important about that use. You may ask them to consider specific alternatives, hypothetical or real, and ask what is good or bad about each. Any questions that stimulate thoughts of the individual about product values are useful.

The process of deepening our understanding of one's values involves inquiring about why the individual cares about each item on the list, and how one can influence the achievement of each item. Asking why provides reasoning for a means to ends relationship. Asking how provides the reasoning for an ends to a means. With a cellular phone, an individual may say that easy to use buttons are valued. Asking why leads to the response that it reduces errors in dialing and the attention needed to correctly dial. Asking why reducing errors matters leads to avoiding unnecessary costs and wasting time. Asking why these matter, the individual may simply say, "because they are some of the things that I care about". This suggests that the latter two values are fundamental customer values in this situation. Asking how one can influence the value of easy to use buttons, the individual may state, "make the buttons bigger and further apart". Each of these values suggests potential design alternatives.

The process described above is for a facilitator interviewing individuals one at a time. When a facilitator interacts with a group, it is not possible to go into the same level of depth. You try to provide personal attention to push deeper thinking of individuals without losing interest of other group members. With questionnaires, because it is easier to involve large numbers of individuals, you may identify some completely missing values that may provide insights for creating products. In such cases, it may be useful to discuss these new values in subsequent personal interactions with the same or other individuals to increase your understanding of these values.

D. Organizing Customer Values

Once you have obtained lists of customer values from several individuals, the lists should be combined. This is a straightforward process. First put all items on any individual list on a common list. Then eliminate duplicate values. If the same words are used for a value, this is trivial. If the words are similar, such as "large buttons" and "big buttons", then select one word and combine these. In more difficult cases, you might need to decide if "readable type" and "large type" mean the same thing. In this case, I would reason that large type is a means to readable type and keep them both on the list. Finally, combine at the detailed level. For values like "ease of use" or "simplicity," keep them separate at this stage, as they can be aggregated later if appropriate. For stimulating creative designs, potential redundant stimulants are not a shortcoming.

The combined list of values will contain items in many different forms. Some might be considered criteria, interests, measures, alternatives, aspirations, concerns, goals, or objectives. The list will include nouns, verbs, and adjectives. To better understand the list of values and to enhance its usefulness, it is important to develop consistency. This is done by converting each item on the list into an objective. An objective is something that is desired that can be stated using a verb and a noun. For instance, if "phone number storage" is on the list of values, the corresponding objective might be "maximize size of phone directory". If "keep costs under \$200" is on someone's list, this might be converted to "minimize cellular telephone cost". To reduce clutter, several verbs that are obvious were deleted from Figs. 2 and 3 and Tables I and II.

It is useful to understand the relationships among different customer values. Specifically, one cares about means-ends relationships [16]. Examining the full list of values will help identify many of the means-ends relationships. Others can be made apparent by asking how and why questions for each of the objectives now on the list. At this stage, we would expect that most responses to these how and why questions will lead to other values already on the master list. If not, they should be added.

It is often useful to aggregate closely related values by making them components of a major value. The cases illustrated in Sections III and IV used such an aggregation. For instance, major values for cellular telephones included usefulness, cost, and ease of use. When there are many detailed values, as there were in these cases, it is difficult to see the overall picture if all means-ends relationships are illustrated. Demonstrating the relationships among aggregated major values can help one understand the entire value structure. This provides a better foundation for creating potential design alternatives.

VI. CREATING DESIGN ALTERNATIVES

Using values (e.g., wants and needs) to create design alternatives is generally accepted as a useful thing to do. But exactly how should you use those values? The cases discussed in Sections III and IV illustrated the use of values to identify several possible design alternatives. From these, it is useful to learn the general principles used in the creation process. Examining the illustrated cases suggested the general procedures, which are organized into the five categories listed in Table III. Alternatives created in Sections III and IV are used below to better describe each general procedure. Many of the examples that illustrate one procedure might also be considered to illustrate another procedure to create design alternatives. Such redundancy is not a shortcoming of the creation process, as the purpose is to create as many good potential alternatives as possible.

A. Use Values Directly

A straightforward way to create potential design alternatives is to use the individual values of customers. A simple case regarding telephones concerns the value of having e-mail. The designs in this case are simply to have it or not. Regarding the single value concerning button size, there is a continuum of potential button sizes that can be considered for design alternatives. There is also a continuum of the distance between buttons

TABLE III
GENERAL PROCEDURES FOR STIMULATING THE CREATION OF DESIGN ALTERNATIVES USING VALUES

1. Use Values Directly
 - Use individual values
 - Use combinations of values
 - Use company values
2. Use Means-Ends Relationships
 - Pursue means to ends value relationships
 - Pursue ends to means value relationships
3. Tailor Alternatives to Individuals' Values
 - Segmentation
 - Personalization
4. Combine alternatives
 - Combine features of different products
 - Allow choice of product after use
5. Expand Range of Product Alternatives
 - Segment by stressing only some customer values
 - Create a new product dimension that customers value

that could be considered and a continuum of the button height that can be considered.

An example concerning combinations of values relates to storing numbers of recent incoming calls. Because of other values concerning the size, weight, and cost of the telephone, it might make sense simply to store only numbers that were not in that telephone file already. Regarding the use of major values, one customer value concerns the cost of the plan. An alternative might be to provide a plan for \$150 a month that covers all use within the United States.

One company objective of cellular plans is to maximize profit. Aspects that contribute to profit by decreasing costs involve printing and sending detailed bills and having to write-off customers that do not pay. Design alternatives that involve prepayment and little detail on the bill are examples of design alternatives based on this company objective.

B. Use Means-Ends Relationships

The usefulness value and the desire to have e-mail lead to the design values of having a large screen size and easily readable text. These values, which are a means to usefulness, suggest a design alternative of larger text. Indeed, a dial could allow the user to vary the text size depending on circumstances.

One can pursue the ends values of any stated customer value. An example concerns the desire to have a vibrating alert, which eventually lead to the desire not to disturb others as an end. Examining other situations where people might be disturbed involves cellular phone speakers in crowded quarters and circumstances where quiet is desired. A design alternative that indicates when the speaker is talking above a certain decibel level was developed from this value.

C. Tailor Alternatives to Individual's Values

By examining sets of values, one can find grounds for segmentation in creating potential winning designs. For instance, certain classes of prospective cellular phone users might want them only for emergency uses or for special occasions, like vacations. This led us to the ideas of very simple telephones with only five buttons for emergency uses that would be associated with a cheaper price and cheaper service plan. It also led to

the idea of a disposable cellular phone, similar to a disposable camera, that might be used for special occasions only.

Personalization is difficult for tangible products, but less so for service products. Using the value of an individual who might want a specific type of bill for a wireless phone service, the suggestion of a bill that distinguished groups of telephone numbers into a business category, a personal category, and others is an example of a personalized product that could be developed.

D. Combine Alternatives

Combining alternatives can often create another alternative. One way is to combine features of different products. Another is to allow the customer to use a general product and then choose the best one. Both phones for emergency use only and disposable cellular phones were discussed above. One could obviously combine these into a disposable emergency phone. Risky endeavors of different kinds from remote adventure travel to a two-week stay in a hospital would be situations where such a phone may be useful. In the former case, a global positioning system that automatically communicated the location of the caller might be included in one design alternative.

With service products, it may be useful to design a combined product that allows the customer to choose the eventual product only after use. For instance, many wireless communication companies have numerous plans, but it is very difficult for an individual to decide which one is the best for his or her use. A combined alternative is a basket plan that works as follows. Each month, each of the plans in the basket would be used to calculate the price an individual would pay had that plan been in effect. Then, the price charged would simply be the minimum of those monthly costs calculated from the plans in the basket.

E. Expand Range of Product Alternatives

One can stress some customer values at the expense of others to create alternatives. The new alternative might have great appeal to a segment of the potential customers [13]. For example, consider the ease of use values for cellular telephones. Ease of use clearly means different things to different people. For some people, all the features included on most phones simply make it difficult to use. For such individuals, a simple cellular phone that works similarly to the standard telephone used in a home might be desirable. You could answer it if you were there and the phone rang, and you could call someone. Otherwise, you did not use it. Such a phone would be different than many cellular telephones and would distinguish it on the dimension of ease of use.

If you can create a new product feature that has value to some customers, this might be extremely useful for selling your product. For instance, suppose a cellular phone was automatically set up to ring also on your residence or office phone, or at other locations that you might be at. This would provide the potential to always be in contact via telephone. For some this might be a nightmare, but for others it could be very desirable. If one could pre-program a cellular phone such that this simultaneous ringing only occurred for a predetermined set of incoming phone numbers, it might become a much more desirable feature. For instance, if one had a relatively incapacitated relative, they

might have the confidence that they could always reach you if necessary, and that might be very important.

F. Process Suggestions

A common way that procedures described above might be used is within a design team. The "science" of the process was discussed above, but there is naturally "art" to the process as well. A few suggestions may be helpful.

The general guideline is that you want each team member to do individual thinking and develop their own ideas initially. Later these can be discussed, combined, and used to stimulate additional thinking. Each team member should first expand the set of customer values. Then they should create a list of alternatives using any of the general procedures described above.

Two big pitfalls to avoid are evaluating alternatives and focusing on the small picture. The intent is to create alternatives. Any evaluation should be a separate process to come later. If individuals begin to evaluate alternatives prematurely, it will severely stifle the creative process. One can also bog down on a single objective like "button size": are small buttons better because they allow for a smaller and lighter phone or are large buttons better because they are easier to use and avoid misdialing? Attempting to resolve such issues is part of evaluation and discussion. Such details also inhibit creativity. Just continue to focus on creating potential phones that are small, light, easy to use, and provide accurate dialing while in the creative process.

VII. CONCLUSIONS

The intent of this paper is to suggest a sound practical approach to stimulate the development of design alternatives. If you ask the question, "Why do I care about the design of a product?", the answer must be "Because I want a high quality product". The notion of "quality" is one of value. The purpose of design is therefore to increase value. Hence, to guide the design process, it makes sense to begin with the values that you hope to achieve.

This paper presents and illustrates procedures to elicit values for potential products from individuals and then use these values to stimulate the creation of alternatives. The intent of the illustrations is to indicate that this is not a theoretical approach, but an extremely practical approach. In stimulating creativity, it is not complex mathematical or scientific skills that are required. It is rather the willingness to systematically apply common sense and pursue thoroughness in expressing values. The technical skills simply involve making and organizing lists of values.

Once you have the complete list of values, we suggest many different procedures to use these values to create alternatives. In this process, there has to be that spark of insight for the "aha" always present in creative processes. So if you still need that creative spark, what is so special about this approach? The difference is, the creative spark does not start from nothing. It starts from the list of stated values, and the jump from there to a conceptual product design is not as great as the jump from no organized structure of what matters in a particular design situation to a proposed design alternative. Also, since the set of values lays out the landscape of all that is valued regarding a potential design, we have a more complete space to stimulate our thoughts.

This should stimulate a larger set of potential design alternatives from which to choose. It is simply a truism that if you have a much richer set of alternatives to choose among, it is likely that some of these are much better than the best alternatives in a small set of alternatives.

An interesting question concerns whether the described studies were used. They definitely were used to create products, but not exactly the products described. As mentioned at the beginning of Section III, IceWireless was a small Internet firm whose business was to help individuals in companies select a cell phone and wireless plan. Our (i.e., IceWireless) software products were decision models that allowed individuals to compare potential products in terms of the set of objectives they felt were important. These software products, one for cell phones and one for wireless plans, let individuals select the relevant objectives from the lists in Tables I and II. They also selected the set of alternatives that had any appeal and our decision models then helped them systematically zero in on their better choices.

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