Principles for User Design of Customized Products

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Product customization uses a flexible production system to deliver a product to order that matches the needs of an individual customer or user. *User design* is a particular form of product customization that allows the *user* to specify the properties of that product. Consider these examples.

- At Nikeid.com, consumers can design an athletic or casual shoe to their specifications on line, selecting almost every element of the shoe from the material of the sole to the color of the shoelace.[1]
- Dell assembles laptop computers to order. Consumers configure their computer using the company's web site.[2]
- Eleuria sells custom perfumes. Each product is created in response to a user profile constructed from responses to a survey about habits and preferences. Eleuria provides a sample at modest cost to verify fit.[3]
- Lands' End offers customized shirts and pants. Consumers specify style parameters, measurements, and fabrics through the company's web site. These settings are saved so that returning users can easily order a duplicate item.[4]
- Cannondale allows consumers to specify the parameters that define a road bike frame, including custom colors and inscriptions. The user specifies the parameters on the company's web site and then arranges for delivery through a dealer.[5]

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TABLE 1

Problem	Principle	Action
Some consumers have more knowledge about the product than others	Customize the customization process	• Provide novice consumers with a needs-based interface • Provide expert users with a parameter-based interface
Not all consumers are interested in fully exploiting the potential of customization	Provide starting points	• Provide multiple access points for customization
Customizing a product is a cognitively challenging task typically requiring many iterations	Support incremental refinement	• Allow consumers to bookmark their work • Allow for side-by-side comparison • Provide short-cuts through "attribute space"
Since customized products are tailored to a specific consumer, the consumer typically must order a product before having seen or tested it	Exploit prototypes to avoid surprises	• Provide rich illustrations of the product • Provide increasing levels of fidelity in prototypes as the customization process progresses
Consumers know very little about the options available to them as well as how these options are useful in fulfilling their needs	Teach the consumer	• Provide "help buttons" leading to meaningful information • Explain the product attributes and how they map to design parameters • Show the distribution of design parameters and product attributes across the consumer population

User design has emerged as a mechanism to build brand loyalty, to fit products to the heterogeneous needs of a market, and to differentiate the offerings of a manufacturer.[6] User design offers the possibility of exploiting the capabilities of the Internet to deliver a highly differentiated product instead of intensifying price competition.[7]

Unfortunately, many user-design systems fail to capture the potential benefits of user design for companies and fail to deliver the potential benefits of user design to consumers. Table 1 summarizes the key problems with existing customization systems and shows the key principles of user design, including detailed actions a firm can take to implement them.

Our recommendations are based on an intensive research project in which we designed, built, and tested different user interfaces for customizing laptop computers.[8] We collaborated with Dell Computer, one of the companies most closely identi-

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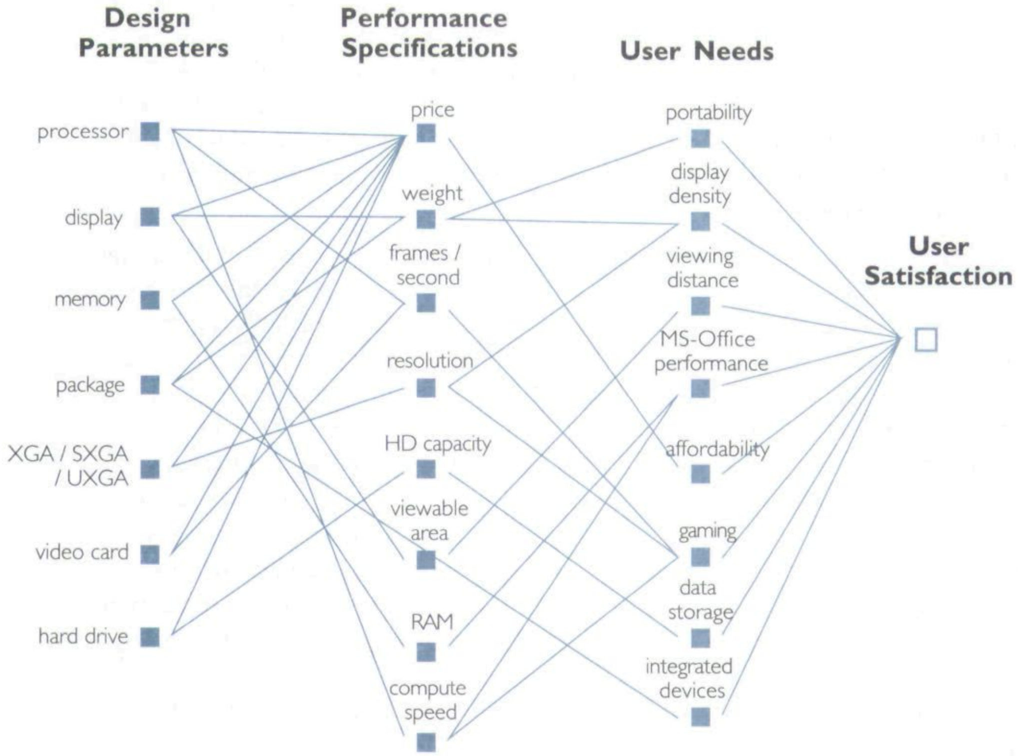
FIGURE 1. Causal Structure Relating Design Parameters to User Satisfaction for Laptop Computers



fied with customization and user design via the Internet. This research is summarized in the accompanying sidebar.

The Fundamental Customization Problem

For customized products, a design problem can be thought of as a search for the values of design parameters that maximize user satisfaction. This problem can be represented by the network in Figure 1, in which the design parameters on the left drive product performance specifications, which in turn relate to user needs, which underlie user satisfaction. This is the basic theoretical framework for product design taught in schools of engineering and management.[9] For customized products, the fundamental architecture of the product is almost always established in advance and customization occurs within a basic "template."[10]

In conventional product design, a professional product designer is in charge of understanding this causal network and linking design parameters to user needs. The product designer, who is typically equipped with professional training and substantial experience, then searches for values of the design parameters that are likely to maximize user satisfaction. Finding the best design for a given consumer constitutes a challenging information processing task.

With user-design systems, the professional designer is replaced by the user.[11] However, the same information processing challenges persist. That is, the user must somehow navigate the causal network relating design parameters to user needs. Users often lack the skills and knowledge to perform this task. For starters, Simonson argues that many users do not understand their basic needs and hence cannot articulate coherently the type of product required to suit those needs.[12] Further, many users lack the technical understanding to configure a customized product.

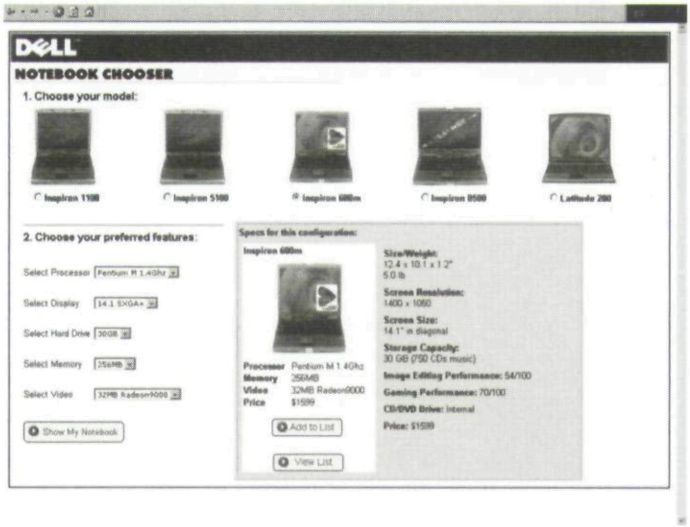
In our research, we considered this challenge in the context of designing a laptop computer. Take the consumer task of choosing laptop memory as a specific example. At the time of our experiment, on-line consumers visiting the sites of nine of the top-ten laptop brands were asked to choose among alternatives like: (a) 512MB,DDR, 333MHz 2 DIMMs, (b) 512MB,DDR, 333MHz 1 DIMM, and (c) 640MB,DDR, 333MHz 2 DIMMs. For computer-literate consumers, this information allowed an informed choice of laptop memory. However, we discovered that a majority of college-educated consumers could not conceptualize their need for laptop memory. For example, they could not answer the question "If I use a laptop for word processing and gaming, how much memory do I need?" In terms of understanding the specifications of memory, these consumers did not know the normal amount of memory in a laptop computer *within a factor of 100*, let alone what "DIMM" means. (DIMM is an abbreviation for "dual in line memory module," a packaging technology for memory chips.)

Given that users in a consumer settings may not fully understand their needs and typically do not have substantial technical domain knowledge nor access to analytical tools, user design bears the risk of a "design defect"—a choice of design parameters that does not maximize user satisfaction. Such a design defect reflects a misfit between the product designed and the product that might have been designed, despite the fact that the user is in control of all of the design decisions. These defects can be mitigated by adherence to a set of five design principles.

Principle 1: Customize the Customization Process

Every good salesperson knows that different customer types are best served by different sales techniques. Some customers know exactly what they are looking for, while others seek guidance and advice. Some customers are willing to spend hours defining every last detail of the product they wish to purchase, while others prefer to get the purchase over with as quickly as possible. Ironically, many sites that are at the forefront of the customization movement offer a single *standard* process for their customization experience. While customers can choose between ten different colors of the laces on their running

FIGURE 2. The Main Screen for an Experimental Parameter-Based Interface



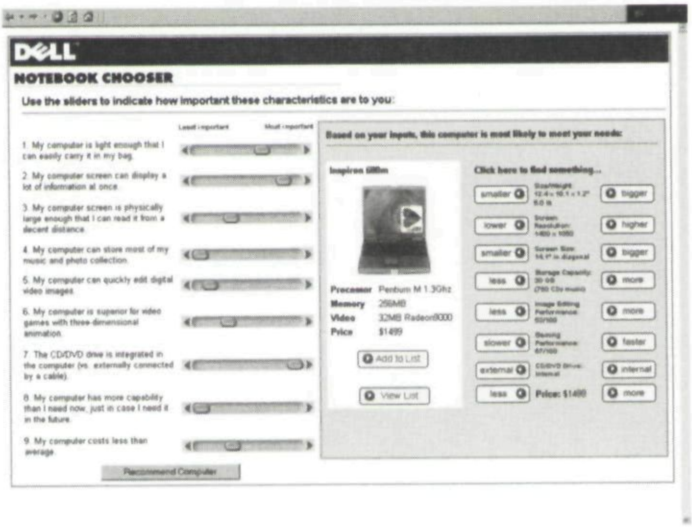
shoes and seven different processors for their laptop computer, they typically have a choice of exactly one user interface for their user-design experience.

Based on the information processing challenges described above, consumer expertise becomes a primary factor influencing the design of the user interface. Other factors such as user types (e.g., student versus professional) and usage occasions (e.g., travel versus home use) may also play a role. However, the primary factor affecting design outcome is expertise.

In addressing differences in consumer expertise, we identify two fundamentally different interfaces supporting the user-design process: *parameter-based* interfaces and *needs-based* interfaces. Parameter-based interfaces allow the users to directly make choices defining the design parameters of the product. For example, much of Dell's web site has historically been parameter-based, as it allowed users to choose the model, the processor, the disk drive, and other design parameters for the computer they wish to purchase. Referring to Figure 1, using a parameter-based interface, a consumer specifies the values on the left, the design parameters, and the implications of these choices are propagated to the product attributes on the right. Figure 2 is a parameter-based interface for customizing a laptop computer.

Needs-based interfaces do not provide direct access to the design parameters, but rather allow users to express their needs in terms of the desired values of the *product attributes* (on the right side of Figure 1), with the system then automatically configuring a product that is most likely to meet those needs. Typically, this is achieved by asking users questions about the relative importance of various product attributes and by having them rank different products according to their desirability. Figure 3 shows a needs-based system for customizing laptop

FIGURE 3. The Main Screen for an Experimental Needs-Based Interface



computers. The interface requires the user to set slider bars, expressing relative preference among nine product attributes. The user can create different designs by changing the importance of the product attributes and can also incrementally change any one attribute.

To illustrate the needs-based approach, consider a consumer customizing her own perfume. Will this consumer be prepared to specify the percentage by weight of distearyldimonium chloride? It is self-evident that a typical consumer could not make an informed choice when creating a perfume using a parameter-based interface. Design parameters for perfumes are difficult to understand for the consumer and it therefore appears obvious that any customization should be driven from user needs such as whether a consumer prefers the aroma of flowers or spices. Unfortunately, many potential users of computer customization sites have about as much knowledge in the computer domain as they have in the domain of perfume chemistry. What is the performance difference between an nVidea graphics card and an Intel-integrated graphics processor when playing the videogame *Motocross Madness*? How much faster will Photoshop operate on a Pentium 4 processor? Without detailed technical knowledge, most consumers are not prepared to answer such questions.

In our research, we let consumers create custom laptop computers from Dell's product line using either a parameter-based system or a needs-based system. We then gave them the computer they had designed and then interviewed them about their satisfaction with the product they had created as well as with the process of obtaining this product. We found that inexperienced consumers were not only frustrated with the parameter-based systems, they also felt—once

Summary of Experiment

In the experiment we conducted in collaboration with Dell, we recruited a total of 164 subjects from various consumer market segments. All 164 subjects were surveyed about their knowledge of laptop computers. We randomly assigned subjects to one of two user interfaces that supported the customization of a Dell laptop computer. Eighty-two subjects were assigned to a parameter-based interface that essentially corresponded to Dell's current web-based order interface (see <www.dell.com>). The other 82 subjects were assigned to a needs-based interface that we created to test the ideas described in this article.

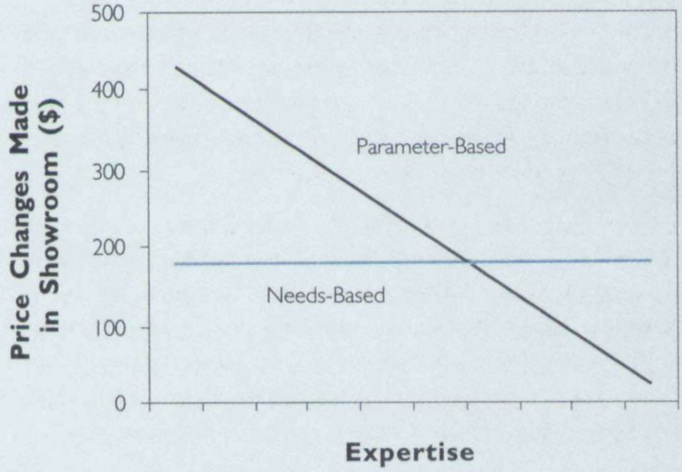
After subjects had designed a computer according to their needs, we took them to a mocked-up "showroom" where we showed them a computer very similar to the one that they had just created, along with other models representing the possible alternatives. During the visit to the showroom, the subjects were allowed to modify the original design they had created using the computer-based interface. We used the absolute value of the price changes that the subjects made to their original design as a measure of the quality of the fit that they had achieved with the user interface. Subjects making large changes achieved worse fit than those making only small changes.

We also surveyed the subjects about their satisfaction with the product they had designed, as well as with the overall user-design experience.

Our experiment revealed the difficulties faced by many consumers in using parameter-based interfaces. These results allowed us to recognize the need for different types of interfaces for different types of consumers, and allowed us to identify a set of principles for successful user design. Specifically, we found that:

- The majority of consumers were unable to answer basic questions about the amount of memory, the size of a disk drive, and the clock speed of a processor of a laptop computer, knowledge that is required to use a parameter-based interface effectively.
- Consumers who lacked expertise generally made design choices using the parameter-based approach that exhibited poor fit. Figure S1 shows the absolute value of the prices of the changes made by consumers during the showroom experience as a function of expertise for the two different user interfaces. The least-expert subjects ended up making several hundred dollars worth of changes to the computer they designed using the parameter-based interface.
- Less-expert consumers were significantly more satisfied using the need-based interface adhering to the principles in this article, than they were with the parameter-based interface. Less-expert consumers using the needs-based interface on average chose to make fewer changes to the product they had designed than did less-expert consumers using the parameter-based interface.
- While the needs-based approach performed well for consumers with relatively less expertise, expert consumers significantly preferred the parameter-based approach. Furthermore, as shown in Figure S1, they achieved a better fit, on average, making very few changes to the computer they had designed with the parameter-based interface.

FIGURE S1



After designing a computer, subjects visited a simulated showroom and were allowed to see and experiment with a computer very close to what they designed, along with a collection of other computer models. During the showroom visit, they were allowed to modify their original design to more closely match their needs. This plot shows the average price (absolute value) of the changes made by consumers during the showroom experience as a function of the subjects' expertise for the two different user interfaces.

they understood the consequences of their design choices—that the laptop they created using the parameter-based system was not right for them.

Fortunately, user design does not have to follow one standard process and the following actions can help producers to improve their user interfaces, making them meet the needs of different customer segments.

Action: Provide Novice Consumers with a Needs-Based Interface

Novice consumers do not possess the domain knowledge necessary to manage parameter-based interfaces (Figure S1). Give them the option of customizing a product using a needs-based interface. A needs-based interface presents technical challenges to the manufacturer—how to specify the design parameters of a product in order to respond to the expressed preferences of a user. However, this challenge is better handled by the manufacturers' engineers than by novice consumers. It is also important to realize that at an extreme some consumers with low expertise prefer not to customize products at all, but prefer a "no customization" option.

Action: Provide Expert Users with a Parameter-Based Interface

When we conducted the same experiment described above with expert users, the results changed dramatically. Expert users view needs-based systems as annoying and desire direct control over the design parameters of the product.

For them, thinking about and modifying product attributes only complicates matters. The implication is that a needs-based approach does not work for all consumers. Give expert users the control they desire through a parameter-based interface.

In practice, providing consumers a tailored interface is often accomplished by having consumers self-select into a choice of interface most suited to their abilities and needs.

Principle 2: Provide Starting Points

Consumers differ greatly in the extent to which they wish to affect the design of a product. For example, in designing shoes, one customer might want to influence the fundamental style of the shoe, while another may just want a custom color. Furthermore, consumers on average do a relatively poor job of generating conceptual alternatives that appeal to their basic needs and sense of style. These two problems are mitigated by the use of "starting points."

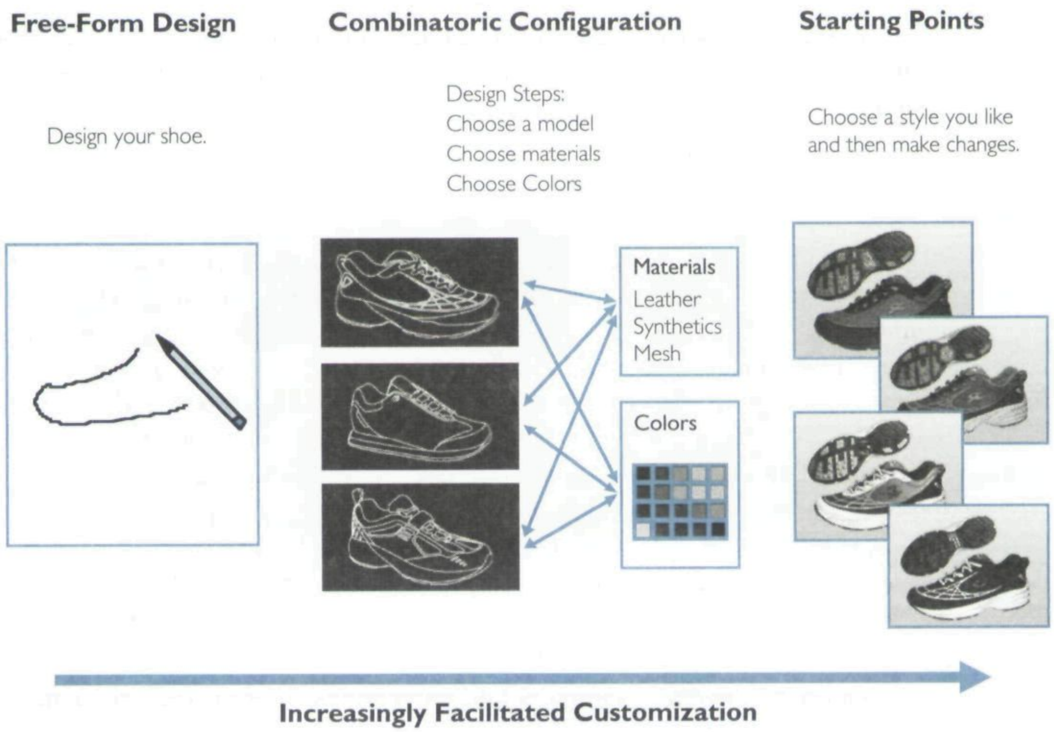
We define a starting point as an initial design from which a customer can perform additional customization. The starting point frames the customization problem. It often limits the customization task to simplify the design process. Yet while limiting the design task, it may also provide appealing design paths or design options to consumers. Consider the example of nike.com, a site that allows the consumer to design different types of shoes.

Figure 4 illustrates examples of different points where nike.com might allow consumers initial influence into the design process. A *free-form design* interface would allow a customer to influence nearly every parameter of the product, including its basic shape and style. An interface using *combinatoric configuration* allows customers to change attributes of a product within a pre-specified product architecture. The customer is constrained to the architecture provided by the company but can select, for example, colors and materials. An interface with *starting points* allows the user to find a predefined design that is closest to the desired outcome and then supports incremental refinement going forward.

Action: Provide Multiple Access Points for Customization, Including Starting Points

Successful sites offer different pathways for consumers to arrive at a custom design, in most cases providing consumers with the option of beginning the process from an existing design. Nikeid.com, for example, uses both the combinatoric-configuration approach and the starting-points approach, as described in Figure 4. When introducing the starting-point option the site reassures the consumer, "Starting from scratch isn't for everyone, that's why we've pre-made some color combinations for you to use as a starting point for your shoe design." Similarly, Dell allows sophisticated computer professionals to configure systems with few constraints. However, less-sophisticated users can opt to incrementally change "recommended configurations."

FIGURE 4. Three Approaches to Customization: Free-Form Design, Combinatoric Configuration, and Refinement from Starting Points



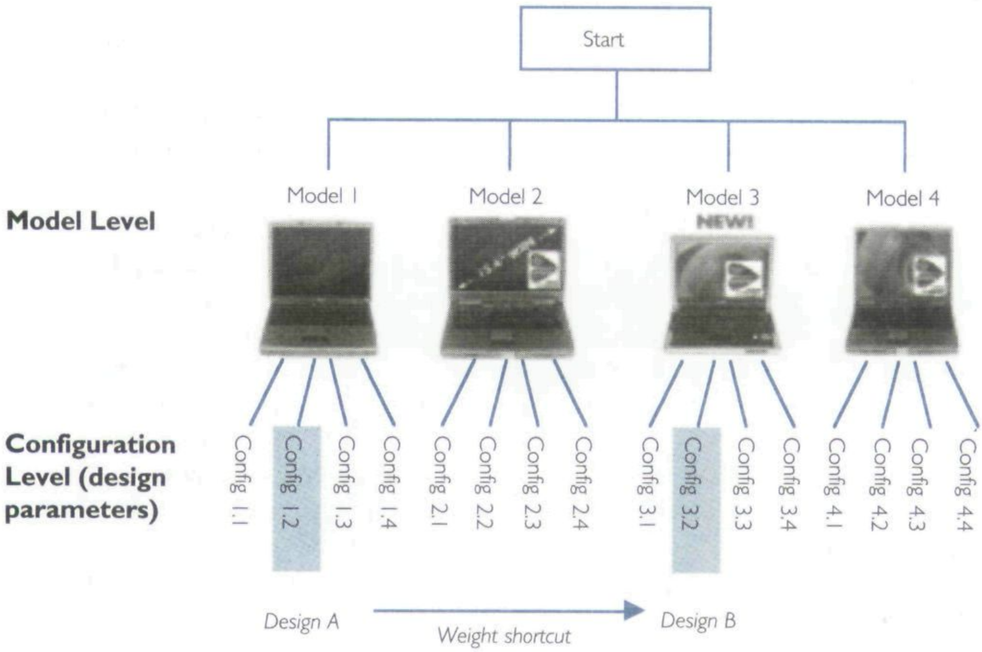
Principle 3: Support Incremental Refinement

Consumers want to iterate and to compare different design solutions so that they can understand the trade-offs characterizing the underlying design problem. For example, in the case of a laptop computer, a consumer might want to understand how the price of the product changes as more storage capacity is added. Similarly, a consumer might want to understand how the weight of the laptop changes as the screen size is increased. We refer to the exploration of the trade-off between several variables as *sensitivity analysis*.

In the world of physical retailing with the help of a salesperson, iterations supporting sensitivity analysis happen so naturally that consumers can take them for granted. For example, a salesperson in a computer retail store would quickly be able to respond to a customer comment such as "This laptop is a little heavy. Do you have something lighter?" by showing a lighter alternative.

Unfortunately, what makes for a simple task for a salesperson is a remarkably difficult task for a consumer shopping online. For example, from the technical perspective, the design space for laptop computers takes the form of the tree shown in Figure 5; consumers initially choose a model that they then

FIGURE 5. A Configuration Tree Showing a Laptop Product Line Arranged by the Logic of Design Parameters and Component Choices



configure by choosing design parameters specifying such things as the processor, memory, and screen size.

Consider a consumer who has customized a laptop and is fairly satisfied with her choice (Model 1, Configuration 1.2), which we will label Design A. However, the consumer wants to explore an alternative configuration that is similar to her current choice, except a little lighter. In order to find such an alternative, a consumer using Dell's web site would have to perform the following actions:

- Note the current configuration (Design A), probably with pen and paper, as well as its product attributes in order to be able to compare subsequent configurations.
- Go to the main laptop screen where the model is selected, essentially starting the customization process over again.
- Compare the weights across different models, which requires clicking on each model and then searching the specifications to find the weight information.
- Choose a model (in this case Model 3) that is lighter and then configure it so that it is as close to Design A as possible.
- Compare the resulting configuration (Design B) with the previous choice (Design A) along the most important attributes.

Even a person with substantial experience with the web site requires about five minutes to accomplish this task. Consumers with less experience using Dell's web site can take more than 10 minutes and frequently are not able to complete the task.

The problem here is that Dell (and this problem is by no means limited to Dell) arranges its product line in terms of design parameters. From Dell's perspective, there are several models, each of which can be custom configured to the needs of the individual consumer. Designs A and B belong to different models and therefore are essentially unrelated.

In contrast, consumers don't necessarily think in terms of models; they think in terms of attributes. In the spirit of sensitivity analysis, consumers want to change these attributes to find out how they have to trade off an improvement in one attribute against an increase in price. Alternatively, they might want to find out how much degradation in performance they must suffer with respect to one attribute in order to obtain a better result with respect to another attribute. Given the disutility that consumers assign to even simple online tasks,[13] a duration of 5-10 minutes for a simple comparison between design alternatives will prevent consumers from engaging in sensitivity analysis. As a result, consumers are likely to end up with products that have a worse fit to their individual needs. In fact, they would be better off interacting with a knowledgeable salesperson than doing the design themselves.

Fortunately, user design does not present these difficulties and iterations can be significantly accelerated. The following actions address the problem.

Action: Allow Consumers to Bookmark Their Work

When moving from Design A to Design B in Figure 5, the consumer has to abandon all previous work in configuring the laptop. However, during an iterative trial-and-error process, the consumer frequently will reject a newly discovered design alternative and will want to recover the previous configuration.

Action: Allow for Side-by-Side Comparison

Incrementally changing one attribute and understanding how this affects others is easier if a consumer is allowed to compare previously saved configurations side by side. This has the advantage that the consumer does not have to manually record relevant information (e.g., design parameters and product attributes) of previously chosen configurations. It also provides a simple, visual way to support the sensitivity analysis. The side-by-side comparison should include all design parameters and product attributes.

Action: Provide Automated Short-Cuts through "Attribute Space"

The problem of finding a lighter laptop computer is difficult using parameter-based interfaces, because the consumer must know which design parameters influence weight. Using a needs-based interface, the user merely specifies that he or she desires a lighter product and the system finds the design parameters that meet that need. Several attributes are likely to be central to the customization problem, such as weight, price, and speed for computers. Even using a parameter-based interface, the system can provide a few pre-selected "short cuts" that automatically find lighter, less-expensive, and faster configurations as incremental improvements to the current configuration.

Principle 4: Exploit Prototypes to Avoid Surprises

By their very nature, customized products are likely to be unique. This makes it difficult for consumers to anticipate their post-purchase experience; the consumer cannot simply go to a retail store or to a friend and take a look at the exact same product as would be possible if buying a product off the shelf. Unfortunately, the same uniqueness of the product that makes customization so compelling can lead to unpleasant surprises and buyers' remorse when the product finally arrives.

There are two root causes to these surprises. First, many product attributes are intangible; this makes it difficult to communicate the attributes via a computer screen. The smell of a customized perfume, the texture of customized jeans, or the fit of a customized running shoe fall into this category. Second, a bad surprise can result, especially with respect to holistic attributes, from a mistake a consumer made in understanding how a product attribute relates to satisfaction.[14] For example, many consumers were surprised by the weight of a laptop they previously had configured online although they were previously informed of the exact weight of the product.

Both of these root causes can be addressed if the user-design process makes use of prototypes.[15] Prototypes are approximations of the real product along one or several dimensions of interest. Prototypes are important even for professional designers; and they play an even bigger role for user design. Consider, for example, the case of Eleuria and Reflect, two companies that allow consumers to create customized perfumes. When designing perfumes, users express various aspects of their utility functions using a needs-based interface. Producers of customized perfumes then use software that matches the user needs to a fragrance formulation. Even so, consumers are hesitant to pay $100 for a bottle of perfume without having had a chance to experience it on their own skin. For this reason, for a fee of $5, Reflect equips their customers with three small sample bottles, including the proposed perfume as well as two alternatives. Similarly, Eleuria allows consumers to refine and iterate a formulation until they are fully satisfied.

As the example illustrates, prototypes can help overcome the natural hesitation of the user to purchase a product they have not yet experienced and to help the manufacturer to create a product that better matches the user needs. Thus, good user-design sites enable the user to iteratively define and test prototypes, using virtual prototypes, samples of the product, as well as the final product itself. The following two recommended actions provide further guidance on avoiding unpleasant surprises.

Action: Provide Rich Illustrations of the Product

Both the manufacturer and the user have an interest in fast and inexpensive iterations. For this reason, it is important that as much as possible of the testing and experiencing of product prototypes occurs in the digital world. Rich illustrations of the product are a kind of *digital prototype* and can include photos, animations, drawings, or any other information about the product that can be conveyed over the Internet.[16] For example, to illustrate the weight of a laptop, Dell uses a picture of milk containers on its web site: a seven pound laptop corresponds to a full, gallon-sized milk container. The site also shows pictures of laptops next to each other, which helps users to visualize the size difference between the smallest and largest models. While technically these illustrations do not provide more information than the numerical values for size and weight, they express these properties in a way that is likely to be understood by consumers.

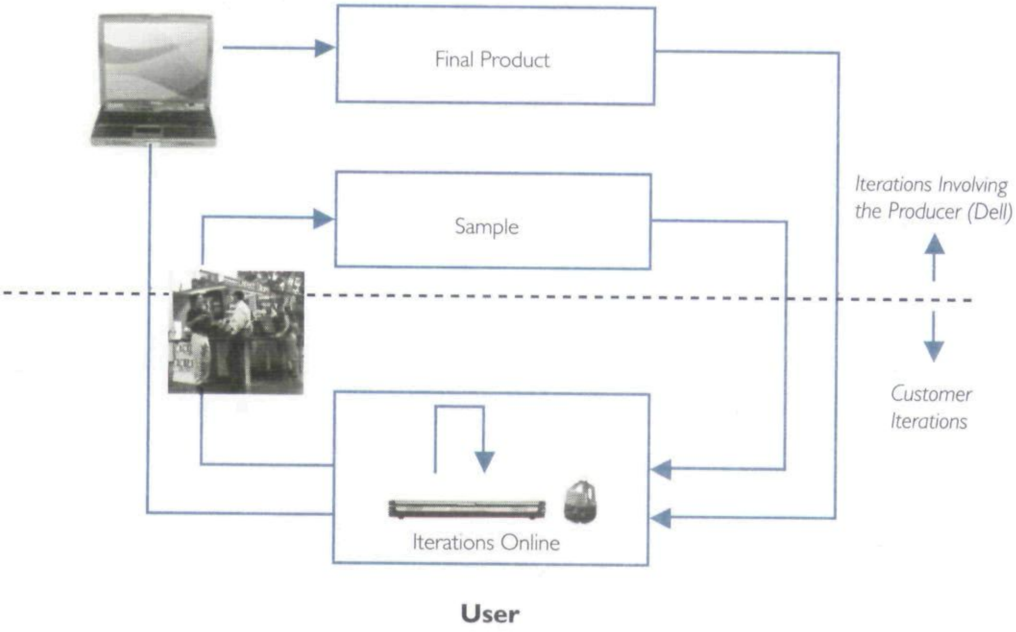
Action: Provide Increasing Levels of Fidelity in Prototypes as the Customization Process Progresses

Physical prototypes are costly to build and can lengthen the user-design process as their delivery typically requires significant manufacturing and shipping lead times. For this reason, user customization benefits from both digital and physical prototypes. Early iterations can be done quickly and inexpensively in the digital world. Once the user feels more comfortable with the product, he or she may be given the option to order a sample.

From the perspective of the consumer, retail stores and existing products provide alternatives to physical examples that have to be custom made. For example, Dell now has a set of outlets in shopping malls that let consumers experience Dell products in a more representative way relative to its web site. Finally, the user can iterate and learn from the real, customized product itself. This form of iteration is most appropriate for products with a high purchase frequency and relatively low prices. For example, a consumer who orders a customized pair of pants from Lands' End for $50 may be tolerant of making incremental improvements on several order cycles. In contrast, a consumer purchasing a $4,000 custom-built bicycle from Cannondale is likely to have less appetite for iterative refinement over several purchase cycles. For this reason, Cannondale insists that the consumer visit a dealer after completing the web design of a bicycle, but before making the final purchase.

These nested prototyping cycles are illustrated in Figure 6. In the "outer loop" of Figure 6, corresponding to iteration on the customized product itself, a decision a firm needs to consider in its user-design approach is the return policy. Many firms offer a "no questions asked" liberal return policy. The role of the return policy is to make it more attractive for the consumer to experience the utility of the product without having to bear the risk of experiencing regret at having purchased an ill-fitting product.

FIGURE 6. Nested Prototype Cycles, Including Digital Prototypes, Samples, and Iteration with the Versions of the Final Product



Principle 5: Teach the Consumer

In our research, we found that the majority of college-educated consumers do not know if processors operate at speeds of kilohertz or gigahertz, nor whether 200 MP3-format music files require one megabyte or one gigabyte of storage on a disk drive. This lack of expertise is a major threat to user design. How can a consumer decide whether to spend US$300 extra to obtain a Pentium 4 with 2.0 Ghz instead of 1.6 Ghz without understanding some basic information about the underlying technology?

Consumers need to understand the design space, including the design parameters as well as the product attributes. This includes the information in Figure 1. What are the design parameters and the product attributes? How do design parameters map to product attributes?

While consumers typically know that more performance leads to better satisfaction, they frequently cannot determine how much performance is right for them. Thus, consumers have to understand how particular levels of performance relate to their own satisfaction.

Consumers benefit from understanding the trade-offs among attributes and how they can be resolved. These tradeoffs often revolve around price and performance, or price and quality (e.g., a lighter laptop computer increases the laptop price). We observed that web sites often taught these tradeoffs through comparison charts.

Action: Provide "Help Buttons" Leading to Meaningful Information

Almost all computer manufacturers provide a "help" option on their web site. However, a closer look quickly reveals that little help can be found there. For example, IBM informs a consumer choosing among processor options who clicks on "Help me decide" that "The processor works with the system memory to influence overall performance." In response to a user's click on "help me decide," Dell praises the "hyperthreading technology" used in INTEL's microprocessors. In general, we observe that help is either too technical, self-serving, or too abstract to be useful.

Action: Explain the Product Attributes and How They Map to the Design Parameters

A description of the basic design parameters is not enough though; design parameters are only of value to the customer if they are linked to the product attributes. Thus, the user needs to be educated about the map that is shown in Figure 1. What attributes are related to a specific design parameter (and, vice versa, what design parameters are related to a specific attribute)? For example, a consumer needs to know that a video card will be of importance in determining gaming performance, that gaming performance is also driven by the processor, and that it is typically independent of the disk drive.

Action: Show the Distribution of Design Parameters and Product Attributes across the Consumer Population

Novice consumers generally have a hard time deciding how much of a specific product attribute they want. This reflects their inability to anticipate their own usage of the product as well as potential future changes in the technology. In general, consumers are much more comfortable with a statement such as "I want my computer to have slightly more than average storage space." For this reason, it can be helpful to offer consumers information about what other consumers have chosen. For example, Sierra's Nascar2002 site allows consumers to benchmark their current systems with respect to a distribution of gaming systems currently available in the market as well with respect to the minimum system requirements.

Concluding Remarks

Before the introduction of customization and user design, producers had to aggregate individual consumers into market segments and invest in elaborate market research techniques to hear "the voice of the customer." In contrast, user design constitutes a major step forward in industrial history, as it moves the specification decisions of a product from the producer to the user—the agent in the value chain with the most knowledge about user preferences.

While in principle this move should lead to higher customer satisfaction and potentially larger producer profits, user design as implemented by most firms fails to live up to its full potential. Our research has shown substantial dissatisfaction and regret among consumers when presented with the products they design themselves. The reason most customization sites do not live up to their full potential lies in a simple dilemma. User design has shifted decision power to the agent in the value chain with the most knowledge of preferences, but the least knowledge of the underlying design domain.

The five principles outlined here led to substantial improvements in the research setting we studied. Moreover, their applicability extends well beyond our initial focus of customization and user design. A bewildering array of products currently confronts the consumer in the domains of digital cameras, automobiles, television sets, and home appliances. Moreover, consumers are facing an increasing number of choices in many service industries, including retirement planning, air travel, vacation planning, and medical services. In a world of make-to-order production and sophisticated IT-enabled services, the primary obstacle to consumers obtaining the products they truly need is their own ability to make choices. By adhering to the five principles, producers and retailers can enable their customers to more naturally navigate these large search spaces, identifying products that better fit their individual needs and—ultimately—increasing profitability and customer satisfaction.

Notes

1. <www.nikeid.com>.
2. <www.dell.com>.
3. <www.eleuria.com>.
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