The Limits of Mass Customization

Do not be seduced by the allure of mass customization. Carefully assess the technology and the market demand before committing your company to such a strategy.

Paul Zipkin

Is mass customization really the best way to deliver variety to consumers? Managers understand how critical variety is to adding value to their product offerings. And mass customization has been touted as the premier way of achieving that goal. But there are several ways to deliver variety, and mass customization may not always be the best.

Mass customization is the capability, realized by a few companies, to offer individually tailored products or services on a large scale. Levi Strauss, for instance, sells custom-fitted jeans. Andersen Windows can build a window to fit any house. Consumers can get their names printed or sewn or embossed on just about anything. And personalized information services for everything from financial planning to travel guidance proliferate on the Web.

The phrase "mass customization" is striking, for it seems a contradiction in terms. Mass production implies uniform products, whereas customization connotes small-scale crafts. (See "Mass Customization vs. Mass Production.") Combining the best of both promises exciting choices for consumers and new opportunities for businesses.

Mass customization has its limits, however, and should be approached cautiously. Several elements have to work well — both individually and together — to make mass customization a plausible business strategy. Mass customization actually requires unique operational capabilities. The technologies that can produce custom-fitted Levis, for example, have developed over decades. The innovations needed to customize other products are likely to be just as slow.

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What exactly does a mass-customization system consist of? How does it differ from traditional mass production?

Commodities from grain to gasoline are typically manufactured under mass-production systems. The great virtue of mass production is economy of scale. Production facilities are typically expensive and inflexible, but variable production costs are low. Also, after production, the finished product is stocked in inventory, which serves to meet customer demands.

Mass-production systems can be adapted to make several different varieties of a product. Items from automobiles to toothpaste are manufactured in that way. In addition to deciding whether and when to buy, a customer selects one of the variants. The production facility must be somewhat flexible — enough to switch between variants with few delays and at a low cost, thereby retaining economies of scale.

The basic structure of mass customization is similar to that of mass production with variety, but there are important differences. Instead of selecting one variety of a product, each customer provides unique information so that the product can be tailored to his or her requirements. The production process must be very flexible in order to meet those requirements. There is no finished-goods inventory — there can’t be if the product is really customized. The lack of inventory has advantages (low carrying costs) and disadvantages (customers have to wait). It also involves a delivery capability that reaches directly to the customer.

The technological differences between mass production and mass customization, while considerable, are matters of degree: Mass customization entails richer information flows and more-stringent requirements for process flexibility.

Elicitation Elicitation is hard. Customers often have trouble deciding what they want and then communicating or acting on their decisions. That creates problems for any company aiming to serve those customers. There are situations in which customers clearly articulate their requirements. More commonly, however, customers are unsure. They are easily overwhelmed by too many selections on a store shelf or a Web page. Any elicitation process is an artful means of leading customers through the process of identifying exactly what they want. And it reduces the costs associated with customers’ laborious searching. The difficulty of eliciting customer-specific information varies with the information required. To emboss a customer’s name on a wallet, the only information a
company needs is the name. Deeper levels of customization, however, require more information. Thus, mass customization often requires an elaborate enabling mechanism (sometimes called a configurator).

There are four kinds of elicited information in mass-customization systems: identification, such as name and address; customers’ selections from menus of alternatives; physical measurements; and reactions to prototypes. For the first two, mass customization usually employs the computer and the Internet. Advances in user interfaces now make it possible, fairly cheaply and quickly, to construct a program to guide customers or salespeople through an array of choices. Even so, the process remains frustrating for many customers. People often just give up without buying anything. It is still a very new way for people to shop, and developers continue to refine their methods to make the process smoother. It is fair to say that electronic elicitation has yet to achieve the skill of the average barber.

Improvements will no doubt be aided by progress in customer-relationship management (CRM). CRM collects information about customers, aims to predict their individual desires and behaviors, and targets marketing messages accordingly. Although a targeted marketing message is different from a physical product or a customized service, the goals and technologies of CRM are somewhat similar to those of mass customization.

Many mass-customization systems also elicit information about physical measurements— for example, to fit a garment to a body or a window to a house. But nearly all of those systems still use expensive manual methods. For example, to get custom-made pants from Levi Strauss, the first step is to visit a store. There, customers choose from various styles and fabrics. After an employee takes their measurements, customers try on one or more sample garments. The employee then enters the information into a computer. A relatively new competitor in the custom-apparel business, IC3D, uses a different but still manual system. Its Web site guides customers through the process of taking 11 measurements and then typing the numbers into the computer themselves.

In certain cases, automation is replacing such manual methods. For example, following years of experimentation, Levi Strauss is trying an optical body scanner at one store. The device was developed by the Textile/Clothing Technology Corp., a Cary, North Carolina–based nonprofit organization supporting the apparel industry. Tecmath, located near Mannheim, Germany, is developing a rival system. Automated body measurement, nevertheless, remains at the experimental stage, and its development is turning out to be demanding and slow. Automated measurements in other industries, too, are likely to require long, expensive development efforts.

The use of prototypes is not yet a common method for eliciting customer-specific information. To date, there are few examples of product prototypes, computerized or otherwise, in mass customization. Architects and building contractors use them fruitfully, as do some furniture makers. For example, Simply Together provides online 3-D views of its sofas and chairs. Similarly, Streif’s Web site invites consumers to “Build your house with the mouse.” The technology is developing rapidly and will probably be used more in the future.

In sum, elicitation is both essential and difficult. To give customers exactly what they want, you first have to learn what that is. It sounds simple, but it’s not.

Process Flexibility The next element of a mass-customization system is process flexibility. A high-volume but flexible process translates information into the physical product. Some processes, however, are more flexible and easy to digitize than others.

Considerable effort has been devoted to developing such capabilities for conventional mass-production systems. Flexibility-enhancing innovations range from modular design and lean operations to the increasing use of digital-information technology for controlling manufacturing equipment. In metal fabrication, for instance, numerically controlled machine tools introduced in the 1950s subsequently led to robots and CAD/CAM systems, which in turn led to today’s computer-integrated manufacturing systems. In the apparel industry, innovations began in the early 19th century with the Jacquard loom. More recently, technology providers such as Gerber Scientific have learned how to digitize cutting operations and other tasks. Levi Strauss has benefited from Gerber Scientific’s research and uses a numerically controlled cutting machine to cut the fabric to each customer’s pattern. The machine is capable of cutting virtually any pattern and can switch patterns almost instantly.

The most flexible operations today are those that process information, which partly explains the explosion of mass-customized information services, such as the personalized news providers CyberScan and eNow.

Unfortunately, not all industries have enjoyed the same intensity of innovation. In every industry, moreover, only certain processing stages are sufficiently flexible, and so only certain product attributes can be customized. Levi Strauss, for example, does not offer customized colors because technologies haven’t yet developed that can customize fabric dyeing on a large scale. Bicycle companies have similar limitations. In a 1998 study, each of four bicycle makers offered considerable variety, but for different attributes— partly because the companies had different expertise in process technology. The kinds of variety
offered depended on the technologies available.

To assess the potential for mass customization of a particular process, a good starting point is to determine how many spatial dimensions are involved in each step. Processes that involve only one dimension are naturally easier to customize than three-dimensional ones.

Consider some one-dimensional processes. To make the shaft of a golf club, you cut a metal rod at the right point — a simple task, requiring a simple tool, a saw. To get the right length, you position a guide that holds the rod. Then, you slide the rod across the cutting blade. The tool is quite flexible in the one dimension of interest and can be easily adapted to digital control. Voilà — customized golf clubs.

Bicycle frames are custom-made in a similar fashion. They may not look one-dimensional, but they are merely several metal tubes welded together. To customize the size of the bike, just customize the lengths of the tubes. In these cases, a zero-dimensional pattern (the cutting point) is imposed on a one-dimensional medium (the rod or the tube). Virtually any such process can be made highly flexible, and so virtually any product constructed that way is easy to customize. Cutting glass to make a rectangular window of any given size is a bit more difficult. It requires several straight cuts, one for each edge. But each cut is a one-dimensional operation, like cutting a metal rod or tube.

Next in complexity is two-dimensional printing and printing-like technologies. Paper is a flat, two-dimensional medium. The printer imposes a pattern consisting of objects of zero dimension (dots), one dimension (lines) and two dimensions (shapes). Johannes Gutenberg, as we know, made the printing process much more flexible than it had been before, and laser and digital technologies in recent years have made it still more flexible. (Software is as important as hardware to that flexibility. Today’s printers gain some of their power and flexibility from scalable fonts and page-description languages.) We no longer even think of the setup time required to print one very different page after another. The computer takes care of it all, and the process seems almost instantaneous. Cutting fabric according to a pattern is a similar operation (the cutting tool essentially “prints” the pattern on the fabric) and also has become very flexible.

Most three-dimensional fabrication processes are less flexible, and those that work typically have reduced dimensions. For example, a numerically controlled lathe makes three-dimensional objects, but only those with rotational symmetry, such as baseball bats and the legs of fancy tables. Robots are flexible in all three dimensions, but they are expensive, slow and hard to operate. (High-level languages for robots, analogous to the printing and imaging standard called PostScript, are under development but not yet available.) It is unlikely, therefore, that we will see customized auto-body parts in the near future, because they are three-dimensional objects.

**Logistics** After the product is fabricated to include customer-specific information, there may be additional processing and transportation tasks. All such tasks may be encompassed by the term “logistics.”

At Levi Strauss, cutting is only one stage of a multistage process; subsequent steps include sewing, washing, packaging and shipping. It is necessary that some information (at least the customer’s identity) move along with the physical product through all the stages so that the right product ultimately reaches each customer. Levi Strauss tracks a garment by attaching a bar-coded cloth tag. The tag allows garments to be washed in bulk, an operation with substantial economy of scale. (A washable bar code, in fact, was the only really new technology that Levi Strauss had to invent. Still, inventing it took several years.)

Next companies face distribution — always tricky. Upon emerging from the high-volume production process, each individual product must be sent to the right person. Such direct-to-customer distribution is quite different from the conventional kind, and switching from one to the other has proved difficult. Moreover, the problem has plagued all of business-to-consumer e-commerce, not just mass customization. For example, during the 1999 Christmas season, even Toys “R” Us (a company that is good at conventional distribution) experienced a distribution debacle that was essentially a failure to make the transition to e-commerce.

Still, as the technologies underlying e-commerce logistics (including the Internet, automated warehouses and package-delivery services) continue to develop, they will help bring mass-customization systems to fruition. Today’s problems are opportunities for such companies as Federal Express and United Parcel Service (UPS).

For a mass-customization system to work, the three elements — elicitation, process flexibility and logistics — don’t just have to function well individually. They also must be linked tightly to form a coherent, integrated whole. Mass-customization systems cross traditional organizational boundaries, particularly those between sales and production. Thus, companies must have organizational agility in addition to technical agility to enable cooperation across those boundaries.

**The Demand for Mass Customization**

There are mass markets for some customized products — the emergence of mass-customized apparel demonstrates that. But how broad will the phenomenon be in the future? There has
Alternatives to Mass Customization

Mass customization is only one way to satisfy demand for variety. Traditional mass production, adapted to make a few variants of a product, remains viable. An entirely different way is through a flexible or configurable product, which customers can adapt to suit their individual needs. In that case, the potential for variety is built into a single, uniform product, which can be made and distributed by a conventional mass-production system.*

The elicitation process, however, can still be problematic. Everyone has experience with a VCR with too many buttons or software with too many options. Building flexibility into such products requires artful design.

For instance, Gymboree offers only a few sizes of children’s clothes, but those sizes now come with “grow cuffs” so parents can make adjustments for better fit.† For adults, few modern Western garments are configurable, but the sari and the kimono are. A computer is highly configurable. A belt has multiple holes, and flour can be made into breads or cakes. Instruction manuals in several languages obviate the need for separate manuals for different countries.

Configurable products can be a direct substitute for and competitor to mass customization. For example, a few years ago, there was talk of customizing car seats. Toyota even set up a prototype of a seat-measurement device at its visitor center in Toyota City. It never happened. Instead, adjustable seats developed rapidly. It is cheaper to construct adjustable seats than to customize. Moreover, unlike a seat customized for one person, an adjustable seat can accommodate multiple drivers.

Another example is office furniture. Some desk chairs allow dozens of different adjustments and come with user’s manuals to explain them. Desks often include large screws that allow for multiple height adjustments.

The case of Hallmark Cards, one of the early pioneers of mass customization, is also instructive. In the early 1990s, the company installed kiosks in stationery stores with special computers that guided users through the process of designing their own greeting cards, which they could then print. Those kiosks disappeared. What happened? Technologies advanced, and as a result consumers were able to buy color printers, simple software and high-quality paper to create their own cards using their home computers. Today technology has advanced still further with the e-card, a mass-customized information service provided by Hallmark among others.

† T. Agins, “Go Figure: Same Shopper Wears Size 6, 8, 10, 12.” Wall Street Journal, Nov. 11, 1994, Sec. B, p. 1.

been little research addressing that question, and there are good reasons to be cautious about predicting future demand for mass customization.

Who Wants It? Customization enthusiasts proclaim that everybody wants it, everywhere, all the time. The evidence supporting that belief is, however, anecdotal. One story about a customer who cheerfully customizes a car online does not portend a mass market. It is worth asking, then, what kinds of custom products have mass appeal today — and why.

Many custom products are essentially novelties. Their appeal is precisely their entertainment value or surprise value. Examples of such products include soap stamped with your name and cookies glazed with your picture. The value of such products is by nature transitory.

Customers also demand variety when they differ sharply in their preferences for certain attributes of a product. In such a case — for example, when products require matching different physical dimensions — customization may truly add value. Clothing is a good example. People have different shapes, and they care deeply about a garment’s fit. Similarly, a window either fits or doesn’t fit a particular house, and if it doesn’t, it’s useless.

Beyond that, we enter the realm of taste. Tastes differ, but it is an empirical question in each case how much and how
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It requires a highly flexible production technology. Developing such technologies can be expensive and time-consuming. Some processes, moreover, are more flexible and easier to digitize than others. Examples include information processing, printing, and cutting metal rods and tubes.

It requires an elaborate system for eliciting customers' wants and needs. To make something unique for someone requires unique information. Eliciting such information entails, for instance, asking the right questions and taking the right physical measurements — and that's more difficult than it appears.

It requires a strong direct-to-customer logistics system. Fulfillment is the weak link in much of e-commerce, and the same is true of mass customization.

People are not willing to pay to have everything customized. In every case, companies must determine whether there is a potential mass market for custom features. Customers demand variety when they differ sharply in their preferences for certain attributes of a product. Under such circumstances, customization may truly add value. Products that require matching different physical dimensions fall into that category.

Who Sells It Now? We can get some indication of candidates for mass-customization from the customized (but not mass-customized) products available today. I know of no mass-customized product that was not previously customized on a small scale. There is little research currently on the subject, but I recently conducted a small, informal search of three sources: Yahoo, the online Yellow Pages for Raleigh, North Carolina, and a few Web sites dedicated to custom goods.

Searching for "custom" in Yahoo's business section yielded the following categories: apparel, construction and home furnishings, computers (many companies in each category), sports equipment (predominantly golf clubs), publishing and printing, balloons, and adult videos. There are no major surprises: A golf club works better when it fits the golfer, and balloons are novelties that are often decorated for a particular occasion.

The Raleigh Yellow Pages turned up similar items, plus signs and auto paint and body shops. Some segments of the sign business — such as standard street signs — could be mass-customized, and perhaps they are already, but most will more likely remain small-scale crafts. The same is true for painting designs on cars.

An Internet company called digiCHOICE boasts thousands of custom products in hundreds of categories. The major categories, with examples of subcategories, are as follows: apparel (clothing, footwear, jewelry, accessories), home and office (furniture, artwork, computers, carpets), media (music, television, books, photographs), personal care (cosmetics, vitamins, soap, bath items), services (vacations, training, mortgages, parties), sports (golf, baseball, soccer, bicycles, skis) and other (vehicles, gifts, food, pet items, boats). The list may seem long, but again, there are no major surprises. Many of the items are customizable along physical dimensions. Others are information services or novelties. Several items (such as parties) are inconceivable as candidates for mass customization. Only a couple — custom cosmetics and jewelry — are items now made on a small scale that could perhaps appeal to larger markets.

In sum, the limited evidence available to date suggests a rather modest range of products with the potential for large-scale customization demand.

One of Many Routes to Variety

Companies should not be seduced by the gaudy banner of mass customization. (See "The Limits of Mass Customization.") Any company considering a mass-customization strategy should carefully analyze its ability to deliver on the three elements of such a strategy — elicitation,
process flexibility and logistics — and to integrate them. Investors should insist on a fully developed business plan, including specifics on process technology, market research, and actual and potential competition.

However, companies should investigate the potential for variety enhancements, including customization. For which product attributes might a broader array of choices deliver real value to customers? To what key processes are those attributes tied? How flexible are those processes now, and what can be done to make them more so? How might products be redesigned to be more modular or configurable? What new opportunities for variety do new information technologies enable?

Answering those questions does not require novel methods. Standard market research and product and process engineering are sufficient. What is new, however, is posing the questions and applying the methods in an integrated way. Furthermore, because markets and technologies are changing constantly, such investigations should be conducted continuously. In short, companies must understand their markets, their operations, their environment, their strengths and their weaknesses — conventional wisdom, perhaps, but following it today requires new modes of thought and action.

ADDITIONAL RESOURCES


REFERENCES


2. For an alternative depiction of mass customization, ibid.


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