How technology can drive the next wave of mass customization

Seven technologies are making it easier to tailor products and services to the wants of individual customers—and still make a profit.

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Consumer choice has increased steadily since Henry Ford's Model T, when buyers could pick any color—as long as it was black. After Ford's single product came standard specifications for different consumer segments, for example, clothes in different sizes and colors. In the last decade or so, we've seen features that allow each shopper to customize his or her product or service with a range of components, for instance, when ordering a car, computer, or smartphone. Such *configured* mass customization is bound to reach ever-greater levels of sophistication.

There's more to come. Now *individualized* customization appears to be within reach. This next wave of mass customization—building a unique product for each customer (for example, custom suits and shirts made to fit your body shape)—has been on the horizon but has proved hard to achieve profitably at scale. Successes have usually come from start-ups or from niche plays by established corporations, and there are many examples of costly failures.

Profitable mass customization of products and services—whether they are ones that are unique for each customer or ones that consumers can configure extensively to their needs—requires success in two broad areas. The first is identifying opportunities for customization that create value for the customer and are supported by smooth, swift, and inexpensive transactions for both consumers and producers. The second is achieving a manageable cost structure and cost level for the producer even as manufacturing complexity increases.

We believe the time for widespread, profitable mass customization may finally have come,

Takeaways

Profitable mass customization appears to be within reach, and companies that seize the opportunity could build loyalty, increase revenue, and gain a competitive advantage.

Seven technologies will help drive the shift—some, such as social technologies and 3-D scanning, increase the value created for consumers; others, like flexible production systems, control costs for producers.

Leaders should work hand in hand with functional managers to craft a business model using these technologies to cost-efficiently serve individual needs.

the result of emerging or improved technologies that can help address economic barriers to responding to consumers' exact needs in a more precise way.

For example, online configuration technologies that can easily and cost-effectively assemble customer's preferences and 3-D digital modeling that lets shoppers envision the final product are becoming increasingly affordable and scalable. In manufacturing, dynamically programmable robotic systems can switch between models and variants with little loss of efficiency.

Other trends also support bets on mass customization. In recent years, hundreds of start-ups have created successful business models for providing customized goods, although not at scale. Moreover, the generation that has grown up with the Internet and its personalized delivery of information and recommendations is likely to demand tech-enabled personalized products.

The benefits for successful companies are compelling, not least for global brands struggling with a decrease in loyalty after the recession and eager to avoid a painful race to the bottom of the cost curve in globalized and standardized product arenas. Mass customization has the potential to help companies increase revenue and gain competitive advantage, improve cash flow, and reduce waste through on-demand production. Mass customization can also generate valuable data that may be used in the development of standard products and in online marketing and public-relations campaigns.

We have identified seven technologies that enable mass customization, make it more practical today, and will drive further advances in the near future. We divided these technologies into two groups that correspond with the success factors identified earlier: those that make it easier to create customization value for the consumer and those that control costs for the producer, despite the challenges of manufacturing complexity.

Creating customization value

To create a sustainable, scaled offering, the value of customization must go beyond the novelty effect and have a functional or aesthetic purpose—usually based on preferences dictated by biology (for example, body shape, DNA, and dietary requirements) or taste (for instance, in design or food). Mass customization has configured and individualized applications across industries, including apparel and health care (Exhibit 1).

Before launching customized products, executives must understand what customers want to individualize and what components they want to configure (such as the type of fabric, the shape of a collar, or the thread attaching buttons) and, consequently, which options should be offered and how they should be priced. What used to entail a costly conjoint analysis to define the solution space can now be done much more easily with the help of new technologies, many of which also make the transactions required for creating customization value smoother, swifter, and less expensive.

Social technologies

Social media and crowdsourcing are by no means new, but they pave the way for better customization options by allowing companies

Exhibit 1
Customization is possible in many industries.

Industry	Example of configured customization	Example of individualized customization
Apparel	Sports shoes with the option of choosing different colors for different elements	Suits/shirts fit to body measurements or scans
Food	Frozen yogurt with custom topping choices	Personalized food and vitamins based on nutritional needs
Consumer electronics	Laptop with choice of color, size of hard drive, and keyboard language	Individualized colors and graphics
Automotive	Vehicle with choice for colors, seats, accessories, and so on	Individualized colors, artwork, and body shapes
Health care	Drug combinations customized for the patient	DNA-based personalized medicine

to analyze the value that consumers attach to existing or proposed components of current or hypothetical "virtual" products. Starbucks does this with frappuccino.com, an inherently social site where the company lets users build their own virtual Frappuccino, with ingredients such as raspberry flavoring and protein powder. This allows Starbucks to measure the popularity of different ingredients as well as popular combinations, such as caramel and whipped cream, before investing in any actual process or ingredient changes in its stores.

By allowing customers to create real and virtual products, companies can in effect use customers as marketers and cocreators. Social technologies empower customers to broadcast their creations to a large network, which is essentially free marketing for the company whose products they are promoting. This is uniquely suited to customized products, as many consumers are proud of their creations. One company that has tapped into this is Adagio Teas, which offers consumers the option to create their own mixtures of tea online; these are then made to order and shipped. If consumers want to, they can offer their tea creation to the public through the site, along with a name and image of their choice—for example, "Jasmine Dream," with an image of the jasmine plant. Every time someone else purchases the creation, the maker receives points, which can be redeemed for Adagio products. Increasingly, many company sites only allow customers to save their custom creations after logging in with their Facebook credentials, which semiautomates the social-sharing process.

Online interactive product configurators

Online configurators are at the heart of the mass-customization trend because they

provide a user-friendly and speedy way to gather a consumer's customization preferences. While online configurators have been around for years, user interaction in the past was limited to selecting a few configuration options in a form. Any advanced configuration was cumbersome and expensive, often requiring a salesperson to discuss options and selections with the customer. Today, advances in product visualization and the increased speed and adaptiveness of configuration software have made product configuration engaging and what many consumers describe as a fun experience.

One example is Shoes of Prey, a website that lets its users configure custom shoes. Users choose from 12 general shoe types, from flat to ankle boot. After selecting a type, different designs for the toe, back, heel, and decorations are offered, with each click automatically updating a preview in the center of the screen. The most engaging part is when users click on the different elements of the shoe to select colors and fabric types. The shoe spins around after every selection, as if to celebrate the choice. A "trending now" page shows a seemingly endless list of shoes that are designed by site users, with several updates every minute, attesting to the fact that users of the site are having fun. Shoes of Prey found that the more sophisticated models of the customized product increased conversion rates online by 50 percent.

3-D scanning and modeling

The shape of real-world objects can be analyzed by 3-D scanners, which collect data that can then be used to construct 3-D digital models. These scanners make it much easier to measure, for example, a human body for individualized products that are tailored to fit. Several companies have created scanning software that gathers exact body measurements in seconds or minutes, which can then be rendered into an online personalized 3-D model. Traditionally, these technologies have been expensive, hard to install, and difficult to roll out at scale. Companies like Styku that perform these scans are now using off-the-shelf technology (for example, Kinect cameras and a Windows 8 tablet) to achieve total hardware costs under $3,000.

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The accuracy of the resulting measurements is often even better than those of hand measuring. Styku has sold a large number of the resulting 3-D measurement terminals to retailers all over the United States.

Another company, the start-up Constrvct, invites consumers to enter their measurements into a form on its website and then generates an online 3-D model showing what a certain dress would look like on their body shape. This reduces some uncertainty on the part of the consumer as to whether a garment would fit well with the customization options selected. Indeed, in the future, 3-D scanning and modeling might move directly into the home, giving consumers the ability to scan themselves, upload the 3-D model, and start ordering clothing "tailor-made" just for them.

Recommendation engines

E-commerce software has for years been able to recommend product choices based on previous selections. Recommendation engines are now moving into the customization space by helping customers configure products.

Chocri, for example, operates a site called createmychocolate.com that customizes and ships chocolate bars, helping consumers configure their own bars from four base chocolates and 100 different toppings. The site tells consumers which spices go well with the base chocolate and main ingredient chosen in the previous step. For a milk-chocolate bar with strawberry bits, for instance, the site recommends cinnamon, roasted almonds, hazelnut brittle, and edible gold flakes. Recommendations are based on popular choices users of the site have made and are edited by the company for taste, thereby reducing the risk the customer takes when ordering a product she or he has never tasted. Chocri estimates that its recommendation engine has increased the rate of conversion from people configuring their own chocolate to an actual online order by more than 30 percent.

Smart algorithms for dynamic pricing

On-demand custom orders can often challenge companies with unpredictable spikes in demand, resulting in long wait times, which in turn are a potential deal breaker for consumers. Some companies are managing on-demand capacity by using smart algorithms and better data-processing capacity to enable dynamic pricing, thereby reducing the time consumers have to wait. A US pizza chain that lets customers configure their own pizzas (rather than offering a limited number of combinations) found that some ingredients take longer to place on the pizza base, such as sliced toppings that need to be placed one by one. In contrast, extra cheese, for instance, can be sprinkled over the pizza in one hand motion. When there is a large backlog of pizzas to be customized, prices on the website are adjusted dynamically: smart algorithms

decrease prices for toppings that are quicker to put on the pizza and increase prices for others, discouraging consumers from choosing those that take longer. This reduces the wait time for those customers and increases customer satisfaction as a result.

Controlling manufacturing costs

Technology has driven and will continue to drive dramatic productivity and flexibility improvements in manufacturing. Modularization of product designs, advanced back-office software, and flexible production technology already have the power to reduce the costs of mass customization.

Enterprise and production software

Traditional technology for enterprise resource planning and supply-chain management (SCM) was designed to enable sales and manage production of a limited variety of products with clearly defined input components. Translating an individualized order from a single customer into a custom picking list and assembly instructions for warehouse and production workers was a big challenge. Now companies like Just in Time Business Consulting and Configure One have developed packaged software that enables tracking of individualized design features in customer orders and their translation into sourcing and production instructions. These tools connect the configurators at the front end with the production and SCM systems. This doesn't only mean that the production staff knows what to assemble; it also means that customers are promised realistic lead times and progress updates and that they are not served up any options for which the components are not in stock. These back-office software changes can thus effectively enable smooth production of vast variety.

Flexible production systems

Flexible manufacturing systems are essential to making small-batch production for mass customization profitable. The automotive industry has been at the forefront of building this flexibility. Ford and General Motors have invested in dynamically programmable robotics with interchangeable tooling that can switch agilely between models and variants with no loss of efficiency. Companies from other industries are adapting these technologies. Caterpillar's production system, for example, cuts out shoe parts according to customers' measurements with an automated, computer-guided cutter.

Furthermore, the advent of 3-D printing is truly changing the way we think of manufacturing. These flexible devices can print objects with materials such as ceramics, metals, and even chocolate. While primarily used

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in prototyping, 3-D printers are making inroads into the mass production of customized objects, such as jewelry, home decoration, and clothing. On Shapeways's site, for example, users can enter a poem or custom text, which is then automatically transformed into a visual of a vase composed of the words. Shapeways then makes a 3-D print of the vase and ships it within a few days. The advances of this technology mean that the primary constraint in adoption will be the creativity of entrepreneurs and leaders in how it is applied. As mind-sets about what is possible change, we expect many more innovative concepts and processes to blossom that accelerate the cost-effective production of customized goods.

And there's more to come. On the horizon, manufacturing, supply-chain, and logistics functions will benefit from the broad penetration of digital sensors and smart tags that will offer greater potential for visibility, flexibility, and control of product flows, as well as for automation of tasks that enhance product value. This is the broad trend toward what is known as the Internet of Things, which blends sensors, standards-based networks, and smart analytics to enable new information architectures for optimizing production. Imagine, for example, products that adapt to their users' habits and usage, or the use of predictive analytics to ensure parts or modules are automatically replenished when they are approaching end of life or failure. The falling cost and growing capabilities of connected sensor-driven systems can make these techniques, applied to expensive equipment such as large turbines today, applicable for consumer goods. Indeed, modular design, coupled with new manufacturing and logistics chains, will allow businesses to break the traditional compromise made between variety and production cost.

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Mass customization has been driven primarily by sales and marketing teams that understand the demand for customized products but can't enable profitable customization on their own. Few large companies have brought the different approaches to customization together across business units and supported them with appropriate technology from the start. True scale in mass customization can only be achieved with an integrated approach where technologies complement one another across a company's various functions to add customization value for the consumer, bring down transaction costs and lead times, and control the cost of customized production (Exhibit 2).

The technology platforms that come together to enable mass customization could rejuvenate stagnant markets and help companies pioneer new opportunities that deliver attractive growth and margins. However, to shape this next wave of mass customization, leaders must work closely with business-unit, IT, and other functional managers to create a new inte-

Exhibit 2
Companies need to make fundamental, coordinated changes across six major business functions to be successful at mass customization.

	Increase value to customer	Control cost of customization
Marketing	• Provide option for customers to market products to their friends in return for store credits	• Provide free marketing by giving customers opportunities to easily share and express their individualization experiences on digital media
Sales	• Turn those in customer-facing roles into customization advisers; turn "stores" into "showrooms" • Use dynamic promotions to manage capacity	• Offer simple and fun online configurators to gather preferences
Product/service development	• Leverage big data and ancillary developers to develop and curate customization options, eg, via social media • Curate "recommended configurations"	• Undertake modular approach in product development • Tightly integrate new-product development with manufacturing/service process design
Manufacturing/service operations	• Implement modular approach with a limited number of standard baseline specs and a menu of options that limits complexity for consumers	• Postpone customization to latest possible point • Build flexibility in low-capital-intensive process steps
Supply chain	• Provide visibility (via radio-frequency identification or scanning) to keep customers invested in "their" creation	• Catalog total cost to serve for each option and manage capacity accordingly
IT infrastructure	• Increase investments in customer-facing, data-warehousing, and data-analytics technologies • Upgrade enterprise-resource-planning and legacy systems to manage additional complexity of product and service attributes • Tightly integrate e-commerce and digital strategy with back-end IT • Support operations with technology that helps control complexity of inputs	

grated business model that can harness the power of new technologies to cost-efficiently serve consumers on the exact needs they have. While many will start with pilots to prove the potential, this shift will require a true commitment to break many established orthodoxies. We believe the rewards will be great for those that lead the change.

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