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Cracking the Code of Mass Customization

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Most companies can benefit from mass customization, yet few do. The key is to think of it as a *process* for aligning a business with its customers' needs.

BY FABRIZIO SALVADOR, PABLO MARTIN DE HOLAN AND FRANK PILLER

THE CONCEPT OF mass customization makes sense. Why wouldn't people want to be treated as individual customers, with products tailored to their specific needs? But mass customization has been trickier to implement than first anticipated, and many companies soured on the approach after a number of high-profile flops, including Levi Strauss & Co.'s failed attempt at manufacturing custom jeans. Now, executives tend to think of mass customization as a fascinating but impractical idea, the preserve of a small number of extreme cases, such as Dell Inc. in the PC market.

Our research suggests otherwise. Over the past decade, we have studied mass customization at a number of different organizations, including a survey of more than 200 manufacturing plants in eight countries. (See "About the Research," p. 72.) From that investigation, we found that mass customization is not some exotic approach with limited application. Instead, it is a strategic mechanism that is applicable to most businesses, provided that it is appropriately understood and deployed. The key is to view it basically as a *process* for aligning an organization with its customers' needs. That is, mass customization is not about achieving some idealized state in which a company knows exactly what each customer wants and can manufacture specific, individualized goods to satisfy those demands — all at mass-production costs. Rather, it is about moving toward these goals by developing a set of organizational capabilities¹ that will, over time, supplement and enrich an existing business.

That set of fundamental capabilities is threefold: (1) the ability to identify the product attributes along which customer needs diverge, (2) the ability to reuse or recombine existing organizational and value-chain resources and (3) the ability to help customers identify or build solutions to their



THE LEADING QUESTION

How can companies benefit from mass customization?

FINDINGS

- ▶ Managers must tailor the process to an existing business — rather than vice versa.
- ▶ Three capabilities are required: (1) identifying the product attributes along which customer needs diverge, (2) reusing or recombining existing resources and (3) helping customers determine or build their own solutions.

ABOUT THE RESEARCH

The findings reported in this article are the results of a number of research projects. The fundamental concepts and ideas come from a large-scale, multi-respondent internal survey of 238 manufacturing plants in eight countries: the United States, Germany, Italy, Sweden, Finland, Spain, Austria and Japan.ⁱ Additionally, this article integrates findings from multiple research projects on mass customization and theoretical insights gained from more than a decade of research on the topic. Multiple methodologies and perspectives were utilized, including experiments,ⁱⁱ a longitudinal three-year case study,ⁱⁱⁱ additional multiple case studies^{iv} and conceptual papers.^v Some of this research is described in two books on the subject.^{vi}

own needs. Admittedly, the development of these capabilities requires changes that are often difficult because of powerful inertial forces in an organization, but that makes the argument more compelling: Those companies that are able to develop the capabilities will be able to enjoy long-lasting competitive advantages. In addition, we believe that many obstacles can be overcome by using a variety of approaches, and that even small improvements can reap substantial benefits. The trick is to remember that there is no one best way to mass customize: Managers need to tailor the approach in ways that make the most sense for their specific businesses.

Understanding Mass Customization

The term “mass customization” was first popularized by Joseph Pine, who defined it as “developing, producing, marketing and delivering affordable goods and services with enough variety and customization that nearly everyone finds exactly what they want.”² In other words, the goal is to provide customers what they want when they want it. Consider the following examples.

Pandora.com relieves people of having to channel-surf through radio stations to find the music they like. Customers submit an initial set of their preferred songs, and from that information the company identifies a broader set of music that fits their preference profile and then broadcasts those songs as a custom radio channel. As of December 2008, Pandora.com had more than 21 million listeners who had created 361 million custom radio stations that play 61 million songs from 60,000 artists every day.

Customers of Bayerische Motoren Werke AG can use an online tool kit to design the roof of a Mini Cooper with their very own graphics or picture, which is then reproduced with an advanced digital printing system on a special foil. The tool kit has enabled BMW to tap into the custom after-sales market, which was previously owned by niche companies. In addition, Mini Cooper customers can also choose from among hundreds of options for many of the car’s components, as BMW is able to manufacture all cars on demand according to each buyer’s individual order.

My Virtual Model Inc., based in Montreal, is changing the very nature of the buying experience.

The software enables consumers to build virtual models, or “avatars,” of themselves that allow them to evaluate (by virtually trying on or using) products from retailers like adidas, Best Buy, Levi’s and Sears. More than 10 million users have already signed up for the service, and the early results are impressive: Land’s End Inc. reports an increase in average order value of 15% and a jump in conversion rate of 45%.

What do these examples have in common? Regardless of product category or industry, they have all turned customers’ heterogeneous needs into an opportunity to create value, rather than a problem to be minimized, challenging the “one-size-fits-all” assumption of traditional mass production. To reap the benefits of mass customization, though, managers need to think of it not as a stand-alone business strategy for replacing production and distribution processes but as a set of organizational capabilities that can help a company better align itself with its customers’ needs.

Three Capabilities Required

Of course, any approach to mass customization must take into account various factors that are either industry or product specific. But through our research we have identified three common capabilities that will determine the fundamental ability of a company to mass-customize its offerings. (See “Three Fundamental Capabilities.”)³

1. Solution Space Development A mass customizer must first identify the idiosyncratic needs of its customers, specifically, the product attributes along which customer needs diverge the most. (This is in stark contrast to a mass producer, which must focus on serving universal needs that are ideally shared by all target customers.) Once that information is known and understood, a business can define its “solution space,” clearly delineating what it will offer — and what it will not. Obviously, correlating heterogeneous customer needs with differentiated product attributes, validating product concepts and collecting customer feedback can be costly and complex, but several approaches can help.

The first is to provide customers with a software design tool like a CAD system but with an easy-to-use interface and a library of basic modules and functionalities. Using so-called innovation tool kits, customers

can by themselves translate their preferences directly into a product design, highlighting unsatisfied needs during the process. The resulting information can then be evaluated and potentially incorporated by the company into its solution space. When Fiat S.p.A. was developing its retro, award-winning Fiat 500, for example, the automaker created Concept Lab, an innovation tool kit that enabled customers to express their preferences freely regarding the interior of the car long before the first vehicle was built. The company received more than 160,000 designs from customers — a product-development effort that no automaker could replicate internally. And Fiat allowed people to comment on others' submissions, providing a first evaluation of those ideas. Of course, mass producers can also benefit from innovation tool kits, but the technology is particularly useful for mass customization because it can be deployed at low cost for large pools of heterogeneous customers; in other words, scalability is the key here.⁴

After a company has collected data about its customers' needs, it has to interpret and render that information in the form of product concepts that customers can then review. But the sheer number of prototype variants that might be generated can make the process daunting. Consequently, some companies have implemented an approach called "virtual concept testing."⁵ Take, for example, adidas AG, which used to produce more than 230,000 footwear samples every season to sell an assortment of 55 million sneakers distributed among more than 10,000 SKUs. But through the use of My Virtual Model technology, adidas has been able to replace many of the physical prototypes with virtual ones that merchandisers can then sample on their virtual models. As a result, adidas expects to save millions of dollars each season.

In developing a solution space, companies should consider incorporating data not just from current and potential customers but also from those who have taken their business elsewhere. Consider, for example, information about products that have been evaluated but not ordered. Such data can be obtained from log files generated by the browsing behavior of people using online configurators. By systematically analyzing that information, managers can learn much about customer preferences, ultimately leading to a refined solution space.

A company could, for instance, eliminate options that are rarely explored or selected, and it could add more choices for the popular components. In addition, customer feedback can even be used to improve the very algorithms that a particular application deploys. When someone skips a song that Pandora.com has suggested, for example, that information is not just used to provide better personalization of the music stream for that particular individual. It is also aggregated with similar

THREE FUNDAMENTAL CAPABILITIES

Mass customization requires three fundamental capabilities: solution space development, robust process design and choice navigation. Various tools and approaches are available to help companies develop those capabilities.

CAPABILITY	APPROACHES TO DEVELOP CAPABILITIES
Solution Space Development Identify the product attributes along which customer needs diverge	Innovation tool kits: Software that enables large pools of customers to translate their preferences into unique product variants, allowing each customer to highlight possibly unsatisfied needs. Virtual concept testing: An approach for efficiently submitting scores of differentiated product concepts to prospective customers via virtual prototype creation and evaluation. Customer experience intelligence: A tool for continuously collecting data on customer transactions, behaviors or experiences and analyzing that information to determine customer preferences.
Robust Process Design Reuse or recombine existing organizational and value-chain resources to fulfill a stream of differentiated customers needs	Flexible automation: Automation that is not fixed or rigid and can handle the customization of tangible or intangible goods. Process modularity: Segmenting existing organizational and value-chain resources into modules that can be reused or recombined to fulfill differentiated customers' needs. Adaptive human capital: Developing managers and employees who can deal with new and ambiguous tasks.
Choice Navigation Support customers in identifying their own solutions while minimizing complexity and the burden of choice	Assortment matching: Software that matches the characteristics of an existing solutions space (that is, a set of options) with a model of the customer's needs and then makes product recommendations. Fast-cycle, trial-and-error learning: An approach that empowers customers to build models of their needs and interactively test the match between those models and the available solutions. Embedded configuration: Products that "understand" how they should adapt to the customer and then reconfigure themselves accordingly.

Skepticism of mass customization is partly a consequence of how the concept has often been oversimplified and vulgarized.

feedback from millions of other customers to prevent the system from making that kind of incorrect recommendation in the future.

2. Robust Process Design A mass customizer also needs to ensure that an increased variability in customers' requirements will not significantly impair the company's operations and supply chain.⁶ For this, the business needs a robust process design — the capability to reuse or recombine existing organizational and value-chain resources — to deliver customized solutions with near mass-production efficiency and reliability. But how can companies reach that state?

One possibility is through flexible automation. Although the words “flexible” and “automation” might have been contradictory in the past, that's no longer the case. In the auto industry, robots and automation are compatible with previously unheard-of levels of versatility and customization. Even process industries (pharmaceuticals, food and so on), once synonymous with rigid automation and large batches, now enjoy levels of flexibility once considered unattainable. Similarly, many intangible goods and services also lend themselves to flexible automated solutions, frequently based on the Internet. In the case of the entertainment industry, increasing digitalization is transferring the entire product delivery system from the real to the virtual world.

A complementary approach to flexible automation is process modularity, which can be achieved by thinking of operational and value-chain processes as segments, each one linked to a specific source of variability in the customers' needs.⁷ As such, the company can serve different customer requirements by appropriately recombining the process segments, without the need to create costly ad-hoc modules. BMW's Mini factory, for instance, relies on individual mobile production cells with standardized robotic units. BMW can integrate the cells into an existing system in the plant within a few days, thus enabling the company to adapt quickly to unexpected swings in customer preferences without extensive modifications of its production areas. Process modularity can also be applied to service industries. International Business Machines Corp., for example, has been redesigning its consulting unit

around configurable processes (called “engagement models”). The objective is to fix the overall architecture of even complex projects while retaining enough adaptability to respond to the specific needs of each client.

To ensure the success of robust process designs, companies need to invest in adaptive human capital. Specifically, employees and managers have to be capable of dealing with novel and ambiguous tasks to offset any potential rigidity that is embedded in process structures and technologies. After all, machines aren't capable of determining what a future solution space will look like. That task clearly requires managerial decision making, not software algorithms. Capital One Financial Corp., for example, rightly recognizes that its business developers are the brains of its mass-customization business. These individuals are not ordinary employees: They are screened for special skills and attitudes that Capital One has identified as crucial for the position.

3. Choice Navigation Lastly, a mass customizer must support customers in identifying their problems and solutions while minimizing complexity and the burden of choice.⁸ It is important to remember that when a customer is exposed to myriad choices, the cost of evaluating those options can easily outweigh the additional benefit from having so many. The resulting syndrome has been called the “paradox of choice,” in which too many options can actually reduce customer value instead of increasing it.⁹ In such situations, customers might postpone their buying decisions and, worse, classify the vendor as difficult and undesirable. To avoid that, a company can provide choice navigation to simplify the ways in which people explore its offerings.

One effective approach is “assortment matching,” in which software automatically builds configurations for customers by matching models of their needs with characteristics of existing solution spaces (that is, sets of options). Customers then only have to evaluate the configurations, which saves considerable effort and time in the search process. Using the My Virtual Model software, for example, customers build avatars of themselves by selecting different body types, hair styles, facial characteristics and so on. From that information, the system can then

recommend items out of the full assortment of a given online merchant.¹⁰

But customers might not always be ready to make a decision after they've received recommendations. They might not be sure about their real preferences, or the recommendations may not appear to fit their needs or taste. In such cases, software that incorporates fast-cycle, trial-and-error learning can help customers interactively conduct multiple sequential experiments to test the match between the available options and their needs. Consider the online shoppers at 121Time.com, a leading provider of mass-customized Swiss watches. Those consumers might have a general idea of what they want, but while using an online configurator to play around with various options, combining colors and styles, they can actually see how one choice influences another and affects the entire look of a watch. Through that iterative process, they learn about their own preferences — important information that is then represented in subsequent configurations.

Other companies are pushing the boundaries of choice navigation even further by completely automating the process. Take, for instance, recent products that “understand” how they should adapt to the customer and then reconfigure themselves accordingly. Equipped with so-called embedded configuration capability, these products might be standard items for the manufacturer but, paradoxically, the user experiences a customized solution. Such is the case with the Adidas 1, a running shoe equipped with a magnetic sensor, a system to adjust the cushioning and a microprocessor to control the process. When the shoe's heel strikes the ground, the sensor measures the amount of compression in its midsole and the microprocessor calculates whether the shoe is too soft or too firm for the wearer. A tiny motor then shortens or lengthens a cable attached to a plastic cushioning element, making it more rigid or pliable.

A Journey, Not a Destination

Many managers have rejected mass customization outright, simply on the preconception that it won't work in their business. Of course, mass customization should never be implemented without a critical eye, and this approach is not a universal solution. But



the widespread skepticism is partly a consequence of how the concept has often been oversimplified and vulgarized. Specifically, it has frequently been portrayed in terms of an “ideal state” in which a company knows perfectly how to perform several Herculean tasks: thoroughly understand what its customers' preferences are, completely mitigate the trade-offs between product variety and performance, simplify the way its offerings are presented and produce customized items at mass-production costs. Achieving that ideal state is impossible and even the so-called champions of mass customization have fallen short. Dell, for one, requires a sophisticated call center to assist customers who have trouble configuring a personal computer online. And if the company has indeed achieved perfect mass customization, why does it charge exaggerated prices for options that fall outside its well-defined mass-purchasing agreements with suppliers?

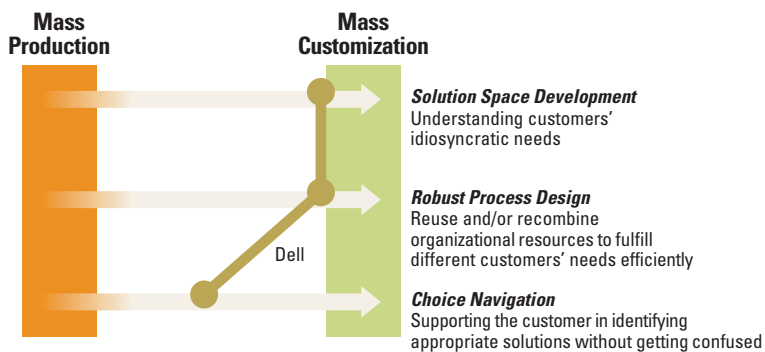
So the question then becomes, what does mass customization really mean in practice? We believe that managers should think of the implementation of mass customization as a process, akin to moving along a continuum whose limits are mass production at one end and the ideal state of mass customization at the other. A company's location on that spectrum is determined by the three criteria discussed earlier: solution space development, robust process design and choice navigation. (See “The Mass Production-Mass Customization Continuum,” p. 76.) When implementing mass

customization, a company might decide to improve all three capabilities simultaneously, or it could focus on one or two of them as a priority, depending on the state of technology and competition in its industry.

In other words, mass customization is a process rather than a destination — a process that can reap significant benefits even if an organization remains

THE MASS PRODUCTION-MASS CUSTOMIZATION CONTINUUM

Managers should think of mass customization as a process in which a company moves away from mass production toward mass customization by building three organizational capabilities (solution space development, robust process design and choice navigation). During that process, a company might decide to improve all three capabilities simultaneously or, rather, to prioritize one or two of them. Dell, for instance, has perfected its capability to define its solution space and to set up very robust processes, but the company now needs to improve its choice navigation. Currently, Dell customers need to know pretty clearly which computer they want ahead of time, whereas many would benefit from having a recommendation system that would lead them to the best product based on their individual personal needs.



far from the “pure” ideal of the approach. So, rather than trying to achieve some state of idealized perfection, the goal for companies should be to improve continually their solution space development, robust process design and choice navigation. Even small improvements can enable businesses to attain some strategic differentiation and competitive advantage, and success in one area can help build momentum for changes in another.

Consider American Power Conversion Corp., a leading manufacturer of network and data center equipment. APC has been relentlessly improving its value chain for more than a decade, progressing from its traditional (and costly) engineering-to-order model and moving toward mass customization. The journey started with the development of module-

based products, followed by the use of a configurator in sales and order processing. Then the company began mass production of standard components in the Far East, with final assembly (per a customer’s order) at various sites around the world. The results: Delivery time for a complete system has plunged from 400 to 16 days, costs have decreased and product innovation has improved.¹¹ Now the company is trying to apply the same mass-customization principles to its after-sales services, which are a major source of revenues and profits.

Overcoming Powerful Inertia

The success of companies like APC notwithstanding, executives should never underestimate the challenges of implementation. Take, for instance, Deere & Co., one of the world’s largest manufacturers of garden equipment. To keep up with its market for premium products, which had been evolving toward greater fragmentation and customization for more than a decade, John Deere’s lawn and garden equipment division began to offer more products, but that then resulted in a proliferation of parts and processes. Divisional managers were aware of this, and they knew that they could save millions of dollars every year by simplifying their product platforms. Yet they stubbornly resisted the change. In fact, it took Deere more than a decade to realign its solution space to the customer base and to add flexibility to its value chain. And this happened only after the very survival of the business was at stake. In our research, we were repeatedly amazed at the difficulty companies had in achieving even just moderate improvements along the three fundamental capabilities of mass customization. Managers typically had to overcome powerful inertial forces in the organization, with the strongest resistance tending to come from the following areas:¹²

Marketing Focus For mass producers, the focus of the marketing group is not about spotting differences among customer needs; it’s about identifying and exploiting commonalities. Consequently, traditional marketers often lack the appropriate knowledge and tools required by a mass customizer and, when faced with the addition of more variety in product lines, are likely to (1) rely unimaginatively on outdated product differentiation criteria that were successful in the past

or (2) mimic differentiating attributes introduced by competitors. Either approach will likely fail to tap into unexploited customers' heterogeneities.

Accounting Procedures With mass production, detailed accounting procedures are not required to compute and allocate to specific product offerings the portion of manufacturing and engineering overhead that results from parts proliferation, simply because there is little or no variety. Consequently, such organizations will often have trouble determining the precise cost implications of expanding their product offerings, and they can fail to appreciate the advantages of parts standardization. When that happens, costs can easily spiral out of control.

Design Culture In mass production, the emphasis during product development is on design uniqueness or on minimizing the variable cost of newly developed components. This leads to designs of maximal uniqueness or the use of ad hoc parts with minimal cost. With mass customization, the focus is instead on designs that have synergy with other designs, that is, designs that share parts and processes as part of the solution space.

Investment Criteria The dominant investment logic for a mass producer is the quest for economies of scale, which tends to favor rigid fixed assets that are unlikely to fit mass customization. This problem is exacerbated by the "sunk costs" syndrome: Managers will often resist divesting an investment they made in the past, even if it's no longer appropriate.

Value-Chain Constraints Reconfiguring a value chain that was originally conceived for volume production in order to accommodate a variable product mix can present a number of problems. An existing corporate purchasing policy, for example, can make it difficult for a division to select a new base of suppliers. Moreover, external structural constraints within supply and distribution channels can also pose significant obstacles.

Customizing Mass Customization

One of the biggest lessons from our research is that there is no one best way to mass-customize, and trying to copy successful companies like Dell can

lead to serious failures. Take, for example, the widespread belief that mass customization entails building products to order. That is not always true. As discussed earlier, customers are looking for products that fit their needs, and they do not necessarily care whether those offerings are physically built to their order or whether those items come from a warehouse — just as long as their needs are fulfilled at a reasonable price. Consider Sears Holdings Corp. and its multibillion-dollar online business that uses avatars and style-matching technology to help customers browse through countless products, including kitchen appliances and furniture. Sears focuses on personalizing the shopping experience but not its products, and the results at some business units have been impressive: double-digit increases in the average order value.

The fundamental message is that a company should "customize its mass-customization strategy"¹³ based on the requirements of its customer base, the state of the competition and the technology available. It should not blindly use successful mass customizers as templates to copy. After all, mass customization is fundamentally not about standard practices; it is about an entrepreneurial endeavor that is broadly applicable to any business for which customers might be willing to pay for tailored solutions or experiences. Indeed, the time has come to view mass customization as a strategic mechanism to align an organization with its customers' needs by deploying three critical capabilities. Ultimately, the challenges of mass customization suggest a potential strategic value of those three capabilities — after all, what is hard to develop will be difficult to copy, and as such the capabilities can be a powerful source of sustainable competitive advantage.

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