Cracking the Code of Mass Customization

Most companies can benefit from mass customization. The key is to think of it as a process for aligning an organization with its customers' needs.

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The concept of mass customization makes business 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' botched attempt at manufacturing custom jeans. Before long, mass customization was tagged as nothing but an unattainable business fad, more hype than substance. Executives now tend to think of mass customization as a fascinating but impractical idea, the preserve of a small number of extreme cases, such as Dell in the PC market.

Our research suggests otherwise. Over the past decade, we have studied mass customization at different organizations, including a survey of more than 200 manufacturing plants in eight countries (see "About the Research"). 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 its customers want and can manufacture specific, individualized goods to satisfy those demands -- all at mass-production costs. Rather, it is about moving towards these goals by developing a set of organizational capabilities[1] that will, over time, supplement and enrich an existing business.

Mass customization requires a business to develop three fundamental capabilities: 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 own needs. Admittedly, the development of these capabilities mandates for organizational changes that are often difficult because of powerful inertial forces with a company, but that makes the argument more compelling: those who are able to develop these capabilities will be able to enjoy long-lasting competitive advantages. In addition, we believe that these 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 customize 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 Pandora's Box 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 21.5 million listeners who created 361 million radio stations and played every day 61 million songs from 60,000 artists.
- BMW customers can use an online toolkit 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 toolkit 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 BWM is able to manufacture all cars on-demand according to each buyer's individual order.
- MyVirtualModel, based in Montreal, is changing the very nature of the buying experience. The software enables consumers to build a virtual model, or "avatar," of themselves that allows them to evaluate (by virtually trying on or using) products from retailers like Adidas, Best Buy, Levis and Sears. More than 10 million users have already signed up for the service, and the early results are impressive: Land's End 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 enrich the portfolio of capabilities of their organizations.

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]

CAPABILITY	APPROACHES TO DEVELOP CAPABILITIES
Solution Space Development: Identify the product attributes along which customer needs mostly diverge	• Innovation toolkits: 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. • Customers experience intelligence: 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 the 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 own 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.

Exhibit: Three Fundamental Capabilities

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, ideally shared by all the 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, understanding heterogeneous customer needs in terms of spotting differentiating attributes, validating product concepts and collecting customer feedback can be a costly and complex endeavor, 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 toolkits," 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 was developing its retro, award-winning Fiat 500, for example, the automaker created Concept Lab, an innovation toolkit that enabled customers to freely express their preferences regarding the interior of the car long before the first vehicle had been 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 toolkits 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 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 that process a daunting task. As such, some companies have deployed an approach called "virtual concept testing."[5] Adidas, for example, used to produce more than 230,000 footwear samples every

season in order to sell an assortment of 55 million sneakers distributed among more than 10,000 SKUs. But through the use of MyVirtualModel technology, Adidas was able to replace many of the physical with virtual prototypes that merchandisers could then sample on their virtual models. The result: Adidas expects millions of dollars of savings each season.

In developing a solution space, companies should consider incorporating data not just from customers but also from people who might have taken their business elsewhere. Consider, for example, information about products that someone has evaluated but did not order. 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's Box 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 feedback from millions of other customers to prevent the system from making that kind of incorrect recommendation in the future.

2. Robust Process Design. Next, a mass customizer needs to ensure that an increased variability in customers' requirements will not significantly impair the firm's operations and supply chain.[6] This can be achieved through 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, nowadays enjoy levels of flexibility once considered unattainable. Similarly, many intangible goods and services also lend themselves to flexible automated solutions, oftentimes based on the Internet. In the case of the entertainment industry, increasing digitalization is turning the entire product system over 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 quickly adapt to unexpected swings in customer preferences without extensive modifications of its production areas. Process modularity can also be applied to service industries. IBM, 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 a 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 in order to offset any potential rigidness 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, for example, rightly recognizes that 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. Our research revealed that, for example, individuals need a broad knowledge base that stretches beyond their immediate functional specialization, in order to be able to proficiently interact with other functions in the process of identifying and delivering tailored solutions to the customer. Such broad knowledge base has to be complemented with relational attitudes that allow the individual to easily connect with other employees on an ad-hoc basis.

3. Choice Navigation Lastly, a mass customizer must support customers in identifying their own 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 alternatives. 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 what we labeled "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). Then customers only have to evaluate the configurations, which saves considerable effort and time in the search process. Using the MyVirtualModel 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 vast assortment of an 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. In such cases, software that incorporates fast-cycle, trial-and-error learning can help. Thanks to this mechanism, customers can engage in multiple sequential experiments to test the match between the available options and their needs. Consider 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.

A number of companies are engaging in even more innovative and drastic approaches to choice navigation. Choice navigation has been completely automated in recent products that “understand” how they should adapt to the user and then reconfigure themselves accordingly. Equipped with so-called “embedded configuration capability,” the products paradoxically become standard items for the manufacturer while the user experiences a customized solution. Such is the case with Adidas One, 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 mid-sole 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 outright rejected mass customization 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 on-line. And if the company had 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"). 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.

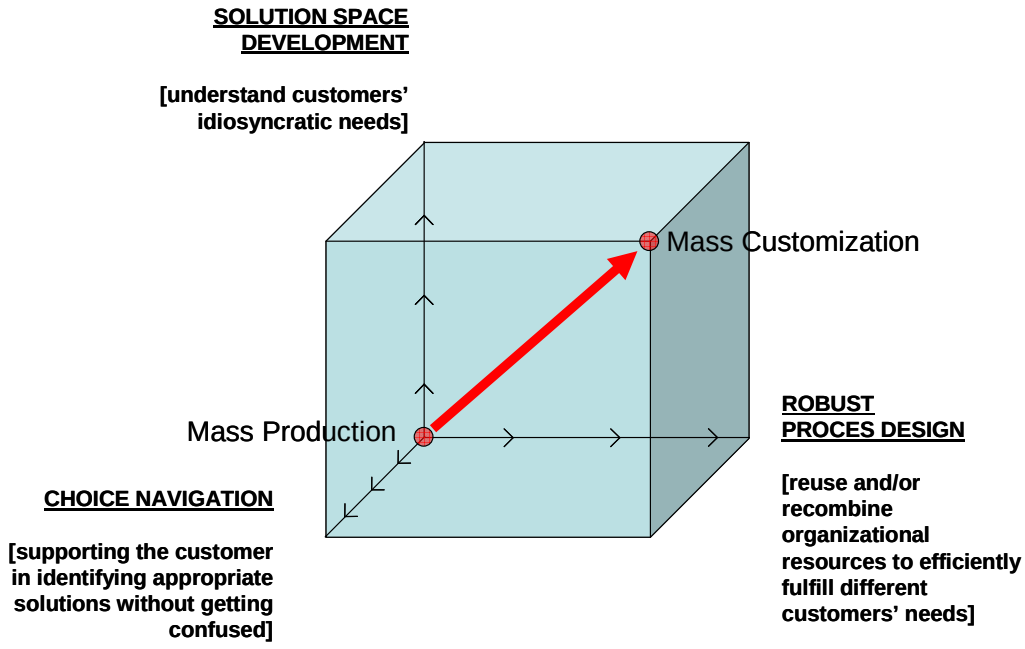

Exhibit: The Mass Production - Mass Customization Continuum

In other words, mass customization is a process rather than a destination – a process that can reap significant benefits even if an organization remains 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 continually improve 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, a leading manufacturer of datacenter and network equipment. The company has been relentlessly improving its value chain for over a decade, progressing from its traditional (and costly) engineering-to-order model towards 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] But American Power Conversion keeps refining its mass customization capabilities. Now the company is trying to apply the same mass-customization principles to its after-sales services, which is a major source of revenues and profits.

Overcoming Powerful Inertia

The success of companies like American Power Conversion notwithstanding, executives should never underestimate the challenges of implementation. Take, for instance, John Deere, one of the world's largest manufacturers of garden equipment. To keep up with its market for premium products, which had been evolving towards greater fragmentation and customization for more than a decade, the company 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 John 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 that 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; it's about identifying and exploiting needs that are similar. Consequently, traditional marketers often lack the appropriate knowledge and tools required by a mass customizer and, when urged to add more variety to their product lines, are likely to 1) unimaginatively rely on 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 At a mass producer, accounting procedures do not need to accurately 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 With 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 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 supplier 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. This is not necessarily 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, for example, Sears Holding, a 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 its 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 the organization with 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.

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 across 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, v, vi] and conceptual papers.[vii, vii, ix] Some of this research is described in two books on the subject.[x, xi]

i. F. Salvador, M. Rungtusanatham, A. Akpinar A. and C. Forza, "Strategic Capabilities for Mass Customization," under revision at the Journal of Operations Management. (Note: A shortened version of the article is included in the 2008 Academy of Management Best Paper Proceedings.)

ii. N. Franke and F. Piller, "Value Creation by Toolkits for User Innovation and Design: The Case of the Watch Market," Journal of Product Innovation Management 21, no. 6 (2004): 401-415.

iii. M. Rungtusanatham and F. Salvador, "Transitioning from Mass Production to Mass Customization – Hindrance Factors, Structural Inertia and Transition Hazard," forthcoming in Production and Operations Management.

iv. S. Ogawa and F.T. Piller, "Reducing the Risks of New Product Development," MIT Sloan Management Review 47, no. 2 (2006): 65-71.

v. P. Martin de Holan, N. Phillips and T. Lawrence, "Managing Organizational Forgetting," Sloan Management Review 46, no. 4 (2004): 45-51.

vi. F. Salvador, C. Forza and M. Rungtusanatham, "Modularity, Product Variety, Production Volume and Component Sourcing: Theorizing Beyond Generic Prescriptions," Journal of Operations Management 20, no.5 (2002): 549-575.

vii. F. Salvador, "Towards a Product Modularity Construct: Literature Review and Reconceptualization," IEEE Transactions on Engineering Management 54, no. 2 (2007): 219-240.

viii. F. Piller, "Mass Customization: Reflections on the State of the Concept," International Journal of Flexible Manufacturing Systems 16, no. 4 (2005): 313-334.

ix. F. Piller, K. Moeslein and C. Stotko, "Does Mass Customization Pay?" Production Planning & Control 15, no. 4 (2004): 435-444.

x. C. Forza and F. Salvador, Information Management for Mass Customization: Connecting Customer, Front-end and Back-end for Fast and Efficient Personalization (London: Palgrave MacMillian, 2007).

xi. M.M. Tseng and F.T. Piller, The Customer Centric Enterprise: Advances in Mass Customization and Personalization (New York: Springer, 2003).

REFERENCES

[1] For a definition of the concept of strategic capabilities, refer to K.M. Eisenhardt and J.A. Martin, "Dynamic Capabilities: What Are They?" Strategic Management Journal 12, no. 10 (2000): 1105-1121.

[2] J.B. Pine, II, Mass Customization -- The New Frontier in Business Competition (Cambridge, Mass.: Harvard Business School Press, 1993).

[3] Paul Zipkin discussed some of the capabilities of mass customization in an earlier article, P. Zipkin, "The Limits of Mass Customization," Sloan Management Review 42, no. 3 (2001): 81-87. The derivation of the three fundamental capabilities builds on work by F. Salvador, M. Rungtusanatham, S. Akpinar and C. Forza, "Strategic Capabilities for Mass Customization: Theoretical Synthesis and Empirical Evidence," Academy of Management Best Paper Proceedings (2008).

[4] Spotting untapped differences across customers is not an easy task because information about customers' unfulfilled needs is "sticky" – that is, difficult to access and codify for the solutions provider. While this problem is shared by both mass producers and mass customizers, it is more demanding for the latter because of the extreme fragmentation of customers' preferences. The notion that the need information of customers is sticky has been discussed extensively by Eric von Hippel. See E. von Hippel, "Economics of Product Development by Users: The Impact of 'Sticky' Local Information," Management Science 44, no. 5 (1998): 629-644. Ogawa and Piller discuss the resulting problems in S. Ogawa and F.T. Piller, "Reducing the Risks of New Product Development, MIT Sloan Management Review 47, no. 2 (2006): 65-71.

[5] Virtual concept testing has been described in E. Dahan and J.R. Hauser, "The Virtual Customer," Journal of Product Innovation Management 19, no. 5 (2002): 332-353.

[6] J.B. Pine, II, J.H. Gilmore and A.C. Boynton, "Making Mass Customization Work," Harvard Business Review 71, no. 5 (1993):108-118.

[7] Pine et al., "Making Mass Customization Work."

[8] The problem of burden of choice in mass-customization systems was described first in C. Huffman and B.E. Kahn, "Variety for Sale: Mass Customization or Mass Confusion?" Journal of Retailing 74, no. 4 (1998): 491-513. Franke and Piller looked at this challenge in an empirical study described in N. Franke and F. Piller, "Value Creation by Toolkits for User Innovation and Design: The Case of the Watch Market," Journal of Product Innovation Management 21, no. 6 (2004): 401-415.

[9] R. Desmueles, "The Impact of Variety on Consumer Happiness: Marketing and the Tyranny of Freedom," Academy of Marketing Science Review 12 (2002).

[10] Consider another example of matching: Zafu.com has created a very profitable business model by taking body measurements of customers and then recommending the best-fitting pair of jeans out of the existing assortments of many major brands. From their users' perspective, Zafu is offering a product that fits like a tailor-made jeans. But from the fulfillment perspective, Zafu is just matching standard inventory with individual needs.

[11] The APC case has been documented by Lars Hvam in L. Hvam, "Mass Customization in the Electronics Industry," International Journal of Mass Customization 1, no. 4 (2006): 410-426.

[12] M. Rungtusanatham and F. Salvador, "Transitioning from Mass Production towards Mass Customization: Hindrance Factors, Structural Inertia and Transition Hazard," Production and Operations Management 17, no. 3 (2008): 385-396.

[13] The advice was suggested by Lampel and Mintzberg in J. Lampel and H. Mintzberg, "Customizing Customization," MIT Sloan Management Review 38, no. 1 (1996): 21-30.