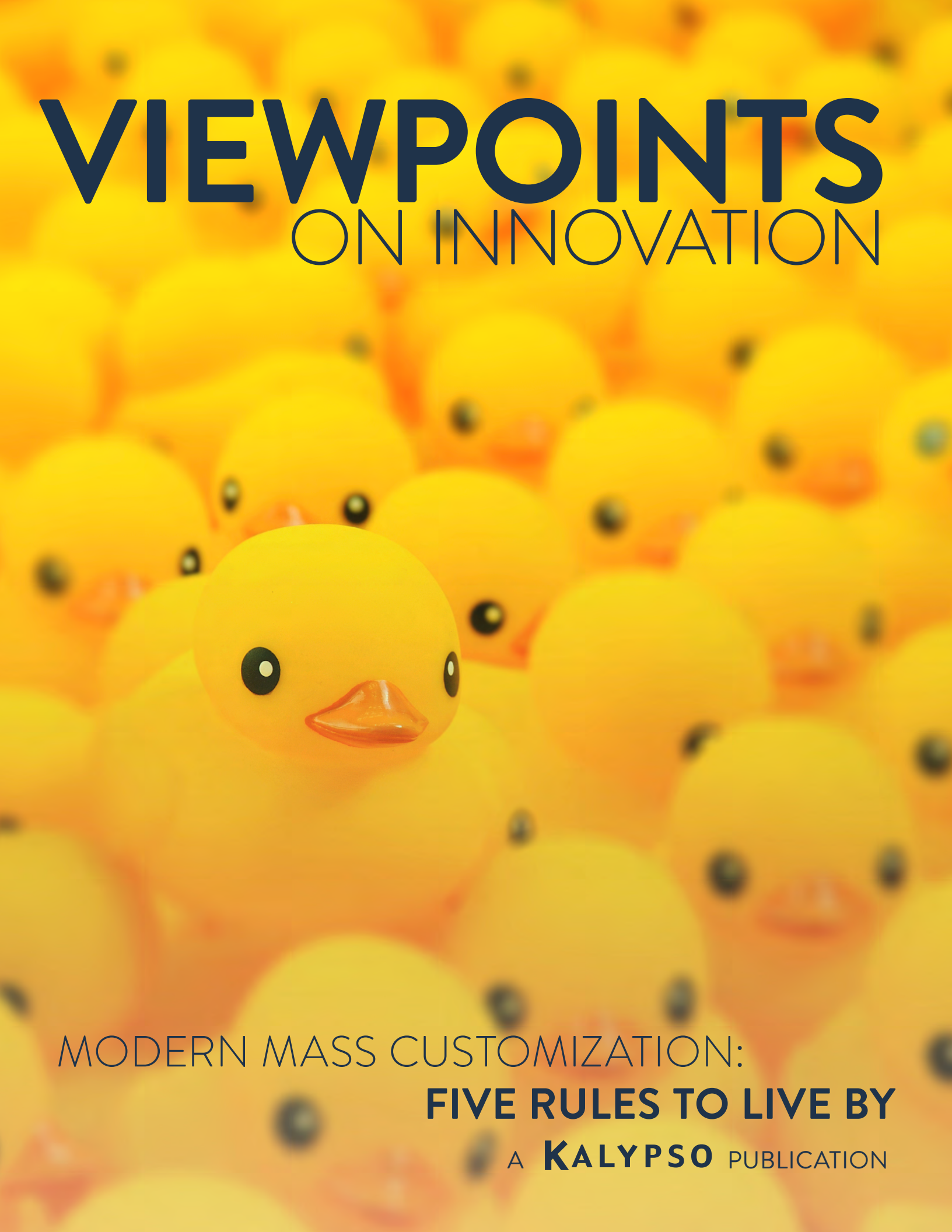
VIEWPOINTS
ON INNOVATION



MODERN MASS CUSTOMIZATION:

FIVE RULES TO LIVE BY

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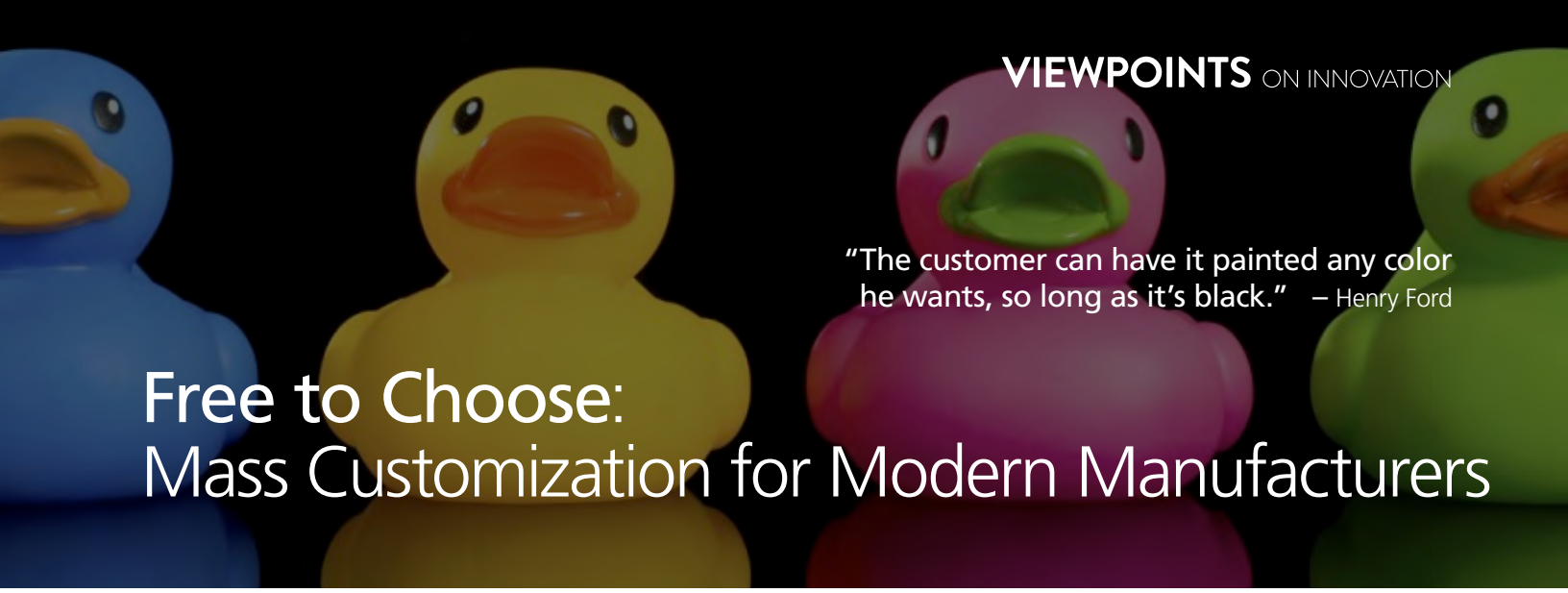
Modern Mass Customization: Five Rules to Live By



"The customer can have it painted any color he wants, so long as it's black." – Henry Ford

Free to Choose: Mass Customization for Modern Manufacturers

by Jordan Reynolds

This famous remark from Henry Ford circa 1909, in reference to his line of Model-T automobiles, captures the nature of product development in the late industrial revolution. In an age when automobiles were perceived as a futuristic luxury for the affluent, Ford recognized that the average consumer was likely to be enthused with low prices offered by economies of scale, rather than a more expensive product that fit their unique needs. Ford set out to "build a car for the great multitude," and reached this goal with great success through a production model that minimized variation while maximizing efficiency. Ford's method of producing "for the great multitude" is appropriately acknowledged today as mass production.

The mass production strategies put forth by the titans of the 20th century still resonate today on manufacturing floors, in business processes, and the systems that support them, like Product Lifecycle Management (PLM). Personalization and production efficiency have long been believed to be on the opposite ends of a continuum; mutually exclusive benefits that manufacturers and consumers are forced to choose between. In the last decade, however, innovative companies in a broad range of industries have shattered this dichotomy.

To get started, manufacturers should consider current challenges, historical approaches and the potential benefits of a modern mass customization model.

The Challenge for Modern Manufacturers

Demand for configurability and personalization is growing in the marketplace and presents a threat to traditional mass production techniques. The Smart Customization Group at MIT estimates that by the year 2020, 15 percent of the clothing Americans buy will be customized for fit, color and style. Clayton Christensen, Professor of Business Administration at Harvard Business School and author of the Innovators Dilemma, predicts wholesale bankruptcy among standard universities in the next decade, as highly customized online learning programs rapidly build market share. Food manufacturers like MyMuesili and YouBar offer customers the opportunity to design products that fit their own personal dietary restrictions.

Discrete manufacturing is no exception: automotive customers can mock up their dream ride using a simple design application on the company's website or a smart phone app. Desktop and notebook computers are highly customizable for features and appearance. One has only to look as far as their kitchen cabinets and countertops to see custom design in action.

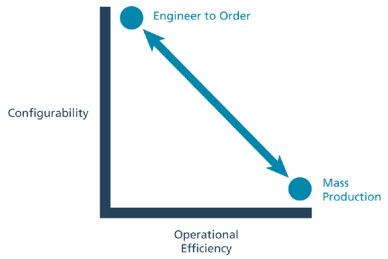
It's easy to see that customer collaboration in the design process is quickly becoming the norm, but manufacturers today still face a difficult question: "How can I improve my customer focus by offering highly configurable products, while maintaining the operating efficiency of a mass-production model?"

Historical Approaches to Customization

Companies have taken a number of different approaches to solving this problem. Some negotiate contracts, estimate cost and effort, and assign engineering resources to develop products directly for customers. This model is known as Engineer-to-Order (ETO) and is prevalent today in construction, aerospace and defense. While appropriate for many companies, ETO falls short for a number of reasons. Since products derived from an ETO model are unique to each order, the engineering processes and work plans used to develop these products are unique as well. This lack of predictability is heavy on operating costs, and usually requires extensive engineering attention on a per-order basis, limiting time spent on innovation and new product development. Aside from a few outliers, manufacturers that operate with a pure ETO model are accustomed to thin margins and creative stagnation.

Other companies attempt to tweak the mass production model by pre-configuring a set of product variants, and mass-producing each variant. This model is not without its shortcomings. To produce predictably and efficiently, the number of variations must be strictly limited. A company whose customers' needs are unpredictable, or require a substantial number of product variations, may find that pre-defining a massive number of bills of material (BOM) combinations can be difficult or impossible.

Most companies that strive to offer product configurability are stuck somewhere on a spectrum of tradeoff between customer centricity and operational efficiency:



A third idea, foreshadowed by Stan Davis' in his 1987 book Future Perfect, is growing today in innovative products ranging from automobiles and semiconductors to designer handbags and nutrition bars. Mass customization, as Davis branded it, describes the process of "producing goods and services to meet individual customer's needs with near mass-production efficiency."

Here's a modern, practical twist on Davis' definition: mass customization means developing a product architecture, within which an indeterminate number of products variants can be configured dynamically by the customer at the point of sale, and with minimal engineering intervention.

Benefits of a Modern Mass Customization Model

As the product of a marriage between mass-production and ETO, mass customization allows businesses to inherit the dominant traits of each: high efficiency paired with a high degree of customer focus.

The business opportunities inherent in this solution quickly stand out:

Customer satisfaction

Delivery times are shortened, extraneous features are reduced, and the utility offered to each individual customer is maximized. A mass customization strategy can help to ensure accurate quotes, lead times, and interpretation of customer requirements.

Shareholder value

Products that are configured to meet unique customer needs have the potential to reach a broader audience, and have a greater range of application than those that are mass-produced. This offers manufacturers the chance to increase the footprint of their products and expand sales. Additionally, an enterprise optimized for mass customization ensures that the costs of order fulfillment are minimized.

Innovation

By removing your engineering resources from solving order fulfillment problems, they are available for new product development, innovative R&D projects, and designing new configuration options for the products in your existing portfolio. The cost of capital is reduced through effective product development.

Mass customization also creates an interface between the manufacturer and the customer, enabling collaboration and open innovation.

Mass customization presents an enticing promise, but as a manufacturing trend it is still in its infancy, and companies may find that the availability of industry testimonials and academic research is under-developed.

Many companies ambitiously venture into mass customization implementations only to find that their enterprise technology is configured precisely to a mass production model. For manufacturers who choose to champion the virtue of consumer choice, please stay tuned for a series of blog posts on five rules to live by.

Five Rules to Live By

Rule 1: **Modularize your People, Processes and Products**

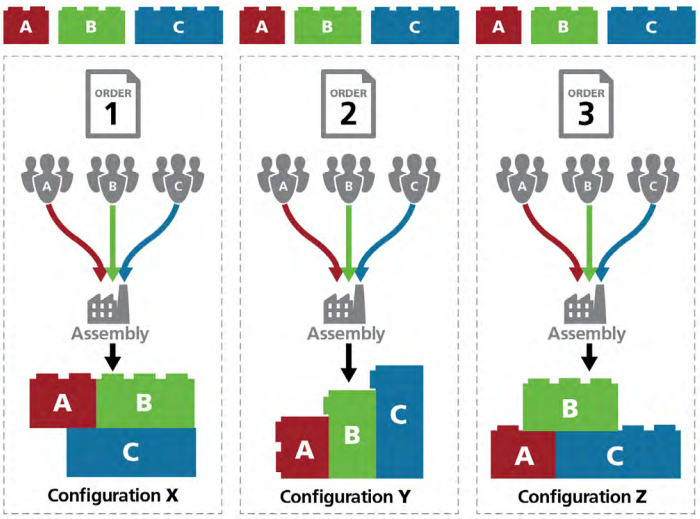
Following from the post Free to Choose: Mass Customization for Modern Manufacturers, here is the first rule to live by for modern mass customizers.

Companies who wish to optimize their business for mass customization should consider modularity to be a critical imperative. In this case, modularity refers to the use of individual product components, processes and teams that exhibit a consistent and predictable function on their own, but can be combined and arranged into systems that function in new and unpredictable ways. For Assemble-to-Order/Configure-to-Order manufacturers, the product that a customer orders can be thought of as the higher level system, and the individual components of that product can be thought of as modules.

While a new order may call out a product configuration that is entirely unique, each module should consist of a standard component that is managed and manufactured with standard processes and executed by standard teams of people. Orders can thus be considered mass-customized, while the modular components that make up the order can be considered mass-produced. This tactic is central to a manufacturer's ability to maximize both dimensions of customer centricity and operational efficiency. Manufacturers who do it well can mass-produce for as long as possible, delaying the product differentiation until assembly, shortly before delivery to the customer. Maximizing time spent doing things consistently enables stable supply chains and internal procedures amidst environments of uncertainty.

From an engineering perspective, product modularity requires you to define the internal, hidden functions of each module, as well as the external, visible rules that control how each module can operate within a final assembly. While independent engineering groups may have sovereignty over hidden design parameters of modules that they are responsible for, product leadership should diligently enforce design standards that impact the way modules may interface together.

It's helpful to think of modular product components as Lego pieces, and the product architecture as a vague suggestion that you see in the picture on the box. If you were designing a set of Legos, what considerations would you make about modularity?



- **Alternation** - Can I replace a given component with another component that has a different structure?
- **Orientation** - Can I reposition a module in 3D space, while maintaining the interface with another module?
- **Placement** - Which physical locations can I move a given module to?
- **Connectivity** - For a given module, which other modules can I interface with?
- **Dependency** - For a given module, which modules are necessary to precede or follow?
- **Adaptability** - To what degree should we allow re-configuration after the initial configuration?

The type and degree of product modularity that you employ in your product architecture is dependent on your company's mass customization strategy. While most companies will not offer a level of configurability comparable to Lego kits, these modularity considerations are important if you want to accommodate diverse customer requests.

Equally as important as product modularity is process modularity, and a company's ability to compartmentalize processes and people along with its product components. To cost effectively fulfill orders in a mass-customization environment, business processes should be identifiable at the point of sale, even in cases of a new product variant that has not been manufactured before. To achieve this, manufacturing work plans, logistics procedures, and workforce should be tightly coupled with the product modules that comprise the order.

Each module should have a consistent process and team for procurement, fabrication, packaging, and any other procedures necessary to get it off the shop floor and into the final assembly facility. In practice, this means that a company's work breakdown structure should aligned with classes of modules in a product architecture, rather than geographical sites, brands or disciplines. While the components of an order may be unpredictable, identifying the processes relied upon to execute the order should be as simple as identifying the modules that are required. This allows production to start immediately, and be executed with repetitious efficiency.

Rule 2:
Follow the Rules

Following from the post Free to Choose: Mass Customization for Modern Manufacturers, here is the second rule to live by for modern mass customizers.

For practical reasons, manufacturers have to set limitations on range of configurability in their product architecture. These limitations are driven by a wide variety of business and technical requirements, including manufacturing constraints (Is it possible to assemble this?), and sales and marketing strategies (Do we want to offer this to our customers?)

For many companies, it is tempting to try to control these limitations with brute force, identifying all the possible product configurations up front, and allowing customers to choose from an approved catalog. Without the right technology, this is often the only option. This is prohibitive, however, when you consider the number of permutations that must be defined, documented, and managed for a highly dynamic product.

Imagine the task of identifying every possibly way a Lego kit could be put together, and you can understand magnitude of complexity with this approach.

A better strategy is to focus on uncovering the governing logic behind the configuration of your products, and to capture this logic into a manageable set of business rules. Establish rules that define what cannot be done, and rules that define what must be done. Part A and Part B cannot be on the same assembly. If you have Part C, you must have Part D. Document and manage rules that define other relevant business and technical requirements to include spatial constraints, approved vendors and lead times. By making your business rules the manageable asset rather than a massive list of possible configurations, you simplify the business problems inherent in product customization, and unleash configuration possibilities that you may not have known existed. Use a customer-interfacing product configurator, and operate within the boundaries set by your business rules, allowing your customer to freely explore and discover product configurations that meet their unique needs.

To realize success from a rules-driven product management approach, rule development should be considered a necessary phase of the product lifecycle. New product components or architectures should not be released without a complete set of business rules that define how those components can be arranged into a saleable product configuration. Integration with a PLM system is critical to oversee this development process, and to maintain associativity between your rules and your product data

Rule 3:
Honor the Order, Abandon the BOM

As a follow-up to the post, Free to Choose: Mass Customization for Modern Manufacturers, here is the third rule to live by for modern mass customizers.

Most mainstream Product Lifecycle Management (PLM) systems in the marketplace today are designed with a mass production model in mind.

These systems offer sophisticated functionality that allows engineers to formulate Bills of Material (BOMs) and define product structure during design stages. Designs are released and pushed to production systems for manufacturing, but the PLM system remains the single source of truth for end-product design information. This is perfectly appropriate in most cases, considering that most discrete manufacturers today operate under a mass production model. However, the role of the PLM system as a tool for the formulation and management of BOMs is largely at odds with mass customization strategy. Companies that strive to offer highly personalized products should minimize engineering's involvement in the order fulfillment process, and this includes the formation of BOMs on a per-order basis.

Companies transitioning to a mass customization model should rethink the product lifecycle, rethink the role of the PLM system, and be willing to abandon the status quo. The relevance of the BOM greatly diminishes as a company transitions to a 'to-order' product offering. For mass customizers, a Bill of Materials, or more appropriately, a Bill of Modules, is a transient artifact. It is entirely possible that a given BOM may only be built a single time, and for a single order. Mass customizers should shift their perspective of the BOM from the identity of the product, to the technical details of the order. The identity of the product then becomes the governing logic that permits a range of configuration possibilities.

As the purpose of the BOM changes, so changes the purpose of PLM and the systems that support it. Rather than originating in PLM, BOM details originate with the order itself, ideally using a customer-facing product configuration system. As long as the order and corresponding BOM are compatible with the business rules that govern configurations, these details can be passed on directly to production systems for manufacturing (ERP, MRP, MES) without making a pit stop at PLM. PLM thus transitions from a tool for managing the lifecycle of a BOM, to a tool for managing the lifecycle of modular components that are used by the configurator. Rather than a 'release to manufacturing,' the product lifecycle ends with a 'release to sales,' whereby newly approved product components are added to the product configurator's portfolio.

This reduction of engineering efforts from the order fulfillment process is key to reducing design cycle times, reducing operation costs, and enabling a highly efficient method for providing highly customized products.

Rule 4:
Look Your Customer in the Eyes

Following from the post Free to Choose: Mass Customization for Modern Manufacturers, here is the fourth rule to live by for modern mass customizers.

Success in a customer-centric business environment requires a seamless feedback loop between supplier and consumer. To maximize value realized from a mass customization strategy, you should view your customer as a collaborative partner in the product design process.

As your partner, customers need visibility into your business and your product offerings

Customers should have access to available product configurations, accurate pricing, and delivery estimations. They should be able to visualize and virtually interact with the product of interest, and see a representation of different configuration options. It should be transparent to the customer how different module options and arrangements will affect the quote and delivery times. In practice, this may require that you offer a customer interface with product configuration and e-commerce capabilities.

As their partner, you need visibility into your customer and their needs

Who are they? What have they ordered before? When do they typically need it delivered by? Why are they ordering it? The answers will help you accommodate your customers and reduce time spent on formalities in the front end of the sales cycle. Finding these answers requires a number of different business disciplines, including Customer Relationship Management and Business Intelligence. Most importantly, you need the ability to collect transactional data and the ability to read the tea leaves. Predicting customer purchasing patterns is an acceptable starting point.
As these capabilities mature, new opportunities arise: Recommendations for different configurations that better fit your existing customer's needs, and improving the purchasing experience for new by approaching them with a refined set of product configurations from which to choose.

Many manufacturers strive to heighten the intensity of interaction with their customers, and most of the time this brings high fixed costs to the business. Modern configuration capabilities can eliminate these costs, expand sales, and increase customer retention. Web commerce platforms equipped with product configurators can be accessed by anyone with an internet-enabled device. By expanding accessibility to the purchasing front end, you will greatly enhance your products' market exposure and expand sales. Direct interaction with customers eliminates the need for wholesale arrangements with distributors, and improves price realization. Customer experience is improved with the convenience of preferences and order history. Retention and trust flourish when your customer can see that you're invested in their needs.

Rule 5:
Brace for Change

Following from the post Free to Choose: Mass Customization for Modern Manufacturers, here is the fifth rule to live by for modern mass customizers.

A successful shift to mass customization requires a holistic strategy with a far-reaching impact across the enterprise, a sound vision for organizational adjustments to the company, and skillful change leadership.

Manufacturers should expect more than technology changes when transitioning to a mass-customization model. The organizational impacts of this transition are far reaching, and typically require role changes in marketing, sales, engineering, manufacturing, and operations teams. These changes are by-products of the order-of-operations shift necessary to develop mass customized products.

Consider the typical phased approach to mass produced goods:

- Executive leadership delivers work orders for products they want to release to the market place
- Engineering designs the products, and releases designs to manufacturing
- Manufacturing builds the products, and stocks them into inventory
- Sales and marketing work to sell the finished goods out of inventory to customers in the marketplace

While mass production techniques end with the customer, mass customization begins with them. This means you should expect your order of operations to be reversed. You may also consider decoupling into two processes that operate concurrently in a closed loop fashion: the fulfillment of orders for the customer, and the production of new product platforms and modules.

Order Fulfillment Process

- Customers interface directly with a product configurator to design a product variant that meets their specific needs
- Orders are broken down into a Bill of Modules
- Orders are submitted with an integrated e-commerce platform; order details and customer preferences are collected on the side and managed for CRM and analytics
- Order processing teams review the orders for validity and pass on to agile manufacturing teams for fulfillment
- Manufacturing teams source the modules from inventory, assemble according to the order requirements, and package the finished product variant
- The finished product variant is shipped to the customer

Product Development Process

- Engineering designs new modular product platforms, and new modular components for their existing platforms
- Configuration rules are defined to govern how components can interface with each other in a saleable product configuration
- Marketing teams filter these rules to ensure compatibility with marketing and sales strategies
- Release to Manufacturing - Components are manufactured and submitted into inventory at volumes proportional to demand trends for that component
- Release to Sales - Final rules and component options are updated in product configurator, making them available to the enterprise, and to be used in product variants by customers

The Role of Leadership

Changes like these do not happen overnight. A successful mass customization program requires sponsorship and a high degree of involvement from executive leadership. Transparent Organizational Change Management (OCM) will enable your leadership and employees to understand changing roles throughout the company. Engineering will shift their focus. Sales will collaborate with the customer. The company will have to break out of departmental silos and share their customer and product findings. Company leadership and management should be able to understand and articulate what this strategy means for them: how they are engaging with, instead of reacting to, the customer.

The Impact on Partners and Customers

These organizational changes are not limited to your company. Your supply chain partners will need to be able to react with the same speed and dexterity that you exhibit. This could extend from raw material through distribution. Changes to your extended enterprise may call for a reassessment of your partners and their obligations.

Your customers will also be impacted, as you are now asking them to interact with you in a different way. Just as you will need to invest in internal training to successfully make this transition, you will need to invest in training your customers. Ensure that they know how to operate the new tools you have presented to them and that they know where to go if they have questions.

Mass customization is achievable now. Customers want to customize their purchases. Manufacturers want to make products the customers will buy. Both customers and the manufacturers want to do this at a price point and on a time line that is mutually beneficial. Through production efficiency and customer configuration, this demand can be met. By embracing the mass customization production strategy emerging across different industries, your company can gain new market share while still investing in the company through research and development.

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