Customization Drives Complexity - Why It's Hard to Design, Sell, and Produce 'Simple' Products

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The Customization Challenge

Imagine walking into a car showroom and saying "I want the late model sedan, but please give it to me with four more inches of legroom in the front, the tachometer moved to the left of the dash, and with an additional trunk release lever on the passenger side." What you would find is that the automotive industry, while they offer many features and options on their products, has significant limitations in providing truly customized products. But these types of requests are commonplace for highly configurable products like windows, doors, kitchen or bath cabinets, office furniture, and some industrial equipment like hydraulic valves.

It seems counterintuitive, but the process of selling, designing, and producing what appear to be "simple" products becomes surprisingly complex when manufacturers introduce high levels of customization. How can manufacturers of configured products address this complexity to streamline their processes, reduce cost, and increase customer responsiveness?

Customization Makes Simple Products Complex

Some products, particularly those with dimensional characteristics, have a seemingly unlimited number of possible configurations. For example, a vinyl replacement window seems like a simple product. But this seemingly simple product can be sold in multiple widths, heights, materials, and colors. It can be produced with different types of glass and sold with multiple styles of grids to provide desired decorative effects. When all of the possible options are considered together, the number of window configurations seems infinite. Developing quotes for products with this level of customization requires an understanding of which options are available, which options are compatible in combination with others, and how each option impacts the final price.

To add to the confusion, there are frequently complex rules that determine how the product will be produced. At the same time that the visible options are being determined, other derived design decisions are often being made. For example, a window for a wide opening requires special engineering. If the width reaches a certain measurement, then reinforced glass must be used, the frame must be reinforced and an additional latch will be required. Often these changes are not visible to or specified by the customer, but make a significant difference in the production processes, bills of material, and associated production costs. Because of the impact of customization on the sales, pricing, and production processes, a simple product becomes complex.

Simple Is Complex in a Different Way

Few people will argue that designing an automobile is a simple process. For the most part, however, the design is completed before the first car is produced. On the other hand, the design for highly customized products can't be completed until after the customer orders the product. It is not until after the customer specifies their order that designs are developed in order to produce bills of material, production instructions, tooling requirements, and engineering drawings. This means that the complexity for a customized product comes after the order has been taken, when customer delivery dates are looming and efficiency is at a premium. In some cases, a manufacturer must contact the customer to alter their configuration because they identify an engineering problem after the order has been taken, resulting in delays, additional costs, and customer dissatisfaction.

There is a significant amount of design work done before an order is taken for customizable products, of course. Where possible, generic designs and designs for standard options are developed in advance. Then, when an order is taken, the exact customer specifications are used to design the actual product to be produced. At this time, the engineers can tailor generic designs to meet the customer's specific requirements. For the most part, however, the process of gathering the order parameters, communicating them to the designers and developing the necessary production information is accomplished through manual engineering efforts that are time consuming, costly, and prone to errors. The manufacturing plant requires customized drawings to produce the product, but the customized designs come at a cost in terms of both engineering resources and customer delivery lead-time. With the rising demand for products tailored to customer needs, how can manufacturers provide mass customization as cost-effectively as they provide mass production?

Streamlining Quotes to Crates

Manufacturers can't afford inefficiencies in their order fulfillment processes. In customized product industries, responsiveness and agility are key factors in winning orders and maintaining customer loyalty. Winning isn't just about speed in quoting the order, but also speed in designing, producing, and delivering the item. In many industries, the design of each individual order consumes precious lead-time and requires the use of design engineers to manually produce drawings and production documentation.

The time and effort spent between the quote or order and the time that the product is ready for shipment drives both cost and customer lead-times. If this time and effort can be streamlined, manufacturers can deliver customized products more efficiently. But to gain this efficiency, a manufacturer must develop or streamline a process that spans quoting the product, taking the order, designing to customer specifications and producing the product. Unfortunately, the current business environment for converting orders for customized products into deliverable products is typically characterized by disconnected people, processes, and tools. Further, the clerical engineering required for customized designs is not glamorous work for engineers, and it distracts them from applying their design expertise to developing more innovative products and features.

Application software and process improvements have helped this process in recent years, but there is still opportunity for significant improvement. Responsiveness in generating quotes is now expected, and automation of configured quotes and sales orders is not a new concept < CRM For Complex Manufacturers Revolves Around Configuration Software >. Product configurators have provided, for the most part, an ability to automate the process of developing accurate quotes. But most configuration solutions in place today lack sufficient integration with design and production, and therefore automate only a part of the process.

Modern computer aided design (CAD) tools offer design automation techniques to improve the efficiency of customizing designs, but the challenge is that most solutions are typically implemented as point solutions, and often in a way that produces "islands of automation." Without harmonization and integration between the configuration parameters and rules used to develop the quote or order and the detailed product design that drives manufacturing, the complete "quote to delivery" process will remain fragmented and inefficient.

Can Customization Be Designed In?

Process improvement needs to start early in the design phase of the product. To shorten product lead-times and reduce inefficiencies, the manufacturer can't afford to manually design the product after the order is taken. Product designs must incorporate, in advance, the ability to accept customer-specific requirements. By developing CAD product models that incorporate design rules and flexibility, the order-specific design work can be more easily automated. For example, the number and spacing of the grids in a window should be calculated based on the window dimensions, as should the number and location of the window latches. If three-dimensional CAD models are used for these calculations, the engineering automation can also include the dynamic generation of production-ready drawings and manufacturing instructions.

There are other benefits of dynamically generating CAD models from quotes or orders. With a CAD model, a 3-D visual image of the product being ordered could be generated and shown to the customer during the order process. This would allow the customer to visualize and validate the product they are ordering, making the process both easier for the customer and less prone to errors.

In addition, the CAD models could support engineering analysis to further validate the product being specified. For example, a custom window could be automatically subjected to a finite element analysis to confirm design pressure ratings. If the design being specified doesn't meet the correct pressure ratings, the order shouldn't be accepted or produced. Without detailed CAD models, this analysis is not feasible.

With models dynamically generated from the quote or order combined with engineering automation, the engineering analysis could potentially be performed automatically while the customer is ordering the product. Of course CAD automation by itself only automates the engineering tasks. The larger benefit can only be achieved when the design work is incorporated into a process that integrates the tailored design, drawings, bill of material, and other manufacturing requirements with the customer order that must be fulfilled.

What's Being Done?

A large provider of complex warehouse automation systems spoke at a recent industry conference about their use of collaborative product lifecycle management (PLM) tools in designing and selling their products. Because of the sophistication of the equipment and the need to design the product specifically to customer requirements, the company faced a challenge in rapidly and accurately designing, quoting, and then producing products for their customers. The solutions used in their environment were standard PLM and CAD solutions, along with a custom product configurator. When asked about the integration of the two, the presenter from the company indicated that this was a challenge, and one that they had to address internally.

While this large company chose to develop and integrate their configurator on their own, there are application software vendors that have tools and methodologies that can help. PLM companies like **PTC** and **Fullscope** provide the ability to take advantage of design automation capabilities in modern CAD tools. Applications from these vendors allow design parameters to be captured and applied to CAD models that can automatically incorporate the changes. PTC also provides product configuration wizards and portals to aid the customer configuration process.

Configuration vendors like **Firepond**, **TDCI**, **Selectica**, and **Trilogy** provide the ability to configure quotes and orders. Applications from these vendors allow for the capture, validation and pricing of customized product configurations. TDCI also provides visualization and 3-D CAD model generation to dynamically tailor designs to customer specifications. Finally, enterprise vendors like **Baan**, **CINCOM**, **Oracle**, **PeopleSoft**, **SAP**, and **Siebel** have configuration solutions that are integrated with their ERP and CRM applications. Solutions from these vendors, and others, can provide a significant first step in streamlining and automating the process, reducing costs, and increasing customer responsiveness.

Recommendations

- Manufacturers who sell customized or mass-customized products should look for opportunities to integrate the processes and software applications that link the customized quote or order through design and production.
- Manufacturers should look for opportunities to automate the design process for customized products to reduce cost and lead-times.
- Manufacturers that are considering introducing mass customization should look for product configuration that's integrated with strong design optimization.
- Product configuration vendors should address the need for design automation and manufacturing requirements in their solutions to streamline the full process from quote through production.
- Product lifecycle management vendors should consider addressing the need for configuration to customer needs in the design phase of the product lifecycle and in their customer-facing PLM solutions.

Summary

Customization adds significant complexity into the process of designing, selling, and producing even seemingly "simple" products. Manufacturers of highly customized products today are addressing this complexity with point solutions and fragmented processes. Through advances in methodologies and tools for product configuration and design, manufacturers now have the ability to break down the barriers in their processes to increase customer responsiveness, increase efficiencies, and enhance their ability to cost-effectively provide customized product to their customers.

About the Author

Jim Brown has over 15 years of experience in management consulting and application software focused on the manufacturing industries. **Jim** is a recognized expert in software solutions for manufacturing and has broad experience in applying enterprise applications such as Product Lifecycle Management, Supply Chain Management, CRM and ERP to improve business performance. **Jim** created his consulting firm, Tech-Clarity Associates, to make the value of technology clear to business. **Jim** can be reached at jim.brown@tech-clarity.com.