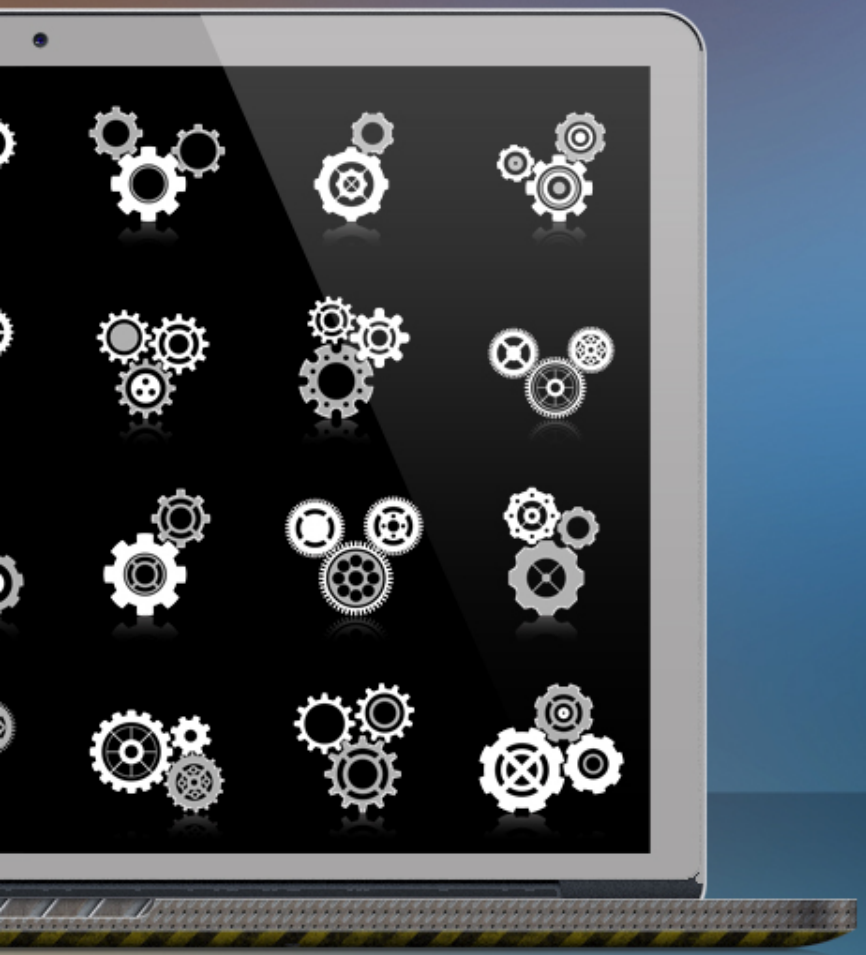


3D Design and Validation for Configure-to-Order

By : Jim Brown| President | Tech-Clarity

The Strategic Value of CTO

Selling configured products can drive significant business benefits including **increased differentiation and price margins**. An increasing number of manufacturers offer customization as a strategic weapon, while for others it's a mandatory fact of life to meet customer needs and ensure products fit into customer sites and scenarios. In either scenario, it's a highly valuable approach.

Configuration is also strategic to localizing products to meet global requirements. Many manufacturers are simultaneously launching variants of a single, global product around the world. This takes a little longer to achieve, but maximizes profits across regions and improves operating margins. It can also prevent competitors from copying and launching differentiating features of a product in other parts of the world where it hasn't been launched yet.

"The product development benchmark for the next decade will be the ability to simultaneously introduce localized products around the globe with increased personalization."

Integrating Product Design and Development Environments
- Tech-Clarity

Configuring products to order, however, is inherently complex. Being able to effectively and efficiently design, validate, and sell configure-to-order (CTO) products is **a strategic capability that drives profitability**. A well-designed CTO process allows companies to define product variants and associate them with customer specifications so they can rapidly respond to customer requests for quote (RFQ) and orders.

Taking CTO to the Next Level

Manufacturers must respond quickly to customer orders or quotation requests. But most companies find it hard to accurately validate configured orders, take too long to quote, and can't quickly estimate costs with any precision. Why? Because it involves a lot of skilled people and most companies have highly people-centric processes. To make matters worse, they have information in different systems that must be updated manually.

These problems increase significantly as products become more complex. Configuration errors result in selling things that can't be produced. Disconnects between marketing strategy and technical rules lead to selling the wrong things. Bill of materials (BOM), part, and manufacturing instruction errors result in costly mistakes that lead to delays. Errors communicating with manufacturing and suppliers lead to negative cost and time impacts.

Taking a thoughtful CTO approach allows manufacturers to do a lot of design and validation up front. They can develop variants in advance, associate them with options, and optimize their modularization on "bread and butter" products with the highest volume and best margins. Then, they can quickly assemble variants based on customer options and validate them visually in 3D without the need for extensive design and validation.

This approach allows companies to rapidly develop accurate quotes and compelling bids, and increases efficiency to allow them to respond to more requests. The result is winning more business, and perhaps more importantly winning more *profitable* business.

"Developing product variations in advance is very important to us. Recreating them for each design would be very expensive so pulling as much as possible 'off of the shelf' is critical for us to be cost effective."

Jeff Erno, Consulting Engineer, GE Power

Making CTO Profitable

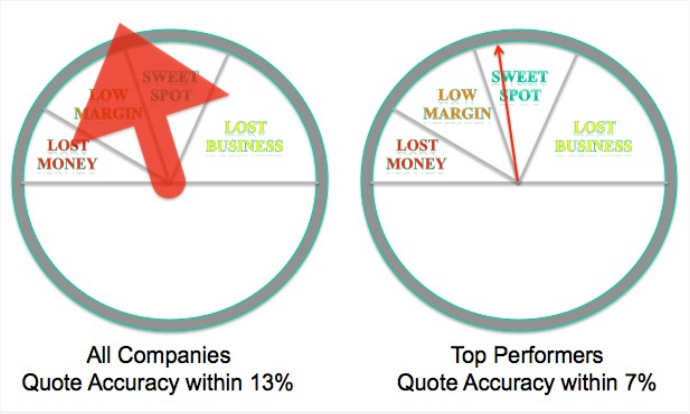
Profiting from configured products is a challenge for most companies. They need **fast quotes** to win business. Slow, people-dependent processes force companies to either wait to get reasonably accurate costs in order to quote or risk losing out to more responsive competitors. Time is not a luxury they can afford in today's competitive markets.

Speed is not enough, however. Manufacturers also need to **quote accurately** to make a profit. Most companies can estimate based on a subset of components and factors that drive cost, but if estimates have a large margin of error companies have to choose between two bad options:

- Adding a healthy cost margin and risk losing deals on price
- Quoting more aggressively without the facts and risk winning unprofitable business

They need the **confidence to quote the margins they want without incurring too much risk**.

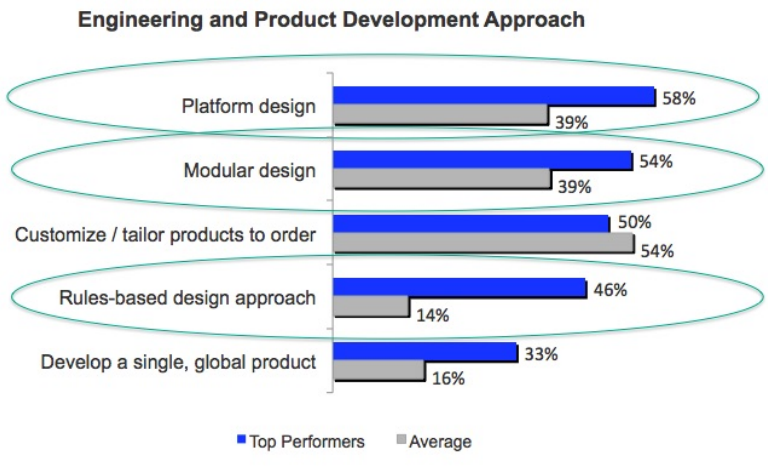
Getting an optimal price is only half of the battle. Manufacturers must deliver. They have to validate orders to make sure items are manufacturable and within the marketing guidelines and strategy defined by product managers. They have to efficiently develop accurate instructions for production, installation, and sourcing. Poor configuration management can result in buying the wrong parts, ordering duplicates, missing parts, production errors, and problems extending into the supply chain and field installation. These mistakes can **cost a lot of money and turn profitable orders into losses**.



Best Practices for Developing Industrial Equipment

Shifting "To Order" Left

The key to speed and accuracy in CTO is **performing design and validation up front**, effectively shifting order engineering effort and decision-making "left." It starts at the conceptual level where product managers gather the voice of the customer (VOC) and requirements. At that point engineers can evaluate options and make tradeoffs to get options and variants right up front where designs are flexible, making iterations early where they cost the least. Making these decisions up front allows them to execute rapidly downstream.



Effective CTO can be aided by leveraging more advanced engineering approaches. Although it's not mandatory, Tech-Clarity research shows that top performing companies have adopted modular design approaches, platform design techniques, and rules-based design approaches (see graphic). Companies with effective modularization can also gain a competitive edge by reducing product cost, maximizing reuse across variants, and adapting more quickly to new market demands.

Manufacturers can relate modules or components with customer requirements and associate options with them. This is also the time to make sure marketing rules are in sync with engineering rules to respect both commercial and technical constraints and strategies. Predefined relationships allow for rapid generation of configured variants for orders. It's much faster and efficient than an engineer-to-order (ETO) approach for those that can design in advance. Of course there will almost always be some **"special" elements with ETO requirements**. The more that can be done up front the better, though, because it drives speed and profitability.

Design for CTO

Configurable products should be designed so modules are interchangeable without causing conflicts or clashes. Designing configured products requires the ability to **design in the context of modules and/or components across all product variants**. This can be done by creating a max case, or "150% BOM" that contains all potential components. This helps engineers achieve an optimal design faster, improves reuse, and reduces the cost and time needed to develop variants.

"Max case structures mean you don't have to create duplicate structures for each variant and you can use effectivity rules to manage the differences. Otherwise, managing configurations is a problem because designers have to compare and contrast from one structure to another and that's difficult."

Jeff Erno, Consulting Engineer, GE Power

Let's look at an example. The design for a brake shoe to be reused across all vehicle variants needs to be designed so it works across all types of brakes. All brake components can be included in an overloaded design session including all brake variants. This allows engineers to identify potential issues early in a single session.

Max case structures provide their own challenges, though. The 150% BOM can be hard to work in. With all potential components in the model, it can quickly become overwhelming. Designers need to be able to easily **narrow down the view** to see different variations and combinations of modules.

Traditional approaches require generating CAD files for each variant. Designs are then validated individually against all variant CAD models. This can be inefficient, particularly when changes occur that need to be made in each variant. This is very cumbersome and error-prone. The max case approach can be a very effective one, but traditional implementations have been challenging due to supporting technologies.

Enabling Design in Context for CTO

"The latest generation of integrated solutions should access configurations in PLM and allow engineers to turn features on and off to review various configurations in real-time as design options are explored."

Integrating Product Design and Development Environments

A more advanced approach than creating multiple assembly files is enabling a **single, database-driven CAD structure** across all variants. Moving away from assemblies in individual files enables multiple variants in a single CAD structure. In this way, there is no need to generate a model for each variant in order to validate it.

With a single model, engineers can dynamically filter the 3D model for any configuration in real time. They can effectively **"turn on" what they want to validate dynamically without creating a new assembly**, creating a real-time visualization or digital mockup (DMU) of a variant configuration. Ideally, they are able to filter by configuration options or active selections such as 3D space search. If components are aware of their positioning and the configuration option they are associated with, engineers can **create a real-time 3D configuration for any ad-hoc or pre-defined configuration** by quickly pulling in the right components into the right positions.

Keeping everything in one place allows engineers to easily change designs without having to propagate the change over multiple variant assembly files. It also provides the opportunity to lifecycle manage everything, including configuration rules, with effectivity and engineering change control.

The max case approach allows better design optimization and fewer mistakes. Leveraging a single CAD model that allows real-time design in context makes it efficient and sustainable.

Effectively Validate CTO

Validating variants in advance for CTO products is very difficult compared to validating standard products. Configured combinations and permeations must be investigated early to ensure feasibility and catch issues sooner. **3D configuration can allow 3D validation of planned variants**.

Validating CTO products in advance requires a tight linkage between configured BOMs and CAD. It can enable companies to validate an accurate virtual representation respecting both marketing and technical rules and allows 3D validation in a configured context so engineers can identify clashes or other incompatibilities up front.

"In many traditional systems all the variant work is done with part numbers and trees and no 3D. Reviewing an order by looking at a laundry list of part numbers is very difficult, and makes it hard to communicate internally and with customers."

Jeff Erno, Consulting Engineer, GE Power

Configured 3D models extend the value of an integrated product innovation environment to CTO products. Engineers can take advantage of proven design validation approaches including:

- 3D motion simulations
- Computer Aided Engineering (CAE) to validate structures, fluid flows, heat transfer, vibration, noise, and more
- Ergonomic studies
- Systems-level simulations
- Simultaneous design and validation of manufacturing processes and equipment
- Simulation of installation procedures
- Service operations validation

3D models allow for better validation and reduce the potential for manufacturing problems, quality issues, or installation. Flat, BOM- or rules-based designs don't offer the same opportunity, even if manufacturers leverage 3D CAD. One change in a BOM component that's used in many combinations needs to be changed and revalidated as many times as it's used. Validating in a 3D configured context eliminates that inefficiency.

Streamline Order Engineering

Order engineering effort and time are significantly reduced when design and validation are performed up front. Components and modules can be automatically included at order time based on associated features. This way, manufacturers can quickly pull together a **predefined, pre-validated, configured variant**. Of course it's still important to execute compatibility rules to validate combinations respecting both technical constraints and company strategy / marketing constraints.

Streamlined, automated order engineering reduces manual effort for bids and orders. Orders can be configured by engineers, sales reps, 3rd parties, or potentially customers. This allows customers to quickly see what they're ordering to gain confidence it will meet their needs. Although ideally companies would have an integrated configurator that handles both technical rules and sales configuration, many wrap customer-facing configuration into a custom front end specific to their company or leverage a sales configurator specialized in configuring, pricing, and quoting (CPQ).

One of the most compelling aspects of 3D configuration is the ability to use dynamic 3D to create more compelling quotes or bids. This way, offers can include 3D, animations, and additional details that impress customers with the "wow" factor. Companies can use 3D models to develop high-end renderings that show the products in high resolution. Leveraging 3D to show customers a virtual, 3D product gives them the confidence that their requirements are understood and that they will get what they need.

"Traditional tools are a bit too slow for companies to use in quotes and bids and are only lists, not geometric."

Jeff Erno, Consulting Engineer, GE Power

Conclusion

It's time for manufacturers to improve CTO performance by leveraging 3D design and validation. With 3D configuration, engineers can develop variants in 3D without generating CAD files for each variant. They can use a max case approach to find errors early using dynamic filters to design in a configured context. "*Configured structures change the ball game because you aren't managing every component in every variant, only the net change*," GE's Erno explains.

Designing variants in 3D, manufacturers can shift the majority of engineering effort "left" in order to streamline quotes and orders and execute more rapidly and accurately. They can develop more compelling quotes and bids leveraging 3D and high definition renderings, impressing customers and giving them greater confidence in their orders.

Using the right processes and 3D configuration technology, manufacturers can **improve efficiency, streamline order processes, reduce errors, and develop accurate quotes much more quickly**.

"The latest generation design and development environment helps manage the growing complexity companies face managing numerous configurations and product variants."

Integrating Product Design and Development Environments
- Tech-Clarity

*"3D configuration can eliminate all or most of the overhead with managing configurations. If I had to guess I think 3D configuration could mean **25% or more productivity improvement** to an engineering department."*

Jeff Erno, Consulting Engineer, GE Power

www.tech-clarity.com

clarityonplm.com

@jim_techclarity

TechClarity.inc

3D Design and Validation for Configure-to-Order

Tech-Clarity

About the Author

Jim Brown is the President of Tech-Clarity, an independent research and consulting firm that specializes in analyzing the business value of software technology and services. Jim has over 20 years of experience in software for the manufacturing industries. He has a broad background including roles in industry, management consulting, the software industry, and research.

Jim's experience spans enterprise applications including PLM, ERP, quality management, service lifecycle management, manufacturing, supply chain management, and more. Jim is passionate about improving product innovation, product development, and engineering performance through the use of software technology.

Jim is an experienced researcher, author, and public speaker and enjoys the opportunity to speak at conferences or anywhere he can engage with people with a passion to improve business performance through software technology.