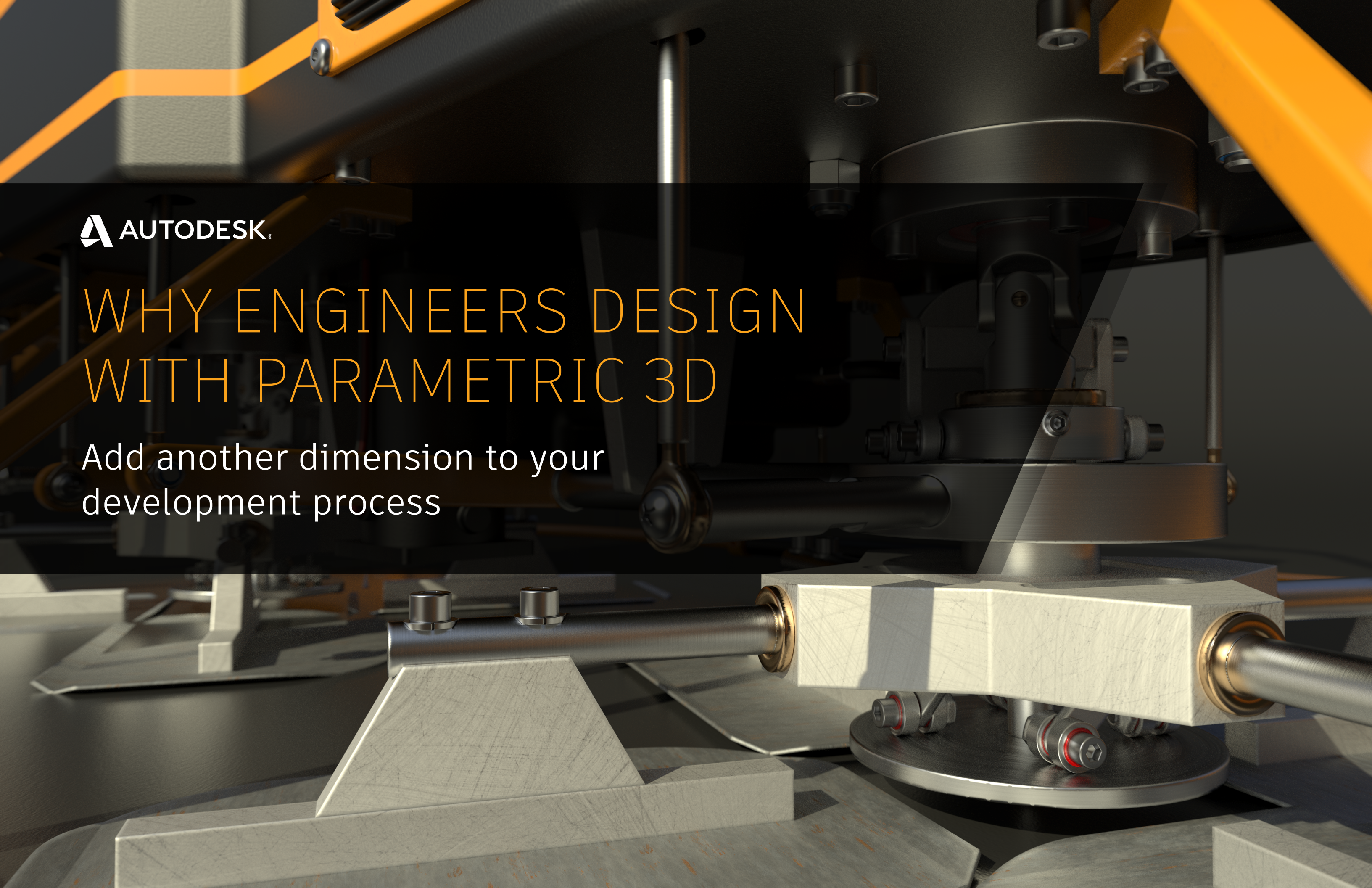




# WHY ENGINEERS DESIGN WITH PARAMETRIC 3D

Add another dimension to your  
development process



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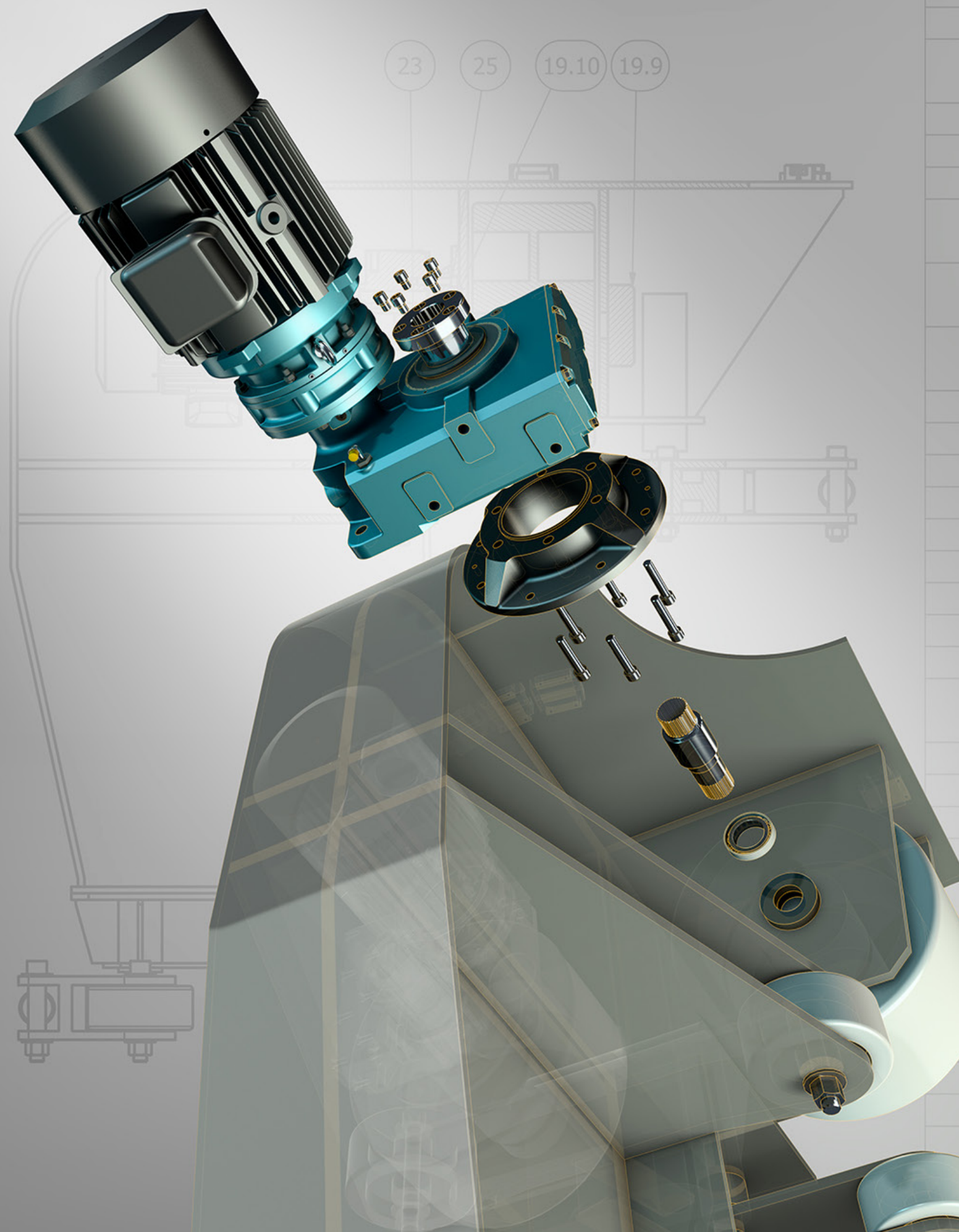
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CREATE ASSOCIATE DOCUMENTATION  
COMMUNICATE YOUR DESIGN INTENT  
CALCULATE DESIGN PROPERTIES  
IDENTIFY SPATIAL INTERFERENCES

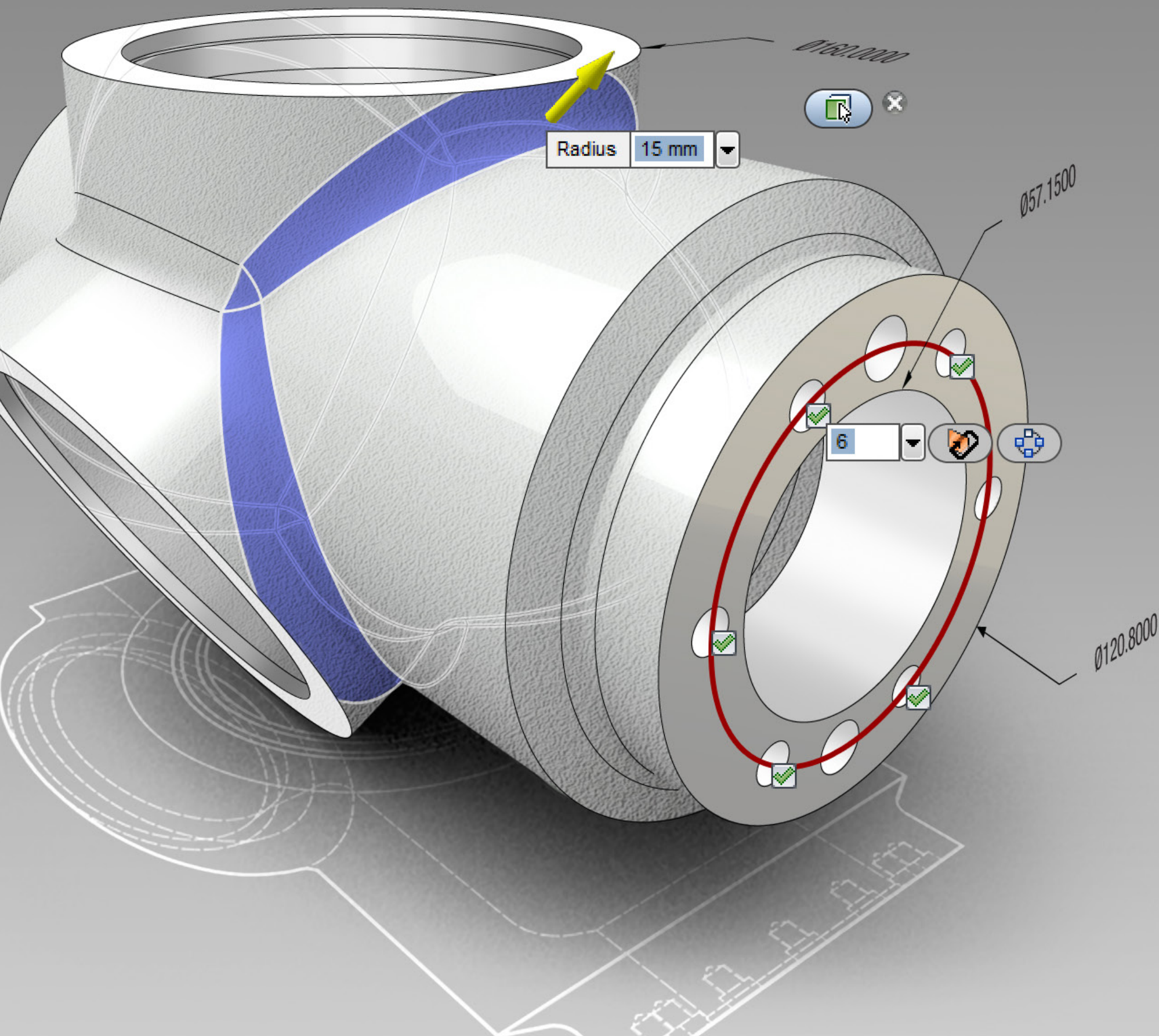
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## CHAPTER 1

# PARAMETRIC DESIGN

From drafting board to computer-aided design, engineers have always sought ways to make things better. Today, they have more tools—and opportunities—to do so than ever. Product design possibilities aren't only in what can be done, but in how to do it.

As an engineer, you have choices (and likely strong preferences) for how you do your job. Whether you've been modeling in 2D for two months or 20 years, how you approach the task at hand impacts so many chances for enhanced product quality and performance, improved productivity, and increased innovation.

We're here to say: parametric 3D CAD is the path to those opportunities.

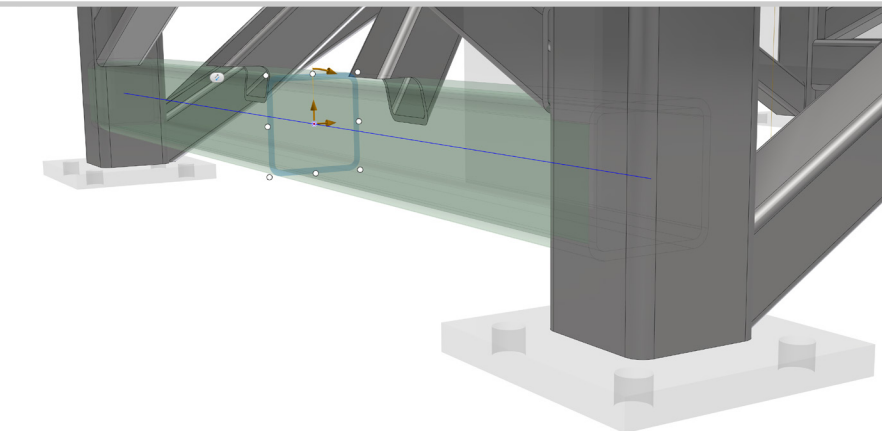
Parametric modeling is an approach to 3D CAD in which a model is built up step-by-step using features and constraints to capture design intent. Unlike direct modeling, designers can create parameters to sketch and dynamically size 3D objects.

The parametric modeling process allows for intent and relationships to be created between geometric features, which means the shape of your model changes as soon as a dimension value is modified. This refocuses efforts on designing while reducing time spent on manual tasks. With 2D and non-parametric 3D modeling, engineering intent and relationships cannot be built into the model. When design changes are required, significant time is spent manually modifying drawing views and directly editing each geometric feature that must be updated.

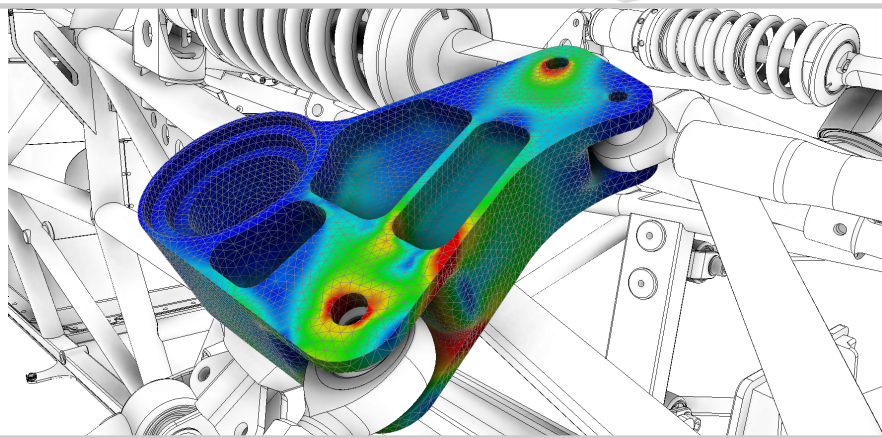
Adding parametric modeling to your engineering process leads to a significant reduction in time spent incorporating design changes, as a single parameter can cascade geometric updates throughout the model. But switching to parametric modeling is not just about saving time. After all, many 2D CAD users have honed their craft to an expert level of speed when it comes to modeling their products. The significant benefits of 3D parametric modeling come into play once you have your 3D model established.

MAKING THE SWITCH TO 3D PARAMETRIC MODELING EMPOWERS YOU TO:

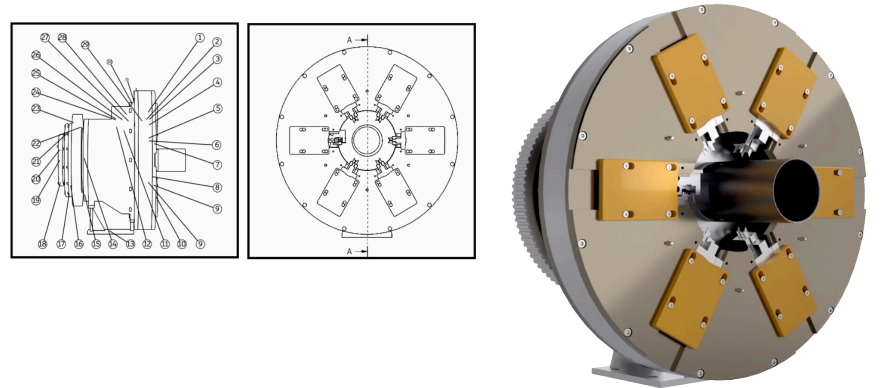
Create models that are easily changed and simply understood



Use your model to help test, make and, sell your product



Reuse your existing design data

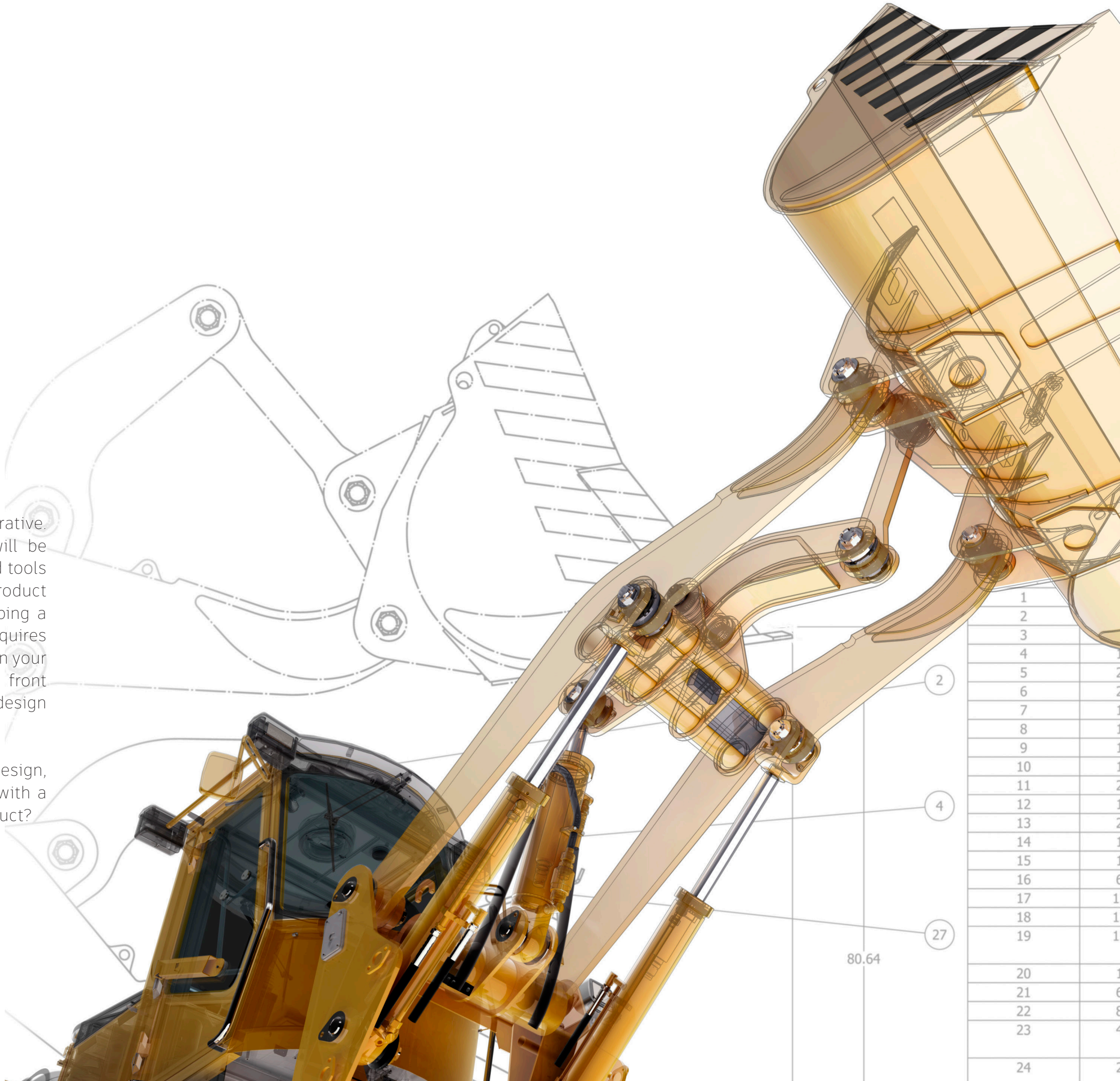


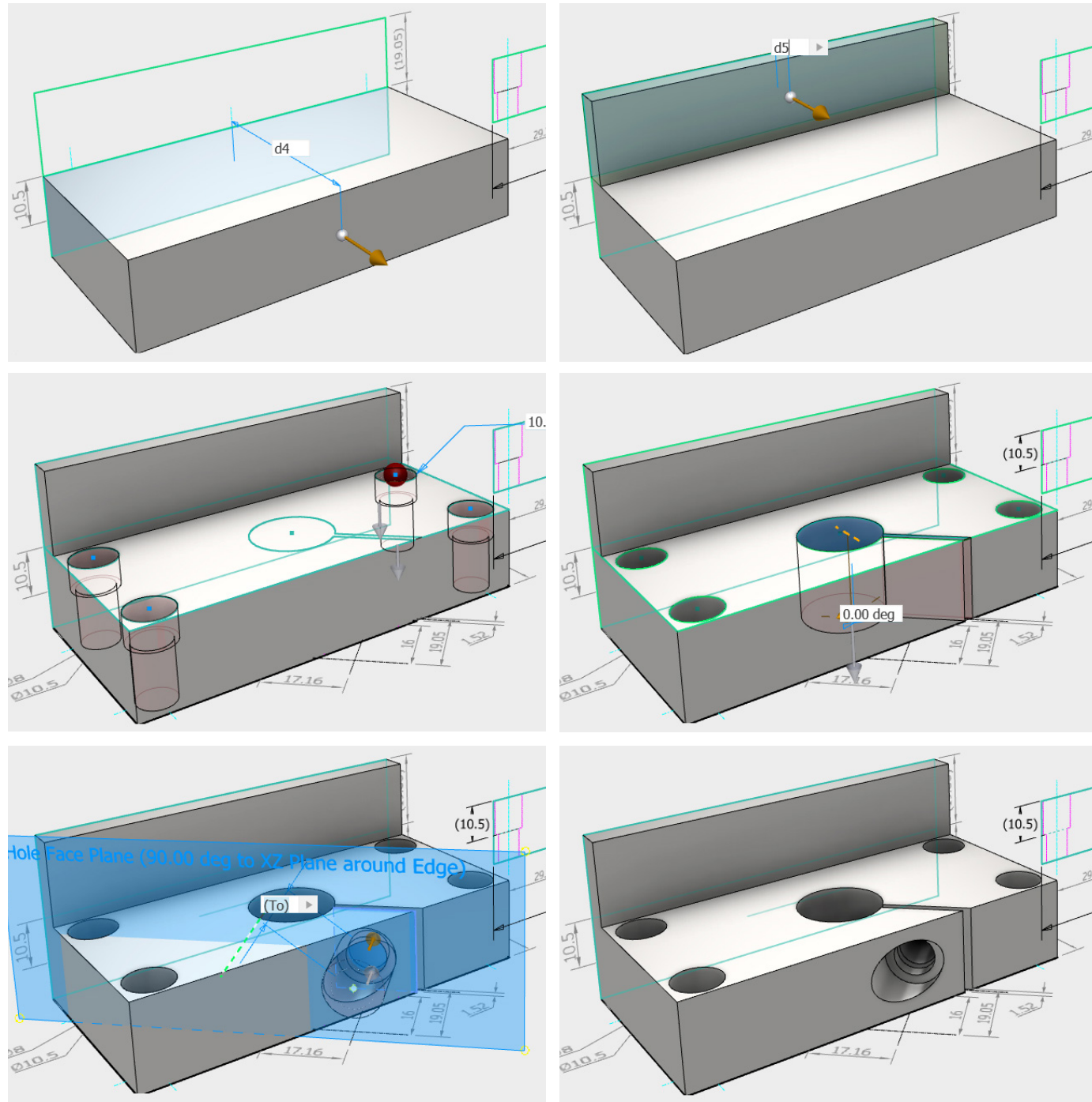
CHAPTER 2

# GAIN DESIGN AGILITY

The design process is, by its nature, iterative. It's highly unlikely that the perfect product will be designed in the first pass, which means you need tools that allow you to make improvements to your product easily, and at any stage in the process. Developing a parametric model may take more time initially—it requires strategy for how you want to create relationships in your design—but the additional investment made up front pays off tenfold when making changes to that design later.

2D modeling might suffice for conceptual design, but why not enjoy the benefits of what comes with a parametric 3D model when fine-tuning your product?





# IMPROVE, CHANGE, AND UPDATE DESIGNS EASILY

Every design must undergo change eventually—it's inevitable. But, due to the complex nature of engineering data, there's no such thing as a small design change with 2D drawings. One revision could cascade into updating any number of views, parts, and subassemblies, which often leads designers down a black hole of broken links and manual updates that go beyond just CAD files.

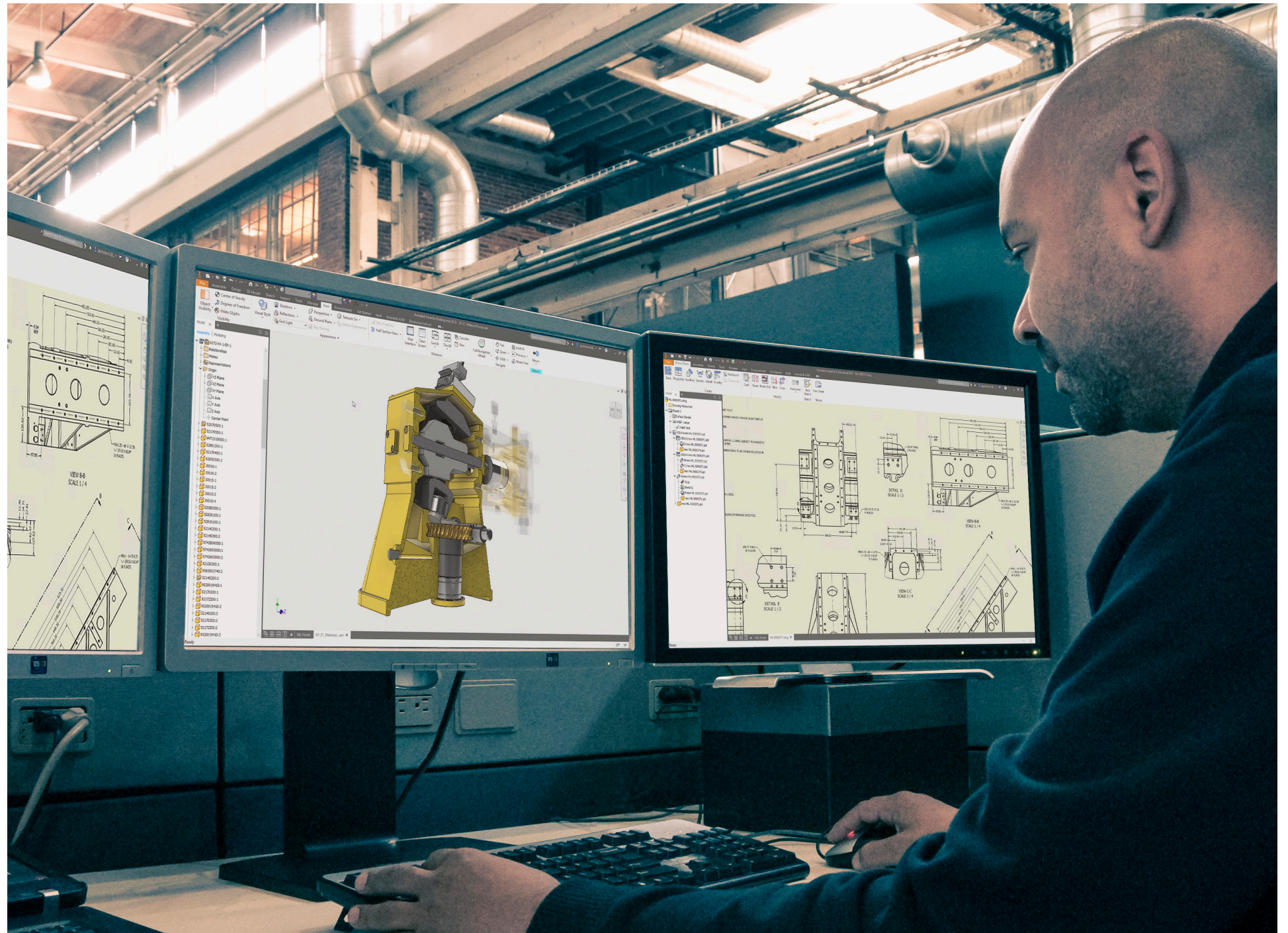
3D CAD takes the heavy lifting out of design changes while significantly reducing risk of error. Because the geometry of your model is controlled by parameters and equations, modifications immediately update in the model, bypassing tedious and time-consuming manual revisions. In other words, you can make your design changes...once.

*"We used to make changes in one view in AutoCAD, but they weren't updated in another view. Now, we know that when one feature changes on a model, every drawing that relates to that feature will be automatically updated."* – Jim Lambert, Design Engineering Manager at Bosch Rexroth Canada Corp.

# CREATE ASSOCIATIVE DOCUMENTATION

There's much more to a product than its design. Drawings, renderings, FEA simulations, NC toolpaths, and bills of material are only some examples of additional product-related files. In 2D-only environments, many of these are not delivered at all. If they are delivered, each one must be updated manually to reflect any changes to the design as it progresses.

On the other hand, changes made to 3D models are instantly updated in downstream deliverables. Because your data is associative, you can automatically generate and maintain accurate documentation, including BOMs. Any time a change is made to the design, these will stay up to date. Plus, you can even generate native documentation from files originally created in 2D using your 3D CAD tool.



# EASILY COMMUNICATE YOUR DESIGN AND DESIGN INTENT

Management, manufacturing, marketing, sales, supply chain, and customers all need to quickly make use of design data. However, what a designer intends in a 2D drawing is not always accurately understood by these extended teams.

## WITH 3D CAD, WHAT YOU SEE IS WHAT YOU GET.

Since 3D models are inherently easier to wrap your head around than 2D drawings, you get a clearer understanding of what is happening in your design. Plus, capabilities like exploded views give you new ways to explore your models. All this means that issues and opportunities for improvement that are difficult to discern in 2D become more readily apparent in 3D. This superior design visualization enables both designers and non-designers to better understand how a product will look and move in the real world and thereby achieve greater accuracy from end to end.

*“Before we build anything, we can see and almost feel it. It makes a huge difference in the accuracy of our design process—we are confident that what we see is what we’ll get.” –*  
Craig Breckenridge, Lead Designer at Dynamic Structures

Also, consider your customers. With only 2D drawings to showcase your product, proposals might create more questions than they answer. 3D CAD provides the solution with visuals that showcase a design in its best light. Beautiful photorealistic renderings and animations give proposals extra dimension and greater clarity, helping manufacturers achieve compelling differentiation from competitors.

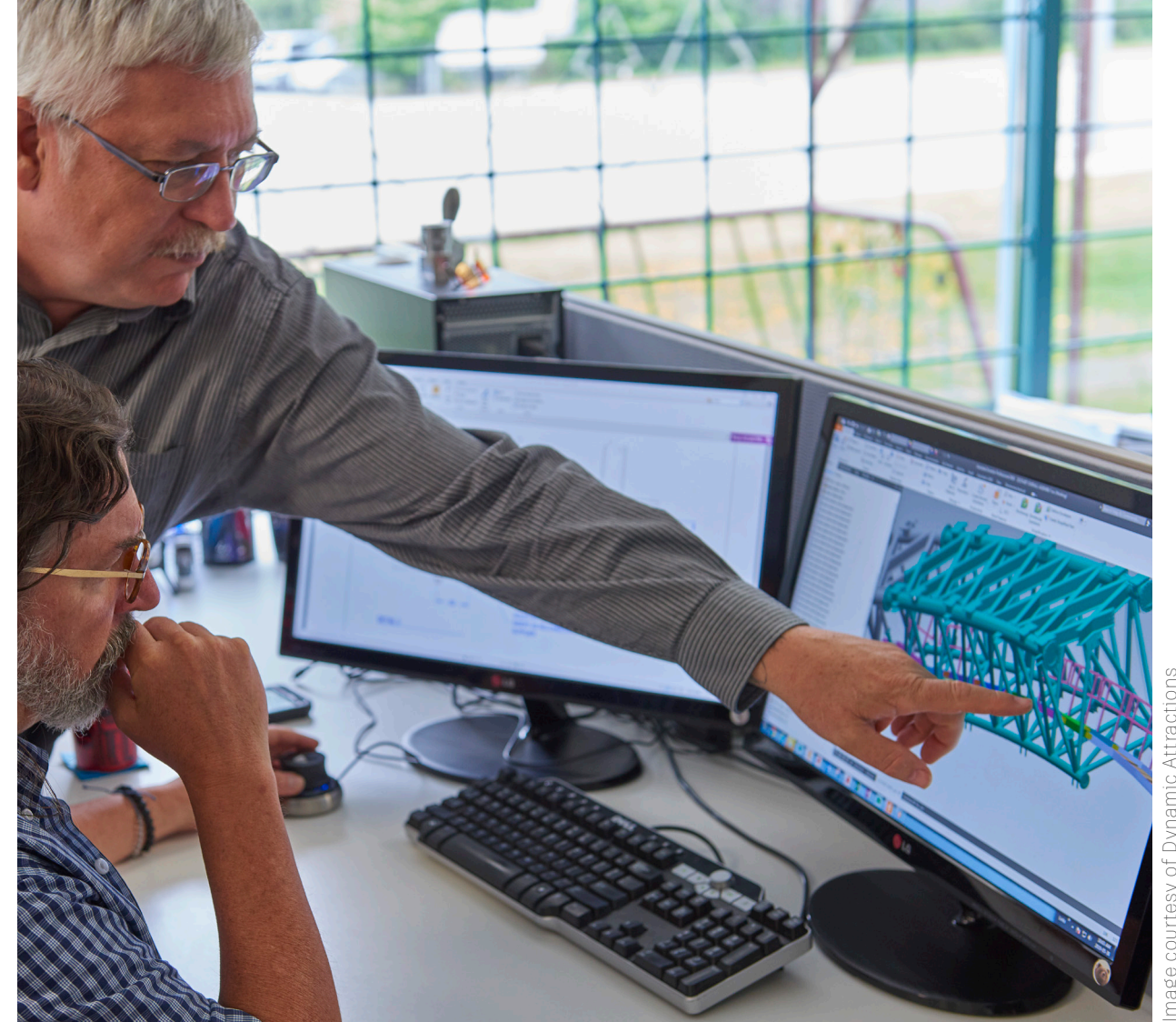


Image courtesy of Dynamic Attractions

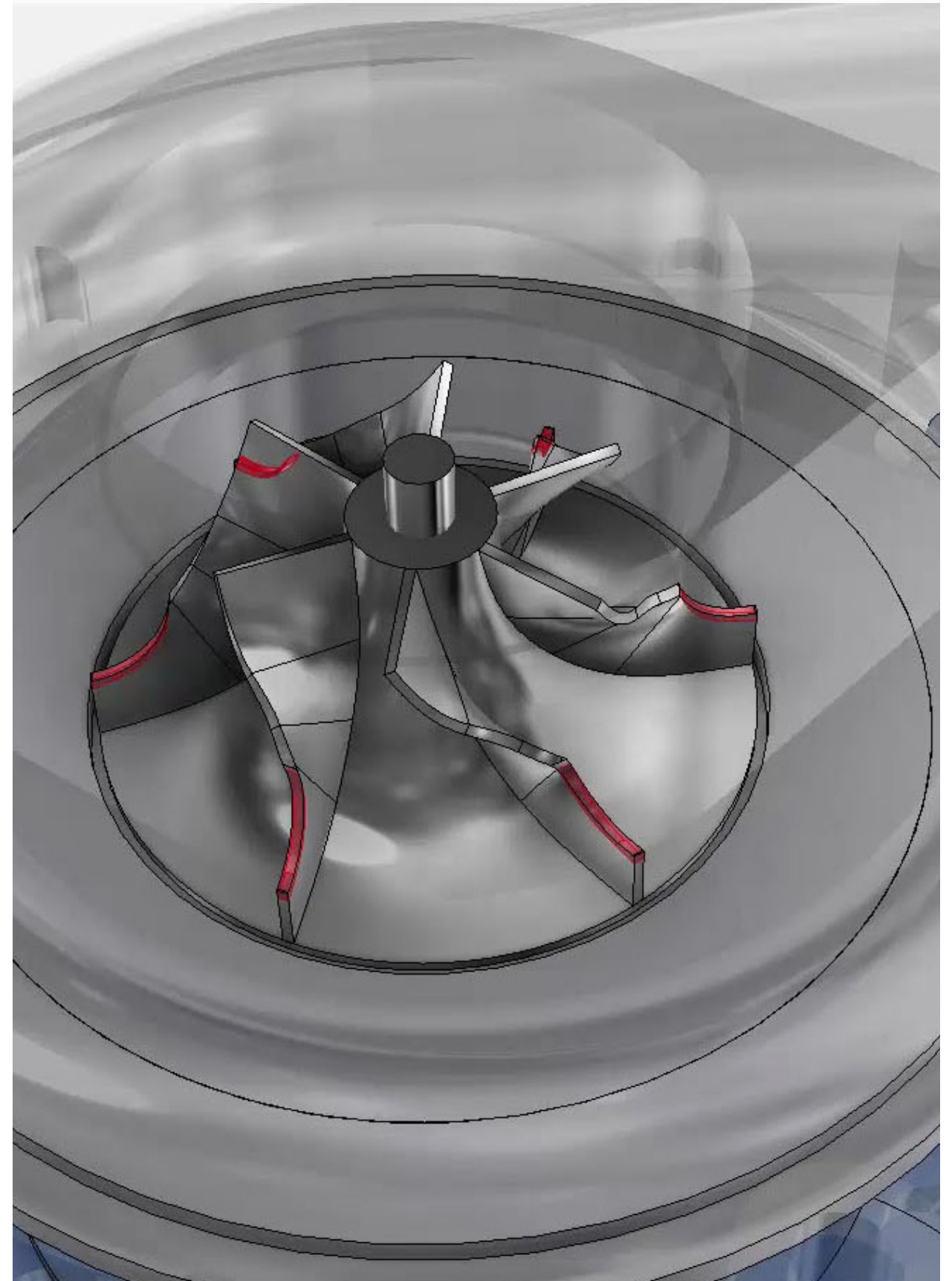
*“When our marketing department sees the renderings, they can’t believe their eyes.” –*  
Jim Lambert, Design Engineering Manager at Bosch Rexroth Canada Corp.

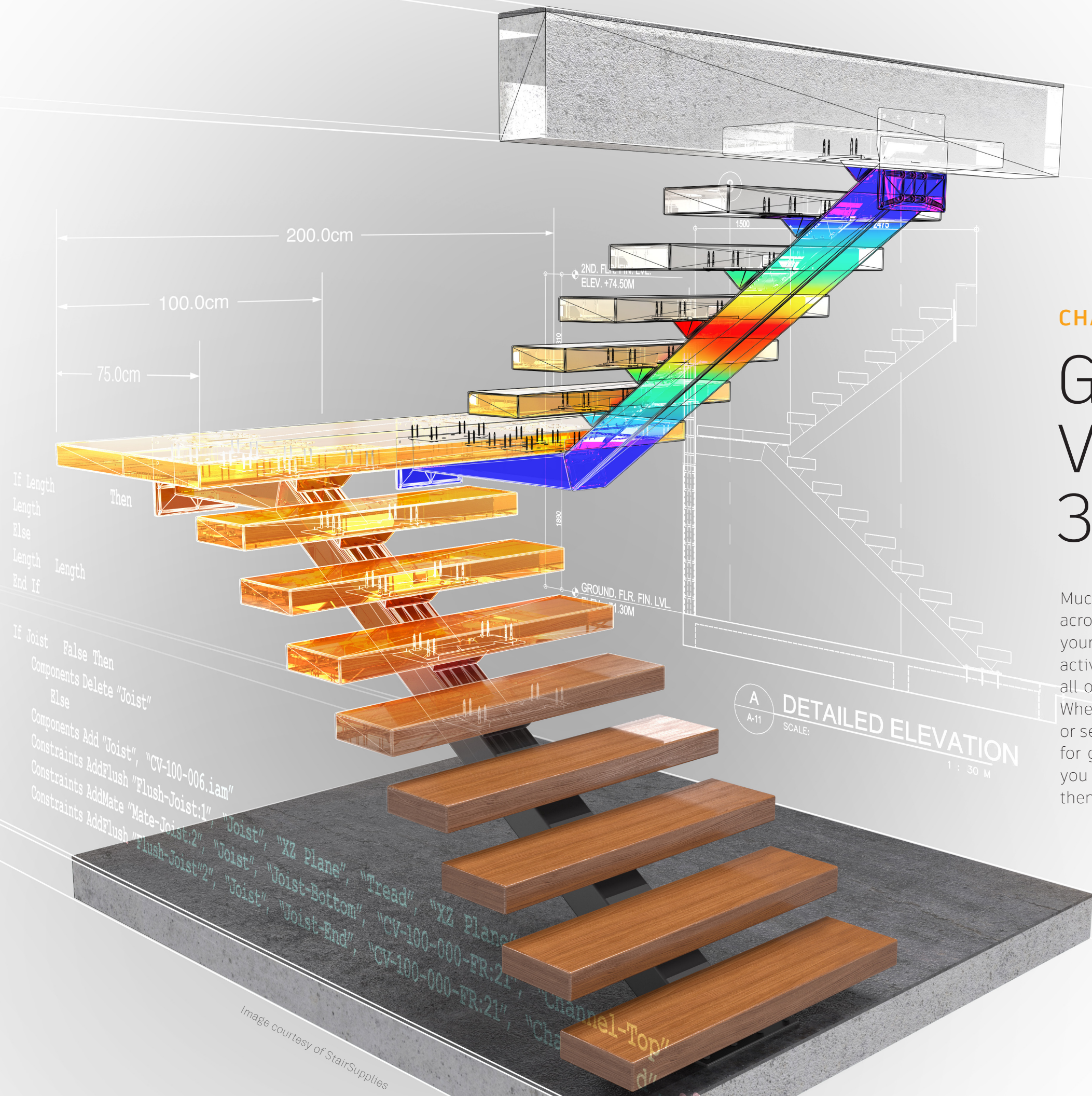
# CALCULATE DESIGN PROPERTIES

By nature, 3D CAD allows designers to manipulate measures that are impossible to determine with 2D CAD. 2D CAD only supports size calculations, but 3D models can denote mass, volume, and center of gravity. This added dimension gives designers a higher degree of control over the product definition from the very beginning of the design process.

# IDENTIFY SPATIAL INTERFERENCES

Tired of unpleasant surprises during prototyping or manufacturing? Prevent these costly mistakes by accounting for assembly and fit as you design to ensure parts will go together and move as intended—avoiding prototypes altogether. With 3D CAD, designers can easily visualize how different components in a design interact and run interference analyses to identify potential collisions between parts. Plus, AnyCAD allows you to work with data from any 3D CAD system, so you can even run checks on assemblies that include non-native parts.





## CHAPTER 3

# GET MORE VALUE FROM 3D MODELS

Much of the ROI of 3D CAD is not only in product design, but across the entire development cycle. Once you've created your parametric 3D model, there are countless downstream activities that can give your development process a boost—all of which can be done faster and more accurately in 3D. Whether you choose to begin with ways to help test, make, or sell your product, 3D CAD opens numerous opportunities for getting more out of your models. And the best part is you get to choose what's highest priority to pursue, and then build on these activities over time.

# CREATE A PRODUCT CONFIGURATOR

Configuring products to customer specification is a time-consuming exercise when using 2D or non-parametric 3D models. Manually copying all the necessary data, modifying geometry, and preparing manufacturing and technical documentation often takes days, if not weeks, of engineering time to complete.

While some configuration options can be automated in 2D, parametric modeling reduces time spent tailoring products to order from days or weeks to just hours or minutes. With iLogic in Autodesk Inventor®, you can easily define logic to configure even the most complex products. Plus, adding forms that drive the rules you've defined means you can equip your sales team with a configurator, enabling them to more rapidly respond to RFPs and freeing up engineering resources for more valuable development projects.

*"To model an impeller manually took a couple of days previously—with the iLogic program it takes about 15 minutes. If we're modeling hundreds of impellers a year, to create this program was absolutely worth it."* – Alex Curtin, Product Manager at FS-Elliott

LP2 Series Configurator

Model Series Sizing (Select from list)  
4000 Series - 340mm

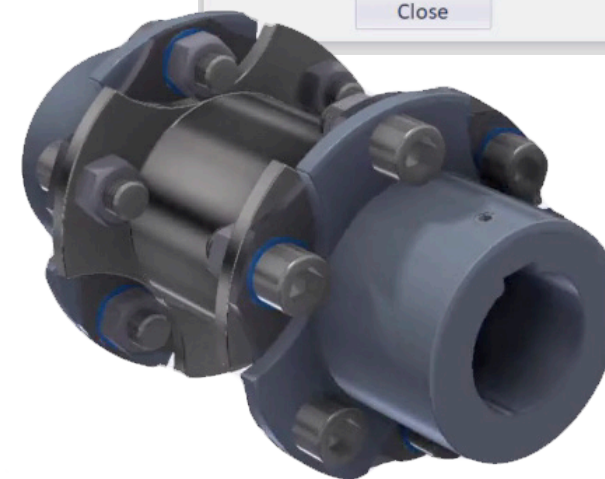
Hub 1 Diameter (Select within range) 70 mm      Hub 2 Diameter (Select within range) 70 mm

Click for PDF Specification Sheet

Reference Values Based on Sizing

Overall Length (A)	Hub to Hub (G)	Hub Fit Length (C)
340 mm	160 mm	90 mm
Set Screw Distance (F)	Hub OD (B1)	Hub Flange OD (B2)
20 mm	198 mm	120 mm
Ass'y Fasteners	Set Screw Hub 1	Set Screw Hub 2
Fasteners M20	Set Screw M12 Length 20.1 mm	Set Screw M12 Length 20.1 mm

Close Cancel Apply



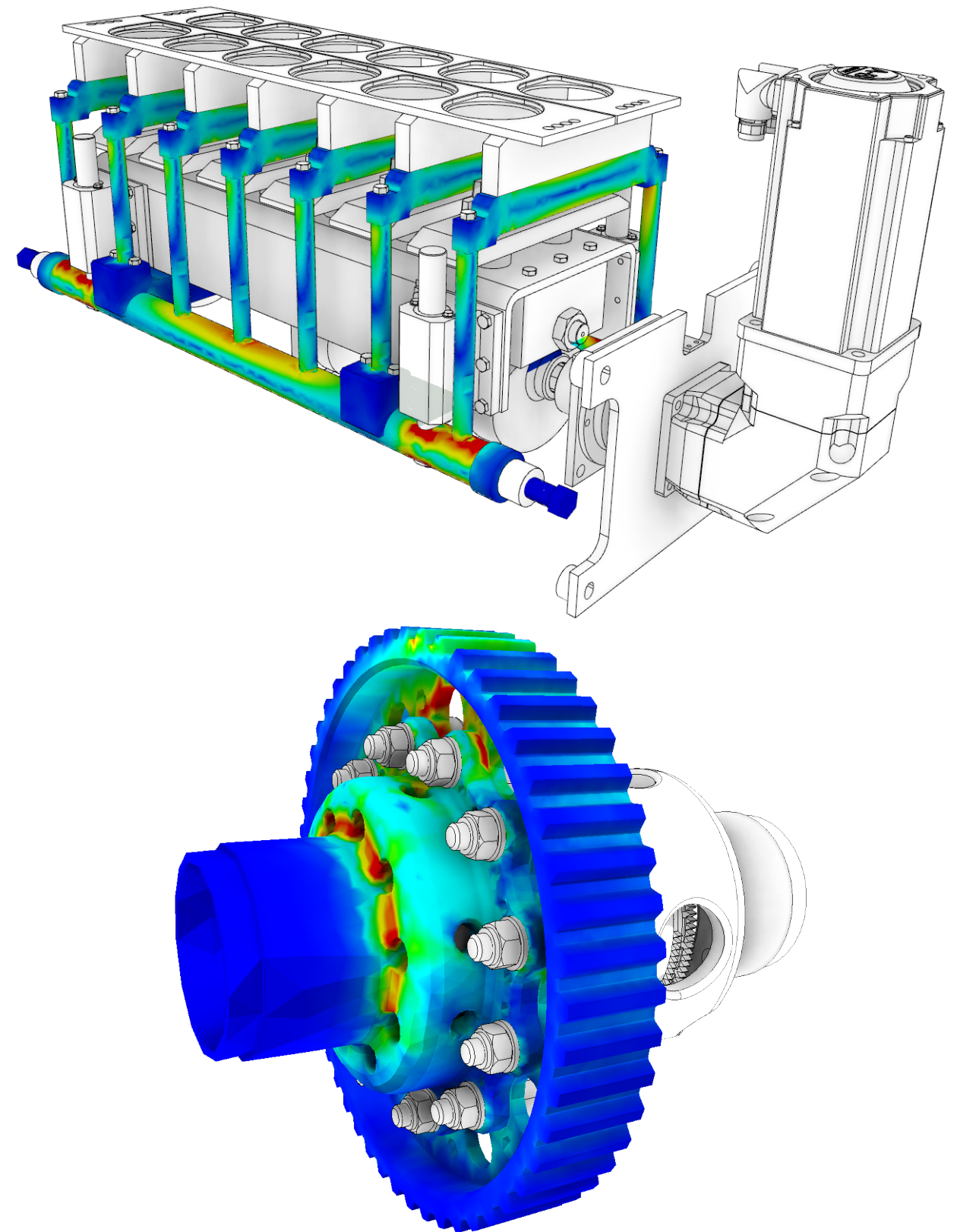
WATCH OUR ON-DEMAND **WEBINAR** TO LEARN HOW TO RAPIDLY CONFIGURE CUSTOM PROJECTS WITH DESIGN AUTOMATION.

# DESIGN VALIDATION

With 3D software, you can test and optimize designs right in the CAD environment. Rather than waiting until you have prototypes to evaluate performance, you can look for issues and opportunities for improvement as you design using advanced simulation tools that work directly on your model.

In addition to advanced motion studies, you can predict mechanical and thermal performance, vibration, fluid flow, manufacturability, and composite behavior. And even if you still need a physical prototype, 3D models make it easy to leverage 3D printing for rapid prototyping. So you can get results faster, save on massive prototyping expenses, and significantly recoup time.

*“Simulation has changed the way we design products. Two years ago, FEA was not part of our standard design cycle and now we do not hesitate to use it.” –Tom Steffan, Design Engineer at Unverferth Manufacturing.*

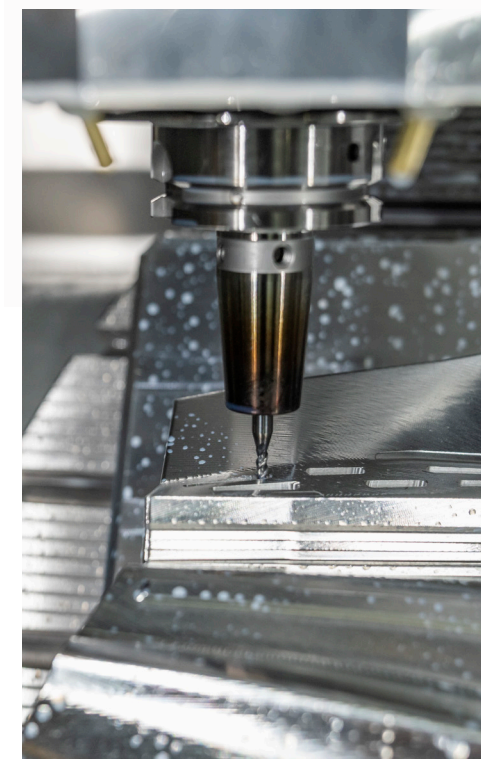
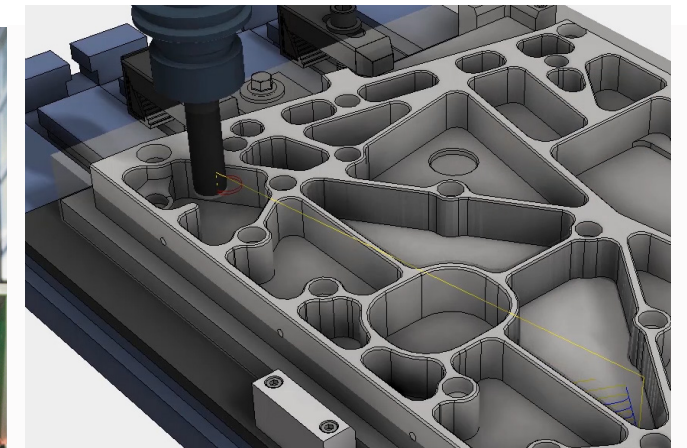


# SEAMLESSLY TRANSITION FROM DESIGN TO MANUFACTURING

Eliminating manual G-code programming for milling and turning operations requires CAM, which can only be done effectively on 3D models. Manufacturing engineers work with CAM software to generate toolpaths from product designs. When they receive 2D data, they are challenged not only to translate the design into 3D, but also to understand the intent of the designer. This extra step takes time and leaves more room for error.

Starting with a 3D CAD file smooths this transition from design to manufacturing. Manufacturing engineers can work right from the same model as the designers. Additionally, if changes are needed after a design has gone to manufacturing, associative 3D CAD and CAM data means that a change made anywhere updates everywhere, shortening the design to manufacturing cycle.

*“The shop gained a clear understanding of the design by viewing the model in a 3D environment, allowing them to fabricate the weldment much quicker. In this way we’ve been able to leverage 3D down to the manufacturing shop floor.” – Jim Lambert, Design Engineering Manager at Bosch Rexroth Canada Corp.*



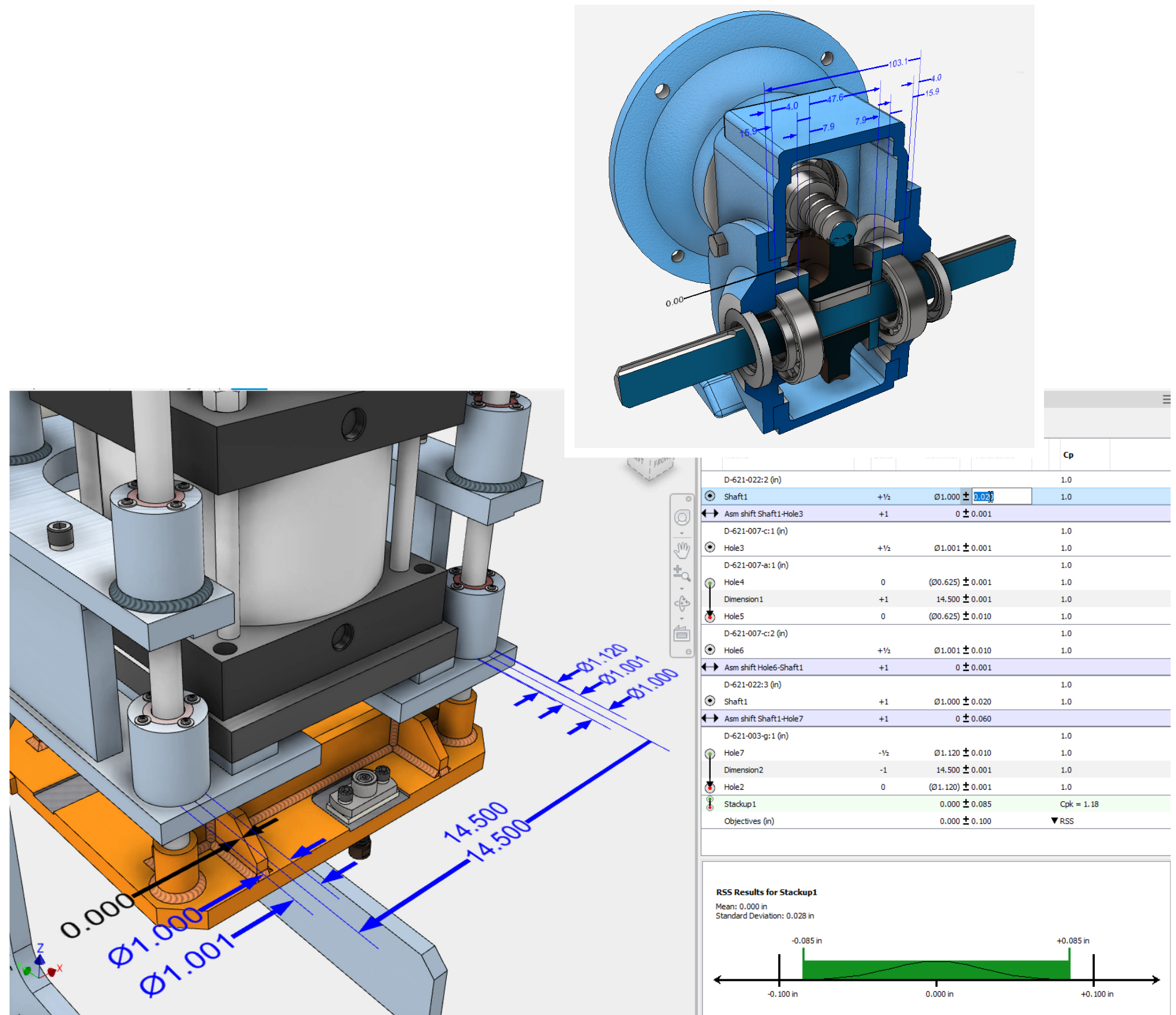
*“Now we’re pushing everything into 3D. The guy drawing glass can open one of these generators and draw the glass right on the stair system. And since it’s drawn right on top of what we’re manufacturing out of, it will be perfect.” – Ryan Rittenhouse, Engineering-Automation Specialist, StairSupplies*

# PERFORM A TOLERANCE STACK-UP ANALYSIS

An assembly is only as good as the sum of its part tolerances, but traditional methods for considering tolerance stack-ups just don't add up. Excel sheets and manual calculations leave room for error. Producing physical prototypes creates a disconnect between the CAD model and test results, which poses a problem when the 2D drawing or 3D model is changed. But, without methods for narrowing tolerance ranges early in the design process, machining processes that account for later tolerances drastically increase manufacturing costs.

So how can engineers make informed, cost-effective decisions to ensure all of the parts in an assembly will always go together while meeting performance requirements?

CAD-embedded stack-up analysis tools can report mechanical fit and performance of designs based on dimensional tolerances, but these capabilities are only available in 3D CAD software. With an in-canvas workflow that uses geometric dimensions and tolerances right on your model, analyze critical areas of your design to ensure they satisfy your objectives for manufacturing. Save on costs by reducing waste, minimizing warranty issues, reducing physical prototypes, and getting your designs to production faster.



# ELECTRICAL AND MECHANICAL SYSTEM DESIGN

When you need to design complex electromechanical systems, you need tools that can speak the same language. Ideally, you should be able to design your electrical and mechanical systems simultaneously, sharing up-to-date information between your electrical schematics and your models. If modeled in 2D, electrical and mechanical systems are disconnected until a physical prototype is made. Take the guesswork out of your design process by integrating mechanical and electrical systems in a 3D CAD system.

Not only can you use the schematic to discover potential design problems early, like where wires will be located on the product itself, or whether there will be enough physical space for servicing, but you can also prepare for manufacturing. Associative linking between your electrical schematic and your 3D model enables you to map electrical connectors and components to a 3D model library, so they automatically populate in your design, while also routing wires, cables, and harnesses. The 3D CAD system will even produce the BOM for the wire and connectors you need to actually make your system.

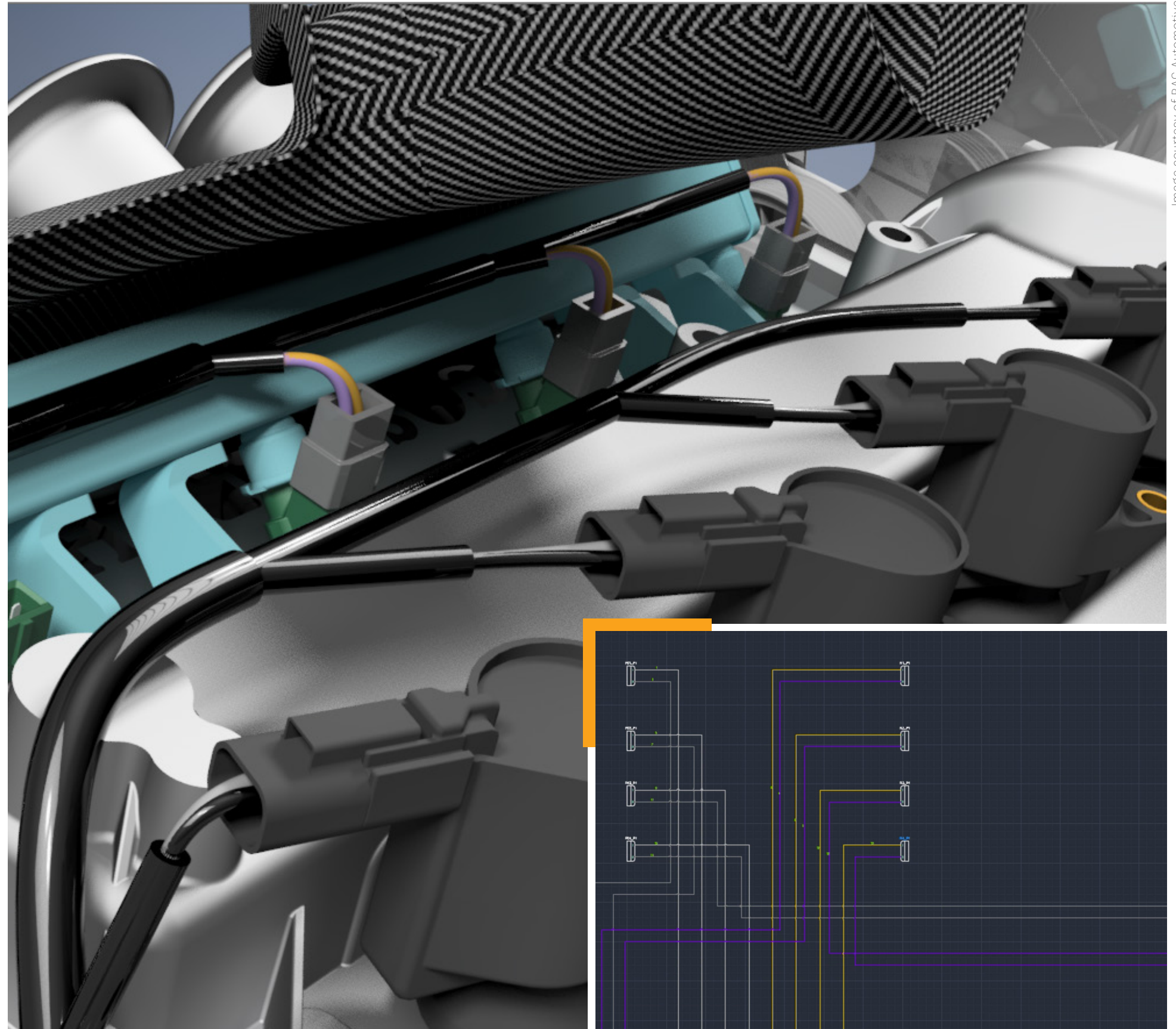


Image courtesy of BAC Automotive

## AUTOMATE COMMON TASKS

The opportunities presented by 3D parametric modeling are not limited to what you can do to a model itself; there are also chances for streamlining your processes. Automation of your processes can help you advance projects to completion in mere seconds, which frees up valuable time for the tasks that require your level of skill and engineering knowledge.

An automated approach offers options from basic parameters to cloud-based automation, but at its most fundamental, design automation provides a systematic way to capture and re-use engineering knowledge and intent to reduce or eliminate human effort on future tasks. Because 3D CAD software contains a rules-based system that can be used to drive parameters and attribute values in your models, you can streamline workflows and tasks by focusing your efforts on capturing and communicating elements of your parametric design. Then, your design intent can be incorporated into your automation workflows and utilized to build on the work you have already completed.

The time it takes to manually model common design elements like bolts and chamfers adds up quickly. For example, every individual bolted connection requires a multi-step process of adding a correctly sized bolt, nut, washer, and a hole for it to pass through. These tasks can be reduced to one step with design accelerators only available in 3D CAD. Built-in rules-based design technology can easily define logic without complex programming. Plus, you can use built-in calculators to determine the appropriate sizing based on loading or other requirements.

WANT TO LEARN MORE  
ABOUT HOW YOU CAN  
STREAMLINE REPETITIVE  
ENGINEERING TASKS?  
DOWNLOAD OUR  
**E-BOOK**, 'PRACTICAL  
APPLICATIONS OF DESIGN  
AUTOMATION'

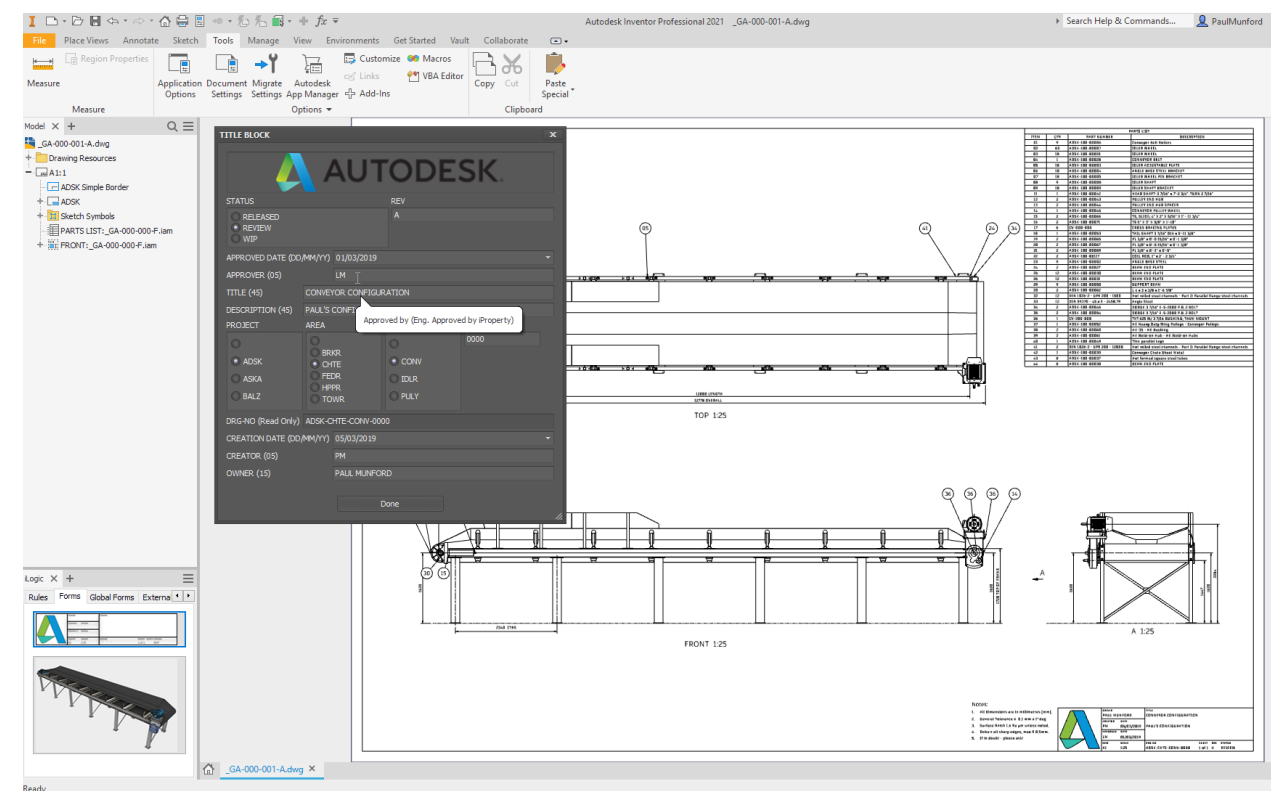


Image courtesy of Balzer Pacific

## CHAPTER 4

# REUSE EVERYTHING YOU'VE CREATED

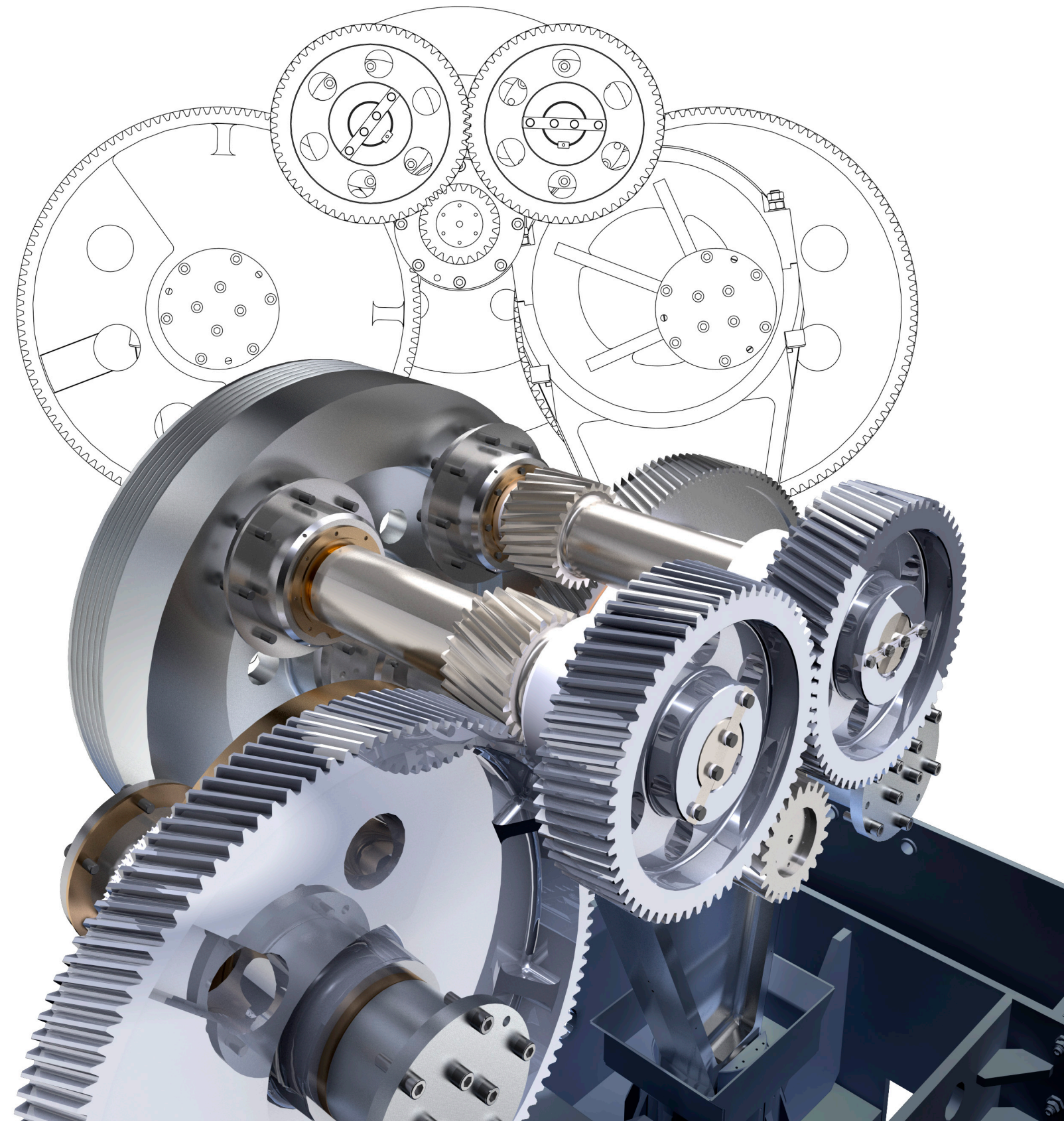
One of the most common concerns over moving from 2D to 3D modeling is the lingering question, "Won't we have to redo or lose all of our legacy data?" The sure answer to that question is no. When making the move to 3D, you don't lose anything you've created to date. Quite on the contrary, you can take all of your existing design data with you and make it even more valuable.



When switching to a 3D CAD system, you can reuse your library of 2D designs by referencing DWG files as associative underlays that can be used to generate a complete 3D model. Then, make adjustments to existing designs more quickly and easily instead of recreating the wheel.

3D CAD helps maximize your return on investment in design data by enabling you to use it again and again. Switching to 3D CAD as a primary design tool might seem daunting when considering all your 2D legacy data, but in reality, you can keep your 2D data just as it is until you need to convert it into 3D. And continue to use 2D whenever it's the right tool for the job—associative connections between software disciplines keep all your data in sync, regardless of where it was created.

Also, creating 3D versions of 2D data might not be as complicated as you think. Existing 2D drawings already have the hard parts covered—the sketches are done and the bulk of the data is already there. When you convert into 3D, the software performs the heavy lifting. All designers might have to do is a bit of fine-tuning.





## CHAPTER 5

# SO, WHY 3D CAD?

Moving from drafting boards to CAD software transformed how products were designed and opened countless new possibilities for engineers. Today, manufacturers have yet another opportunity to upgrade their development processes by introducing parametric 3D CAD. 3D software enables manufacturers to develop products faster while exploring a wider range of options—making the move to 3D well worthwhile.

# WHY NOT 3D CAD? MISCONCEPTIONS HOLDING YOU BACK

Despite its many benefits, some manufacturers have yet to take advantage of 3D CAD due to misconceptions around function and implementation.



**Won't we have to migrate, redo, or lose all our legacy data?**

Nope. Your 2D data works in your 3D CAD tool (and vice versa), so take a case-by-case approach for choosing the best tool for the job.



**Our 2D software is working just fine—we don't need 3D.**

That's a dangerous perspective, and it will only hold you back. Some things just can't be done in 2D, like advanced simulation, parametric modeling, and detailed, photorealistic renderings. Plus, 3D CAD offers advantages in design efficiency and downstream collaboration.



**Simple designs don't require 3D software.**

3D CAD isn't just for designing complex assemblies. Even if 2D CAD seems like the faster and easier option upfront, much of the ROI of 3D CAD is not only in product design (although even the simplest part has something to gain from its enhanced capabilities and streamlined workflows), but throughout development and manufacturing.



**We need to stay productive, but implementing new 3D CAD software will slow us down.**

Manufacturers that have already adopted 3D CAD attest that, with a strategic plan for rolling out the new software, you can keep up your pace and quickly experience efficiency improvements. Additionally, since your design data is associative, you don't have to worry about downtime due to migration or flipping the switch from one to the other.



**Isn't 3D CAD expensive?**

The cost of 3D CAD will be returned over and over again in efficiency gains, reduced waste, improved product quality, and the value you can offer to customers.



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