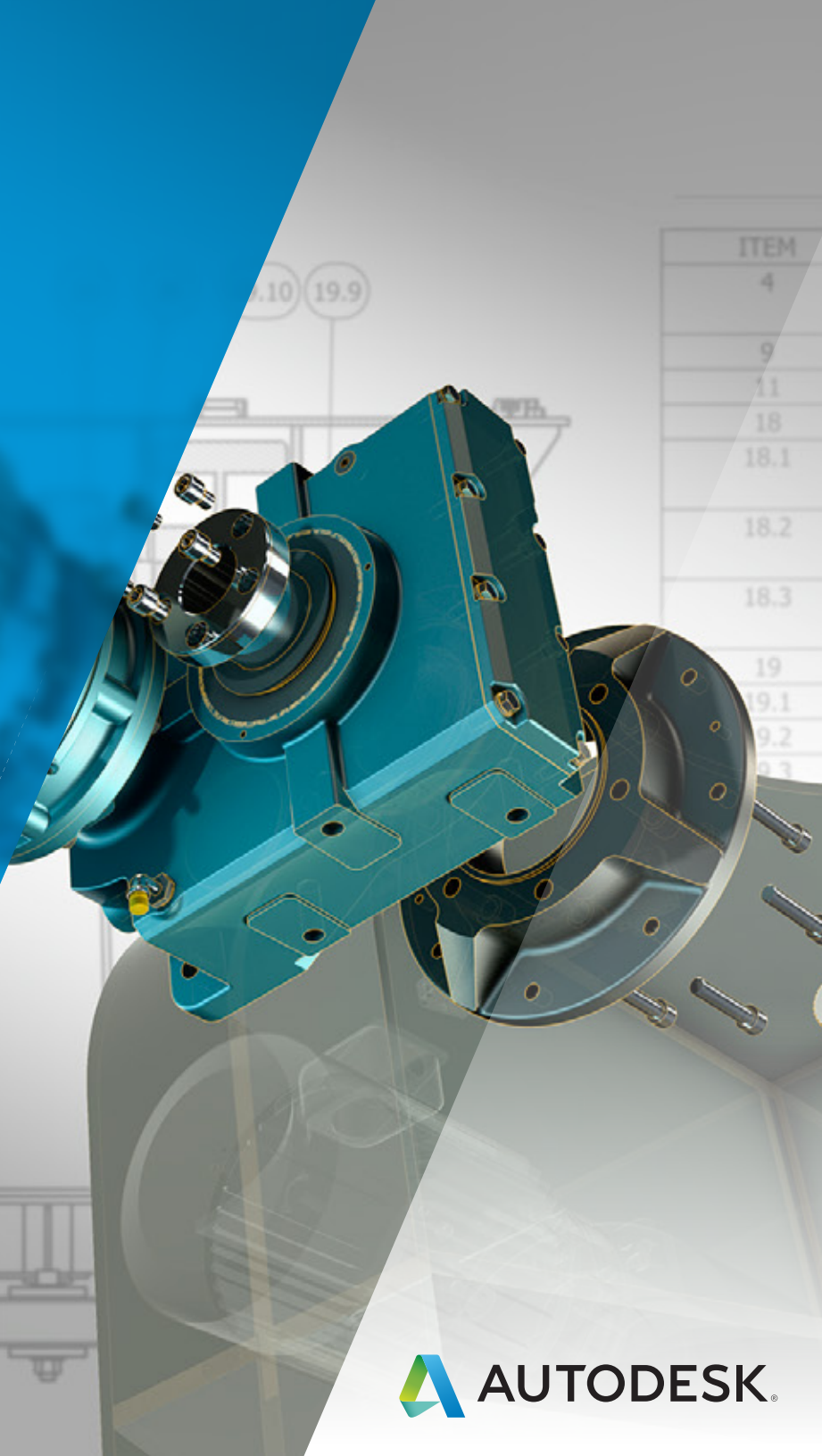
Essentials of 3D CAD for 2D users

How 2D and 3D CAD work better together

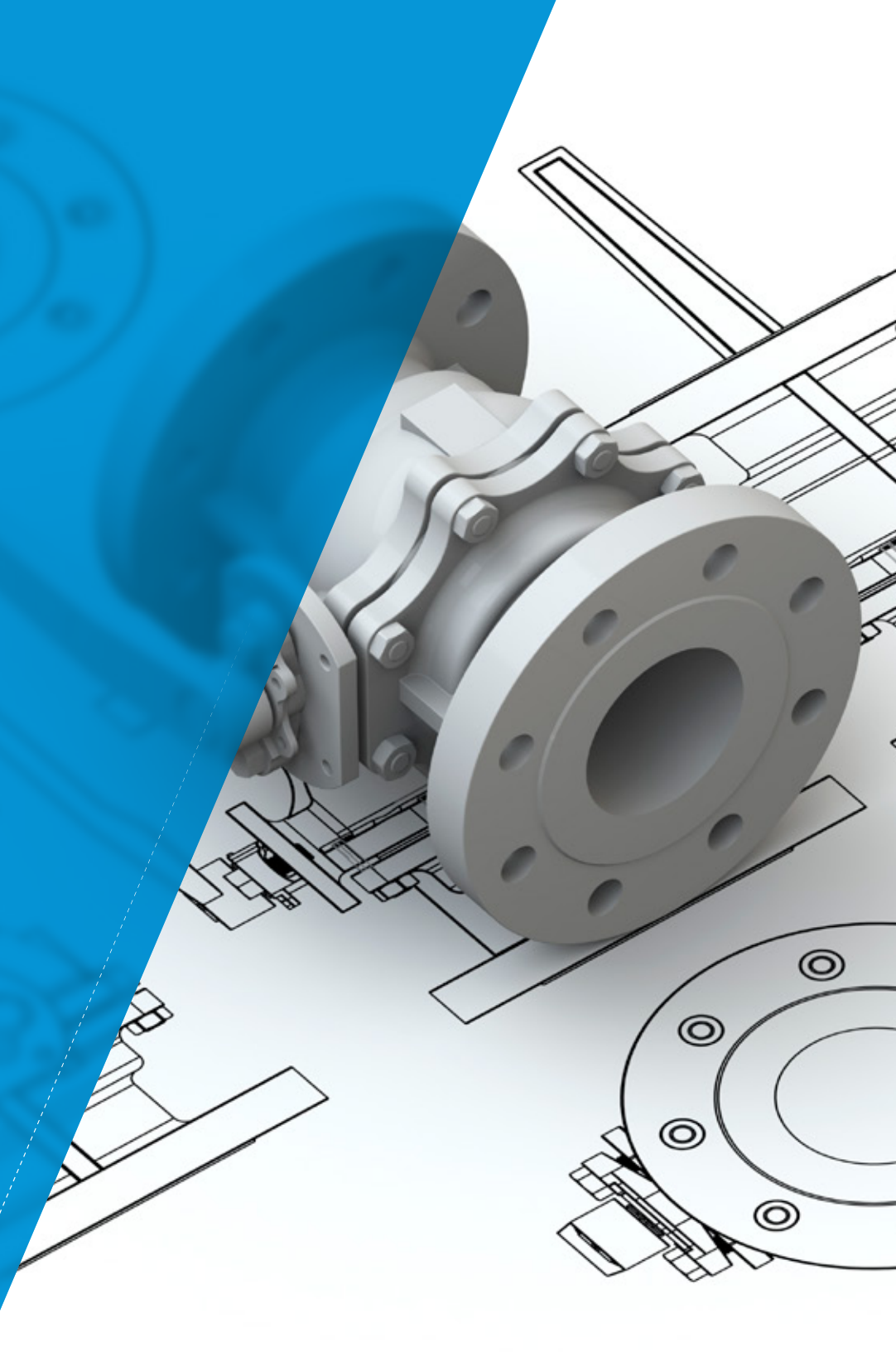


AUTODESK.

Chapter 1

The benefits of 3D CAD

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.



One of these tools is parametric 3D CAD. Adding 3D to the development process helps companies enact changes that help enhance quality and performance, reduce costs, increase innovation, and improve productivity.
Just like digital design hasn't fully replaced pencil and paper, 3D CAD hasn't fully replaced 2D. In fact, they *work better together.* Associativity between 2D and 3D allows you to:

Improve

design efficiency by reducing time spent on manual tasks

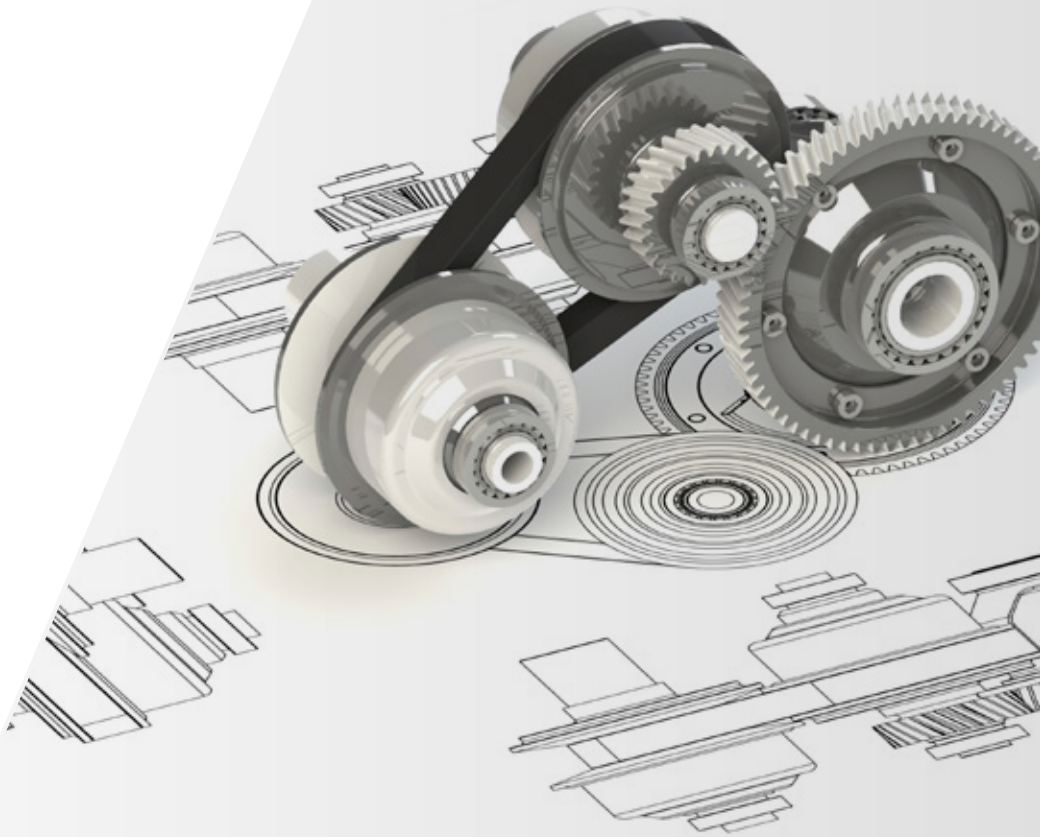
Connect

2D and 3D workflows so the right tool can be used for every job

Get more

value from 3D models across the development

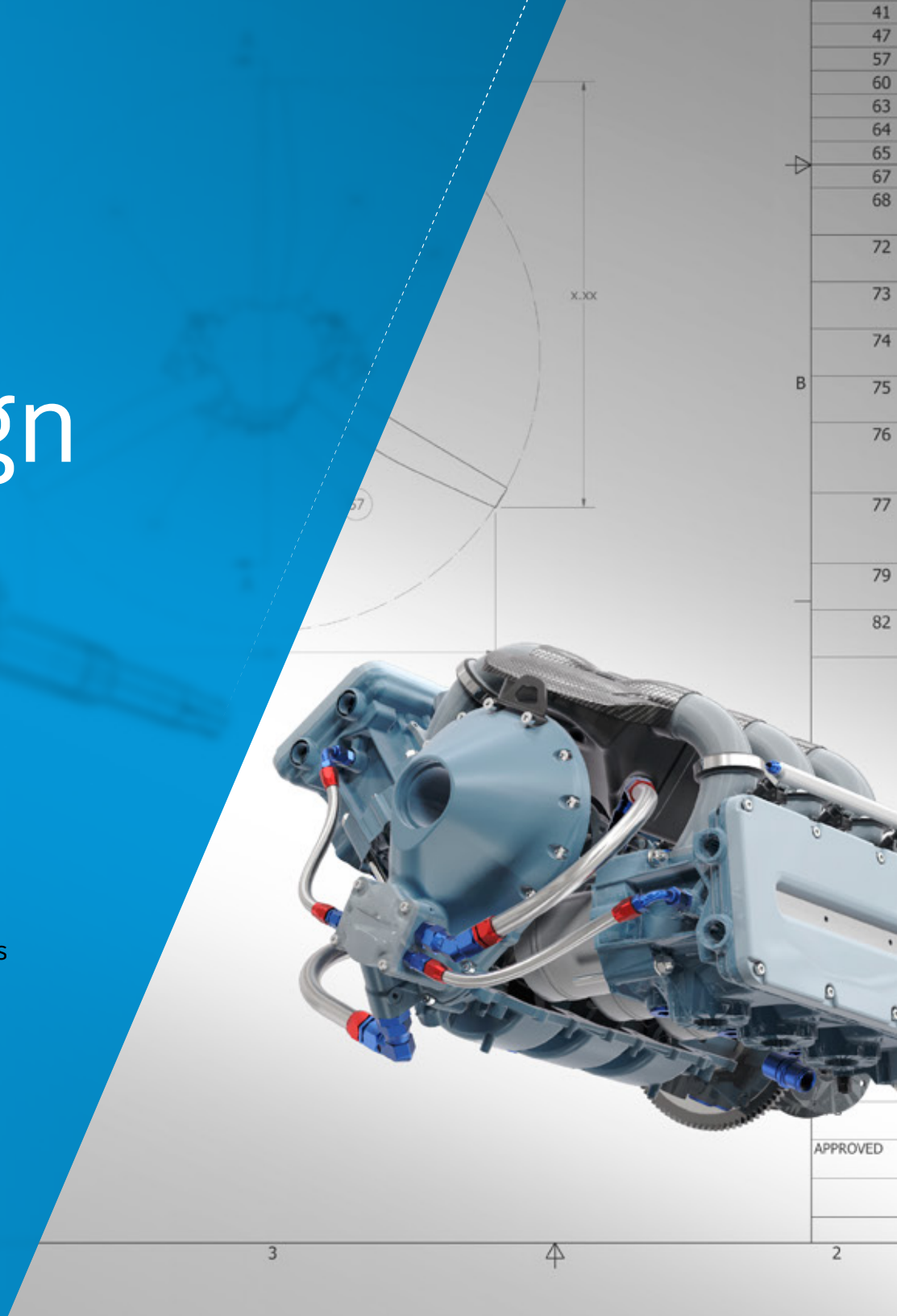
So, why 3D CAD? What can you do with 3D that you can't do already? As it turns out, quite a bit.



Chapter 2

Improve design efficiency with 3D CAD

Parametric modeling builds up a 3D model 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. This refocuses efforts on designing–not the interface–while reducing time spent on manual tasks.



Quickly make design changes

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 impact 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.

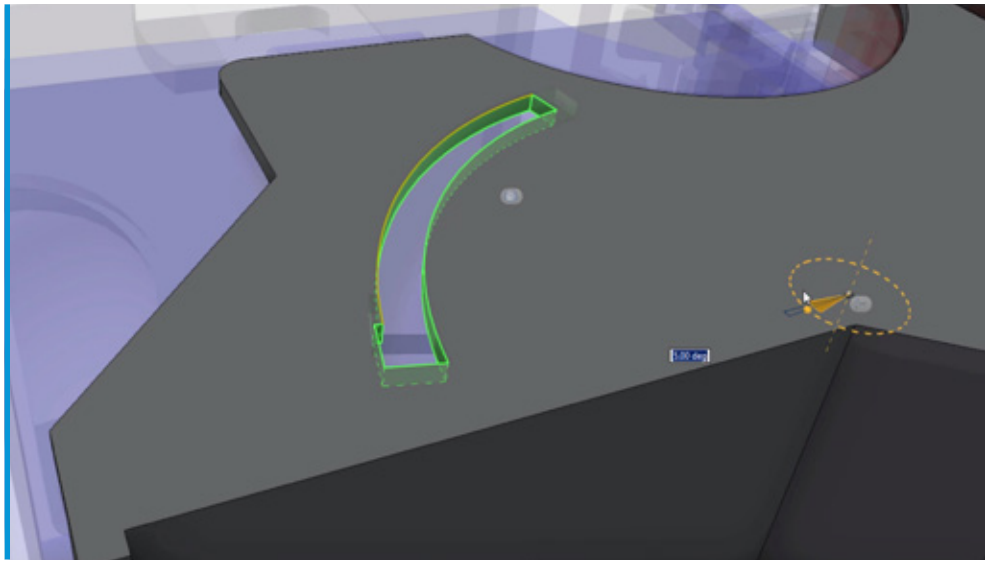
3D CAD takes the heavy lifting out of design changes while significantly reducing risk of error. Modifications immediately update in the model, bypassing tedious and time-consuming manual revisions. In other words, you can make your design changes … once.

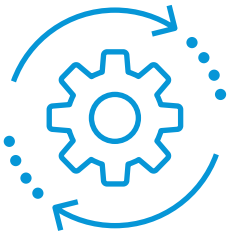
> "We used to make changes in one view in AutoCAD, but they weren't updated in another view. Now, we know that when one feature changes on a model, every drawing that relates to that feature will be automatically updated."
>
> –Jim Lambert, Design Engineering Manager at Bosch Rexroth Canada Corp.

Instantly update all downstream deliverables

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.

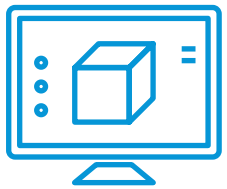
On the other hand, changes made to 3D models are instantly updated in downstream deliverables. Every file stays perfectly in sync.





Automate common modeling tasks

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 multistep process of adding a correctly sized bolt, nut, washer, and a hole for it to pass through. These tasks can be reduced down 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.

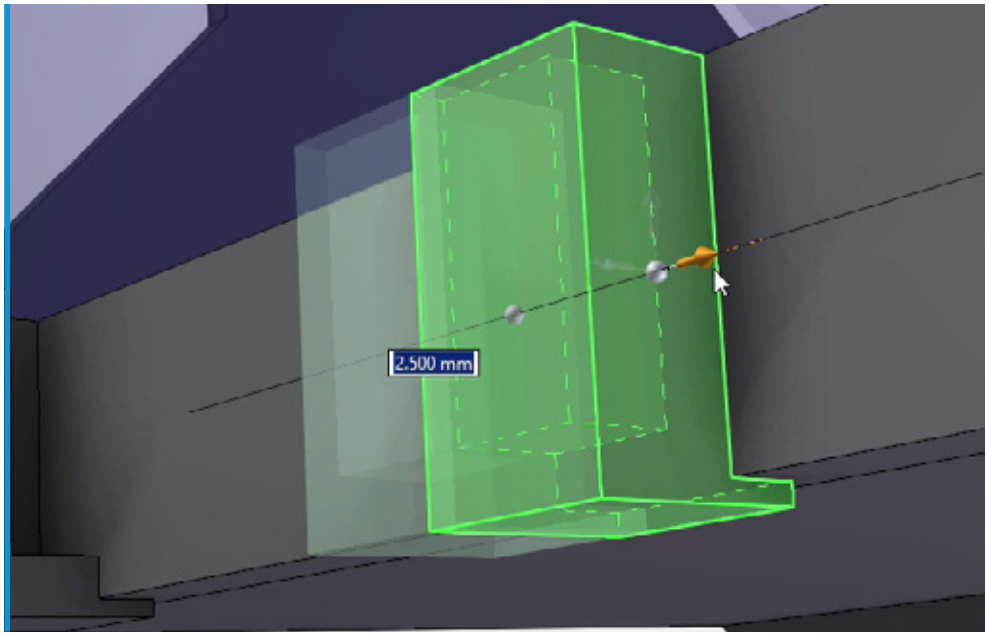


Control product configuration

Configuring custom products to spec is often a tedious exercise. 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. Easily define logic to configure even the most complex products. Plus, adding forms that drive the rules you've defined means you can potentially offload the configuration work to your sales team, freeing up engineering resources for more valuable development projects.

Choose from flexible modeling options

While parametric modeling is undeniably powerful, there will always be situations when alternative approaches are not just more efficient but necessary. That's why 3D CAD doesn't just equip you with parametric modeling. It also empowers you to choose the best technique for the task, including modes for direct, parametric, and freeform modeling.

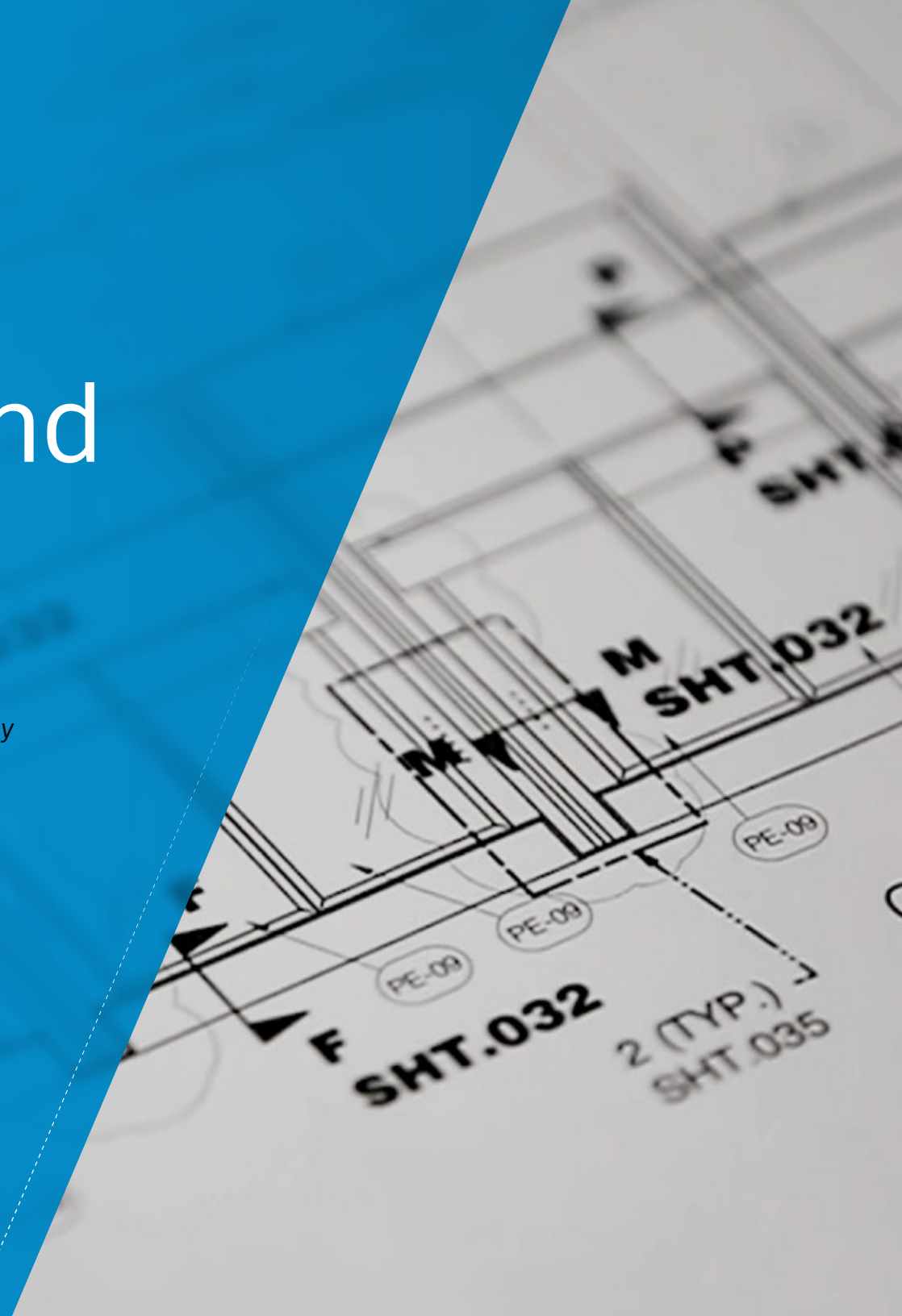


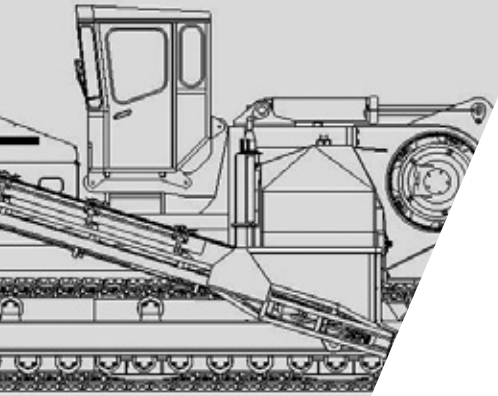
Chapter 3

Connect 2D and 3D workflows

CAD software isn't a matter of either-or. Instead, ask *why not both?* Associative connections between 2D and 3D platforms allow you to choose the right tool for every job. Even if you're starting with existing 2D design files, mechanical concepts, wiring diagrams, or large-scale production system layouts, you can easily generate 3D models for specific use cases.

While it's true that designing with 3D CAD alone allows you to be more productive than working with 2D alone, combining the two produces the best outcomes. Here are some examples of how connected workflows unlock the best of both tools:





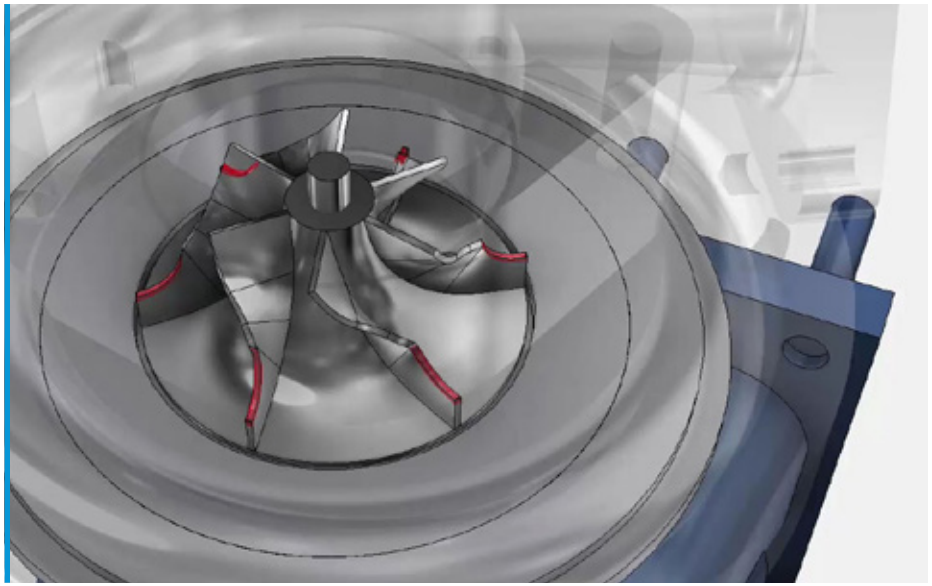
Increase opportunities for design reuse

At its most basic, design reuse involves finding data and leveraging it in another design, but most cases aren't so simple. In reality, reusing designs often requires a number of revisions. This often becomes a tedious task with 2D CAD. Sometimes engineers even choose to start from scratch rather than deal with the hassle of repurposing old 2D data.

On the other hand, it's much easier to edit and fine-tune designs with parametric modeling. 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 re-creating the wheel. 3D CAD helps maximize your return on investment in design data by enabling you to use it again and again.

Checking and collision detection

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 watch for interferences, collisions, and clearances as they work to avoid common and costly downstream issues. 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.

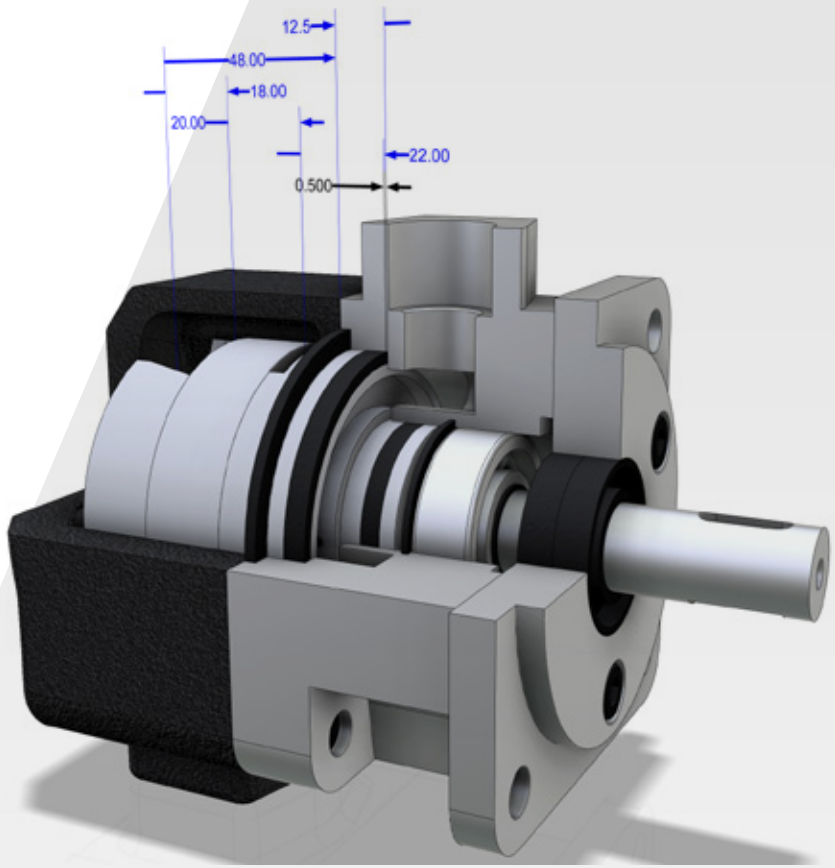


Tolerance stackup analysis

An assembly is only as good as the sum of its part tolerances, but traditional methods for considering tolerance stackups 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 tolerances later on drastically increase manufacturing costs.

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

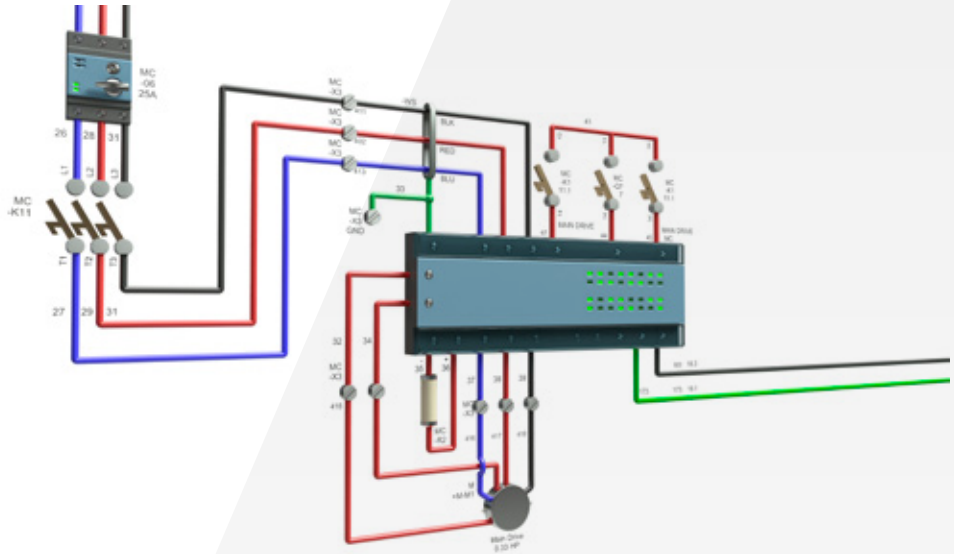
CAD-embedded stackup analysis tools can report mechanical fit and performance of designs based on dimensional tolerances, but these capabilities are only available in 3D CAD software. With an in-canvas workflow that uses geometric dimensions and tolerances right on your model, analyze critical areas 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.



Design electrical and mechanical systems concurrently

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 3D models.

Bridge the gap between electrical and mechanical designers by connecting your individual tools in real time. The foundation of this workflow is the ability to share information back and forth using a simple electromechanical link. Once established, you can start sharing live data between 2D electrical design and 3D modeling platforms. Any changes you make in one system are quickly synced in the other, so everyone is always working from the latest version of the design. In addition, you can even get a catalog of 3D parts mapped to components of the electrical schematic–along with automated wire connections and harness layouts.



Generate 3D representations of 2D factory layouts

Create large-scale production systems by placing components and optimizing factory material flow inside the 2D CAD environment. Interoperable software automatically converts 2D drawings into 3D visual layout environments. You can then integrate reusable 3D models of machine and factory components with simple drag and drop techniques–helpful for collision detection and visualization of the final design. Bidirectional associativity between 2D and 3D means data stays in sync whenever the layout design changes.

Chapter 4

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. Whether you work primarily in 2D or 3D CAD, there are many instances in which 3D CAD can augment both design and downstream processes. Associative design data means you can transition easily from one tool to the other, tapping into the unique capabilities of each with a seamless workflow that maintains the complex relationships between all your files.

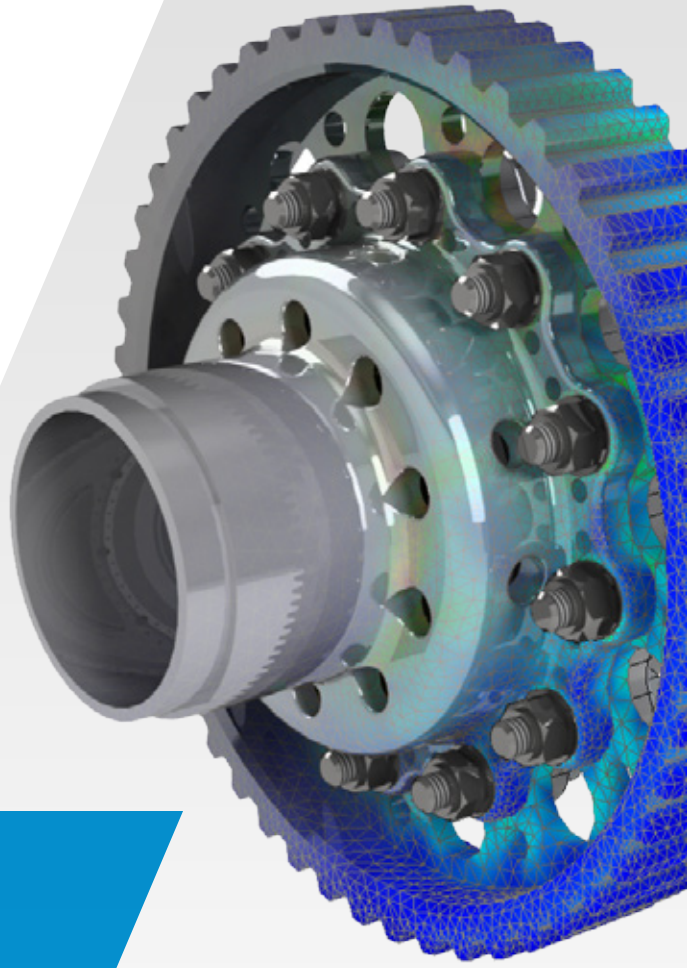
Create documentation

3D CAD reduces costly downstream errors by automatically generating and maintaining accurate documentation, including BOMs. Any time a change is made to the design, these will stay up-to-date since all your data is associative. Plus, you can even generate native documentation from files originally created in 2D using your 3D CAD tool.

Design validation

Test and optimize designs right in the CAD environment with 3D software. Rather than waiting to analyze performance using simulation software or prototypes, you can look for issues and opportunities for improvement as you design using advanced simulation and stress analysis tools that work directly on your model.

Furthermore, with built-in simulation capabilities, you can reduce or totally eliminate the need for physical prototypes. 3D CAD equips engineers to quickly analyze product performance with software instead of creating costly prototypes. Even if you still need a physical prototype, 3D CAD enables you to leverage 3D printing for rapid prototyping. Manufacturers can get results faster and save on massive prototyping expenses and significant time investment.



"Instead of having to look at a flat drawing and try to picture in your mind where you may have potential problems, it's right there in front of you."

–Bob Van Vliet, Assembly Shop Manager at Bosch Rexroth Canada Corp.

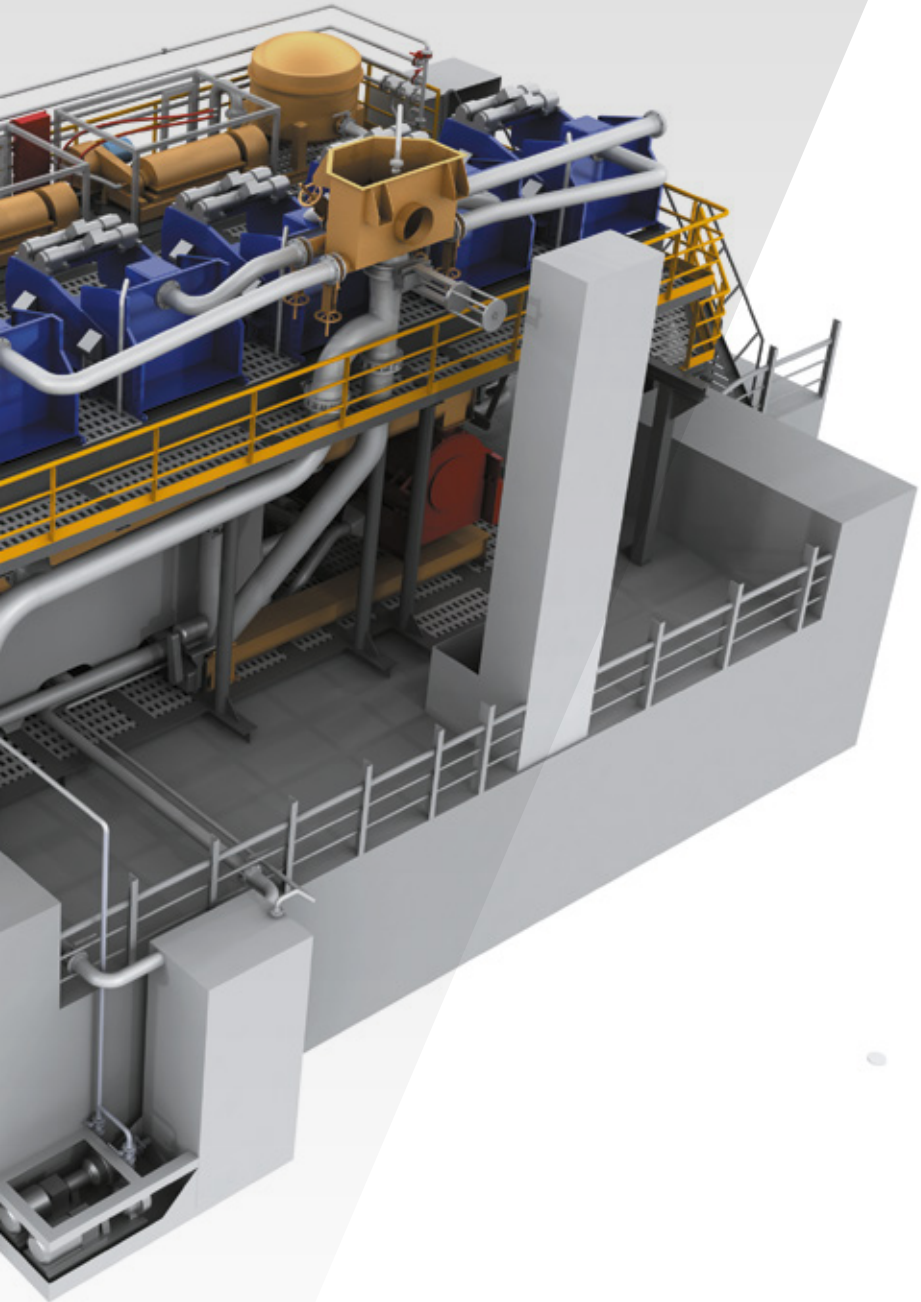
Design visualization

There's a big difference between reviewing a blueprint and walking through a house. A blueprint alone won't reveal areas for concern, like water damage or cracked drywall. It can't show you how the house looks in the real world. Additionally, the home you envision based on the print might not be the same as the home someone else sees, creating a gap in communication that leaves you prone to misunderstanding and error.

In much the same way, 2D CAD doesn't paint the full picture of a product as well as 3D CAD. *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 actually 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, Drawing Office Manager 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.

"When our marketing department sees the renderings, they can't believe their eyes."

–Jim Lambert

Design properties

By nature, 3D CAD allows designers to manipulate measures that are impossible to determine with 2D CAD. 2D CAD only supports height and weight, 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.

Go to manufacturing

3D CAD bridges the gap between product designers and manufacturing engineers.

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 3D 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

Downstream collaborators

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. The solution? 3D models are comparatively easier to comprehend for both frequent CAD users and non-technical staff. If you're throwing 2D drawings over the wall just hoping non-designers on the other side will be able to interpret them, 3D CAD can help.

All this leads to benefits like:

Faster approvals

If managers are able to quickly understand a design, they're more likely to quickly turn them around, too.

Improved collaboration

3D visuals help everyone involved stay on the same page by showing a clearer picture of how a product actually looks and moves in the real world. Associative design data also ensures everyone is using the same, most up-to-date data.

More winning bids

3D visual representation empowers sales and marketing to present stronger proposals by bridging the CAD-to-business language barrier.

Shorter production cycles

Manufacturers can work directly from the same 3D model as designers, eliminating some handoff steps and leaving less room for error.

Quick and clear feedback

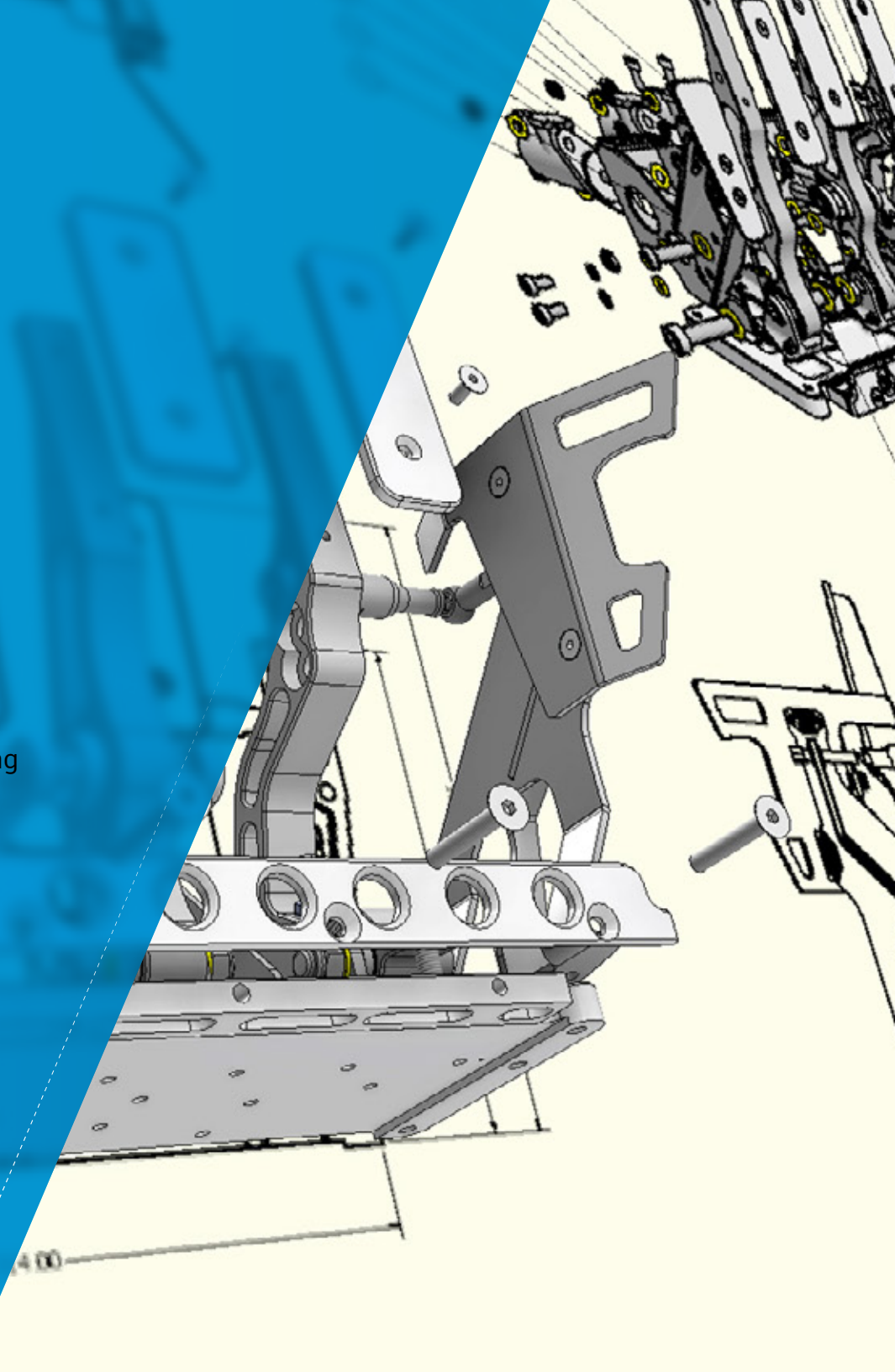
3D CAD allows you to share files with varying levels of permissions. Stakeholders can provide input right on 3D models while gaining perspective on how the product looks and moves in the real world without having to read the designer's mind.

Chapter 5

2D or not 2D?

So, what if you're already using a 2D CAD tool? Implementing 3D CAD software doesn't require a complete overhaul of your current system, nor scrapping or migrating your entire library of 2D data. Actually, there are a couple options for mixed CAD systems that allow you to experience the advantages of both 2D and 3D software while moving at your own pace.

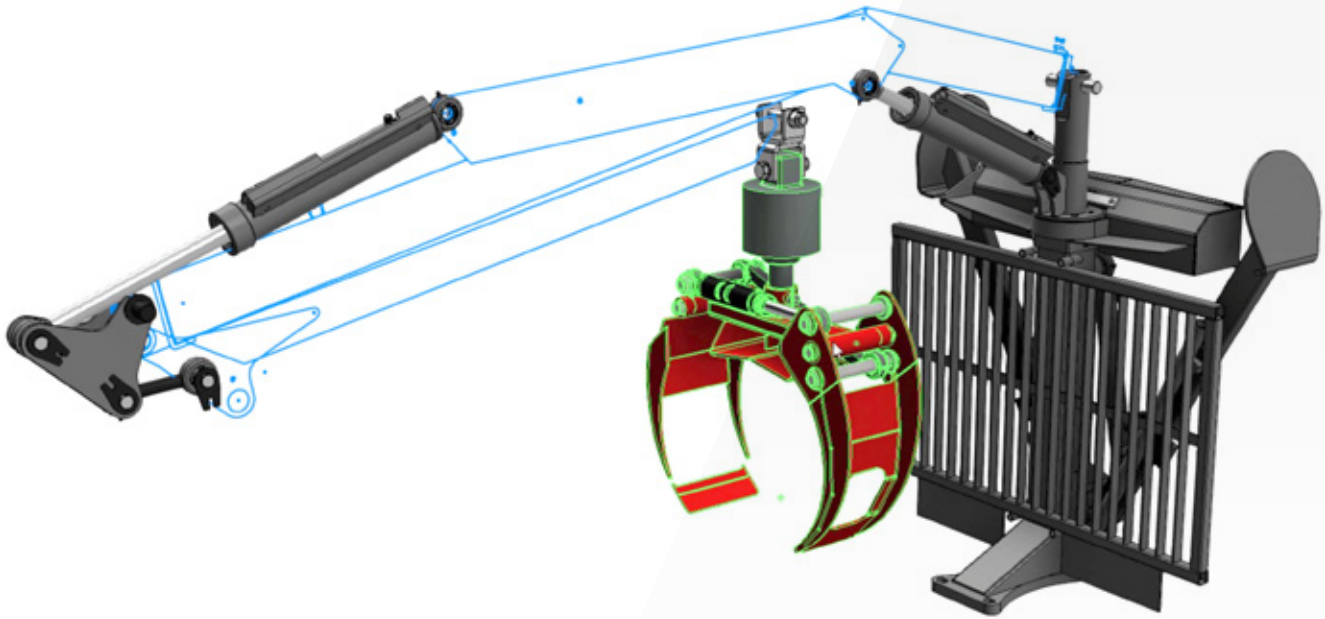
Almost 50% of manufacturers reported concerns around collaboration between 2D and 3D designs.



1. Start in 2D, and generate 3D models for downstream use cases

If you prefer to design primarily with your 2D CAD tools, you can still benefit from creating 3D models from your 2D data at the end of the design process. Do the bulk of your design work in 2D, then leverage 3D models for things like simulation, CAM, marketing and sales materials, and proposals.

This can be a strategic approach if you plan to transition to an exclusively 3D CAD system. Instead of flipping the switch immediately, ease in to a primarily 3D process. This gives teams time to familiarize themselves with your new 3D tool and its capabilities, while continuing use of your existing 2D data without hassle.



2. Make 3D models your single source of truth

In this approach, you can think of 3D CAD as your primary design tool—or the digital master version of your designs—and 2D CAD as a supplementary tool with specific use cases. In other words, work on one master 3D model with multiple CAD tools. *You don't have to ditch your 2D CAD software.* It works well with 3D CAD and still serves some key purposes. For instance, 2D CAD can be a great option for conceptual design or documentation.

Associative 2D and 3D CAD data makes partnering the two tools simple. Make a change on your 2D drawing? It will automatically update on your associated 3D model. Editing with 3D CAD? 2D documentation will stay up-to-date in real time.

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 it. Then, you can choose to continue working with 2D CAD, or migrate the data into 3D.

Small, simple changes can easily be made in the original 2D CAD environment. But if you're starting a new design or need your legacy data for a complex, ongoing project, consider migrating your 2D data into 3D so you can leverage enhanced design capabilities.

Finally, 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 migrate into 3D, the software performs the heavy lifting. All designers might have to do is a bit of fine-tuning.

Chapter 6

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 with 2D and 3D workflows.

By building on the capabilities you already have with 2D 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.

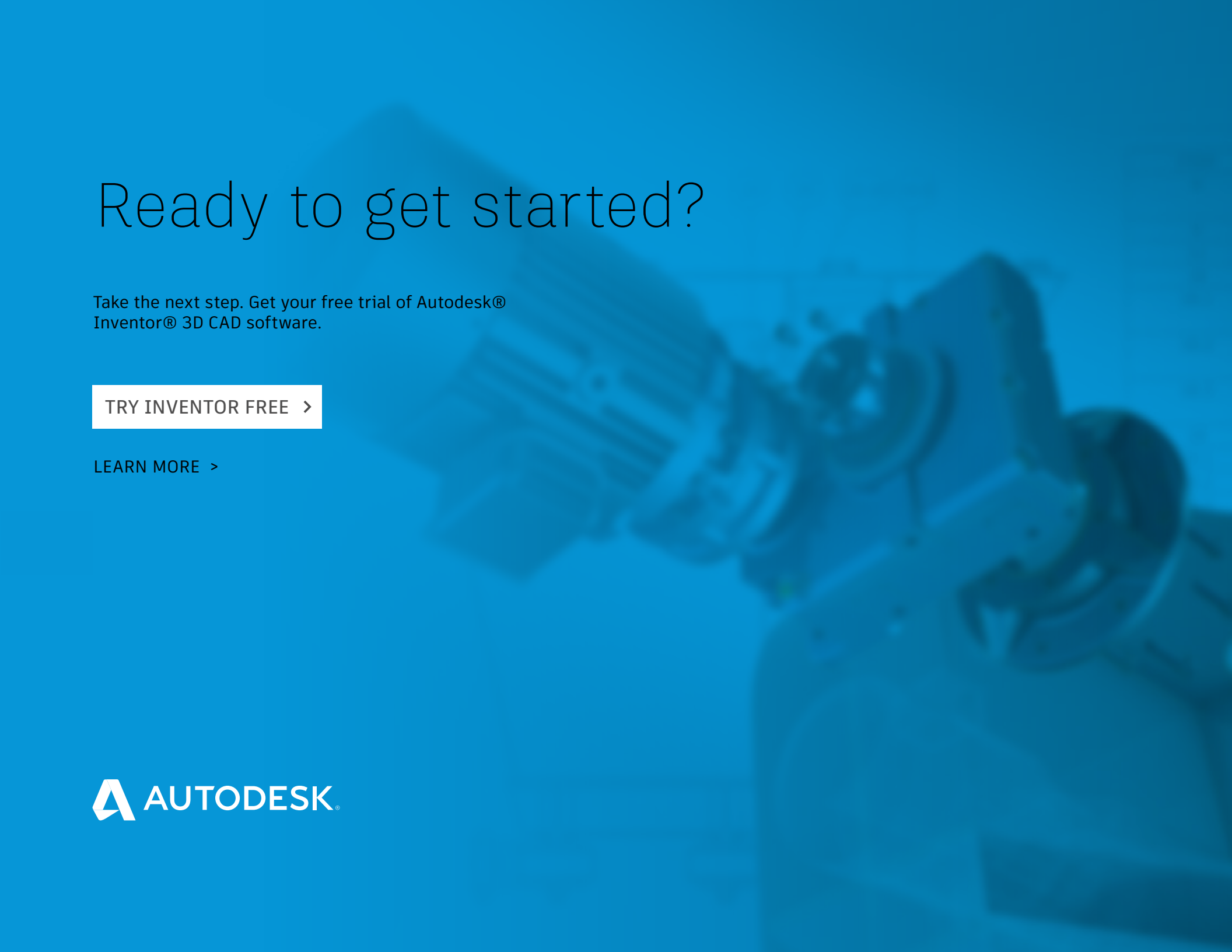
Barrier #1: Won't we have to migrate, redo, or lose all our legacy data?
Nope. Your 2D data works in your 3D CAD tool (and vice versa), so take a case-by-case approach for choosing the best tool for the job.

Barrier #2: 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.

Barrier #3: 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.

Barrier #4: 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.

Barrier #5: 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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