Simplified CAD Models
for Fast 3D Workflows

How companies in the automotive, aerospace and mechanical engineering industries manage the growing complexity of their CAD data and significantly accelerate their 3D processes.

CT CoreTechnologie GmbH
www.coretechnologie.com

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1 Introduction: Turning 3D Data into a Competitive Advantage

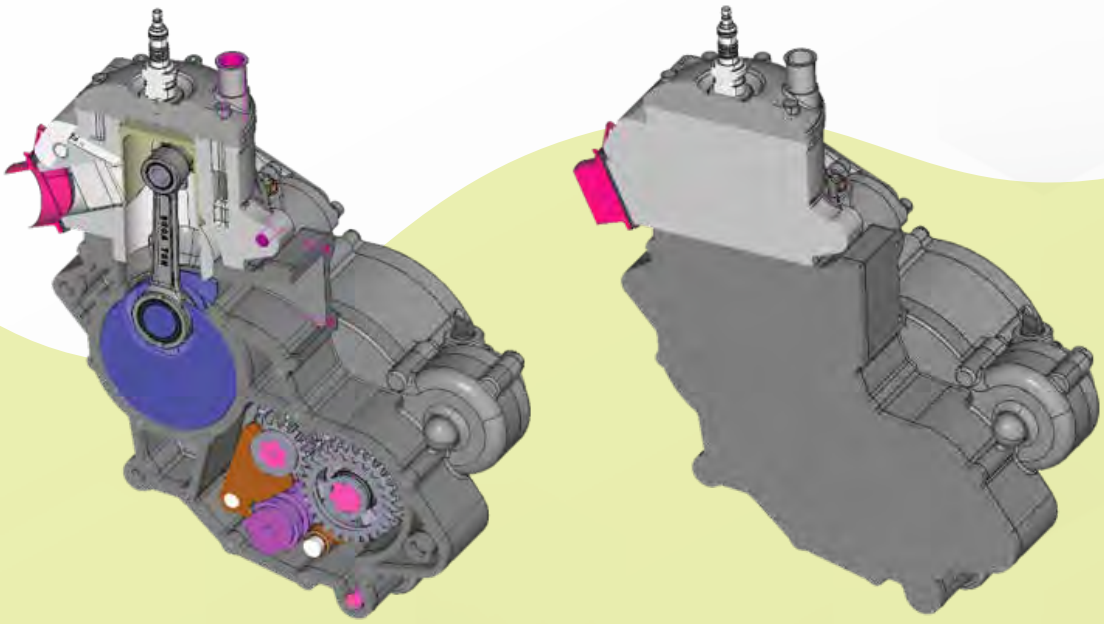
Over the past two decades, 3D models have evolved from pure design data into a central source of information across the entire product lifecycle. Today, they are used far beyond the CAD workstation—supporting CAM manufacturing, marketing visualizations, virtual reality applications, factory planning simulations, quality inspections, and data exchange with suppliers.

There are clear economic reasons behind this development. According to a study by the National Institute of Standards and Technology (NIST), poor CAD interoperability costs the U.S. manufacturing industry between $20.9 billion and $42.9 billion every year. In the automotive industry alone, NIST estimates annual losses caused by inadequate data interoperability at around $1 billion. Aerospace, shipbuilding, and mechanical engineering each account for approximately $400 million.

At the same time, emerging technologies are making 3D data even more important. The global digital twin market was valued at around $36 billion in 2025 and is expected to grow to more than $228 billion by 2031. Manufacturing already represents more than 35 percent of the market. VR applications in manufacturing are expanding at a similar pace, with the market expected to reach $14.8 billion in 2026.

For companies in automotive, aerospace, mechanical engineering, plant engineering, and related industries, the implications are clear: organizations that cannot use their 3D data efficiently across the entire process chain lose time, money, and competitive advantage.

This is the central challenge addressed in this whitepaper.



Automatically Simplified
CAD Assembly

2 The Challenge: When Data Complexity Slows Down Processes

The challenge is straightforward: CAD models have grown steadily in both size and level of detail over the years. At the same time, the hardware used to process them has not kept pace. As a result, the level of detail that is considered a mark of quality in design can become a serious bottleneck in downstream processes.

2.1 By the Numbers: The Cost of CAD Interoperability

The economic impact of this issue is well documented. In several studies, NIST found that reliance on 2D modeling costs the U.S. manufacturing industry $5.2 billion annually. Seamless transfer of digital information between CAD and CAM platforms could generate savings of up to $10.3 billion.

And the problem is not limited to a single industry. Whether it is an automotive manufacturer coordinating its supplier network, an aerospace company working on large assemblies across distributed teams, or a machinery manufacturer planning production systems virtually, friction and inefficiencies arise wherever 3D data moves between systems, departments, and external partners.

But oversized and overly detailed models are not the only challenge. Protecting intellectual property is becoming increasingly important when sharing engineering data. According to IBM's 2024 Cost of a Data Breach Report, 43 percent of data breaches involve the loss of intellectual property, while 15 percent originate in the supply chain or with third-party providers. For companies that regularly exchange CAD data with development partners, this represents a significant risk.

This is especially critical because 3D data has become the central source of information throughout the PLM process. With the growing adoption of the 3D Master approach, these models will continue to contain an increasing amount of product and engineering information.

2.2 Common Challenges in Everyday Workflows

These billion-dollar figures translate directly into everyday challenges for engineering managers, IT managers, and project leads:

- **Long Load Times:** Large assemblies with millions of polygons can take several minutes to load or bring a workstation to a complete standstill. For engineers working with these models every day, those delays can quickly add up to hours of lost time each week.
- **System Instability:** In many cases, the number of elements that need to be displayed exceeds the capabilities of standard workstations. Graphics applications freeze or crash, and even models with around 12,000 components can push native visualization systems to their limits.
- **Manual Model Preparation:** Without automated tools, models have to be simplified manually. Highly skilled engineers may spend hours or even days on tasks that add no design value and are purely focused on preparing data for downstream use.
- **Downstream Process Bottlenecks:** VR applications, digital factory simulations, and factory planning tools may run poorly or not at all when source models are too large. Projects are delayed simply because the available data cannot be processed efficiently.
- **IP Risks When Sharing Data:** Sending fully detailed CAD models to external partners can expose sensitive design information. This is particularly critical in industries such as automotive, aerospace, and defense, where much of a company's competitive know-how is embedded directly in its product models.

2.3 Why CAD Complexity Continues to Grow

Three trends are intensifying these challenges even further:

First

The rise of the Digital Twin. More and more companies are creating digital twins of their products and production facilities. Around 29 percent of manufacturing companies worldwide have already fully or partially implemented a digital twin strategy, while another 40 percent are currently in the pilot phase. By definition, digital twins rely on highly detailed 3D models that need to be processed in real time.

Second

VR and AR in Manufacturing. Among industrial companies using VR and AR technologies at scale, 75 percent report efficiency gains of at least 10 percent. Porsche, for example, uses AR-supported quality inspection and has reduced certain inspection times by up to 40 percent. But these benefits depend on one critical factor: the underlying 3D models must be optimized for smooth, high-performance visualization.

Third

Model-Based Definition (MBD). More and more companies are embedding all product-related information directly in the 3D model instead of relying on separate 2D drawings. According to NIST, MBD can shorten the process from design and manufacturing through inspection by up to 75 percent. Companies also report up to 47 percent less scrap and 41 percent fewer engineering change orders. But MBD only delivers its full value when 3D models can move efficiently across all systems.

Overall

The need for high-performance 3D data workflows is growing rapidly. Companies that fail to address this risk turning their own infrastructure into a bottleneck for digital transformation.

3 Moving from Manual Rework to Automated CAD Simplification

The basic idea behind automated model simplification is simple: not every process needs every detail. A design engineer needs full precision. A factory planner needs the outer geometry. A VR developer needs a polygon-reduced model. And a supplier needs enough information to manufacture the required part—but nothing beyond that.

Until now, the challenge has been to create these different levels of detail efficiently and consistently. This is where CT CoreTechnologie's 3D_Evolution Simplifier comes in. The following sections explain the underlying technologies and the practical benefits they provide.

3.1 Envelope Geometry Generation: Remove Internal Geometry and Improve Performance

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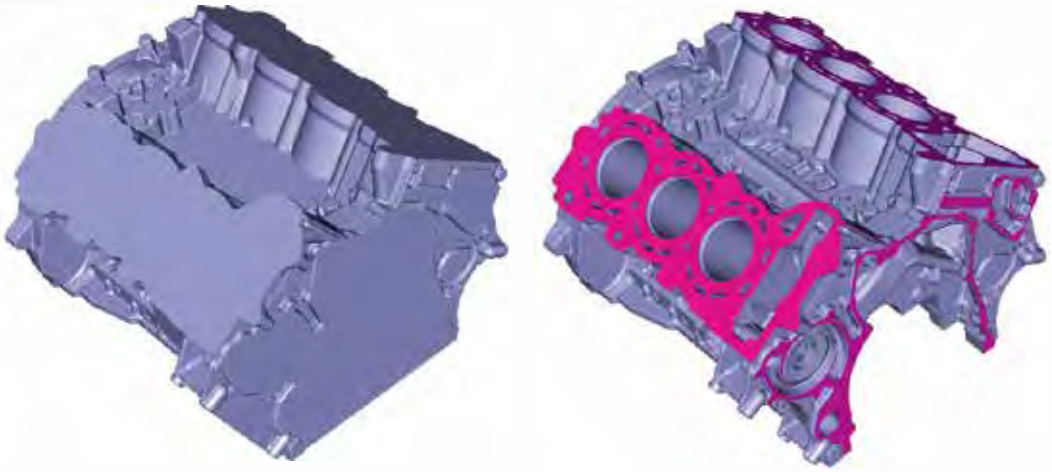
3.2 Polygon Reduction for VR, AR and Factory Planning

For tessellated formats particularly in VR, AR, and digital factory applications—model simplification can go one step further. Once the envelope geometry has been created, an additional polygon reduction can reduce the polygon count by up to 97 percent.

The process takes place in two stages. First, the solid envelope geometry is generated. The polygon count can then be reduced within seconds for formats such as VRML, FBX, OBJ, or JT. Users can either define the reduction as a percentage or specify a maximum chordal deviation or target polygon count.

The result is a major improvement in performance: large assemblies that are difficult to visualize smoothly in their original form become fully interactive in VR environments and factory planning tools. For digital factory planning teams, this means faster workflows and shorter project cycles. For IT departments, it significantly reduces the load on existing infrastructure.

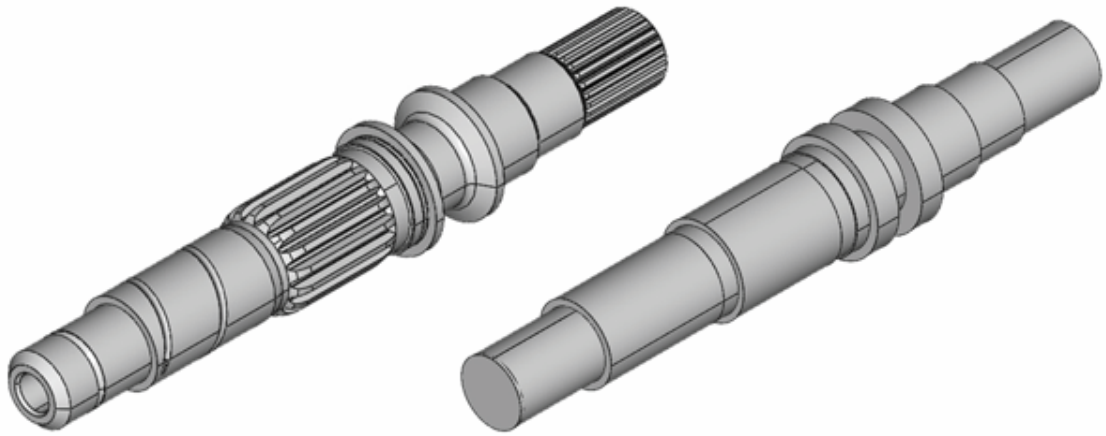


Simplified models can be reduced by up to 95%.

3.3 Bounding Shapes for Maximum Data Reduction

The Bounding Shape function takes simplification even further by replacing the original geometry with minimal envelope shapes. Complex assemblies such as energy chains, profile structures, or cable harnesses are converted into simple bounding volumes that contain only a fraction of the original data.

This is particularly valuable in factory planning. Complete robot cells and large production line layouts can be reduced in a very short time, allowing them to be processed efficiently in simulation environments such as MicroStation (DGN) or via JT and STEP. For plant engineering and energy companies that regularly work with very large facility models, this can deliver significant productivity gains.



Approximate outer geometry enables extreme data reduction while preserving exact B-Rep models.

3.4 Intelligent Selection and Filtering

In many real-world applications, not every component of a model is required. For automotive VR applications, for example, only externally visible geometry may be relevant. Interior visualizations, on the other hand, only require the parts that are visible to the vehicle occupant.
The Simplifier's Balloon function automatically identifies the required areas. Internal components are selected using a virtual balloon that expands from a defined starting point, while external components are detected using a virtual shrink-wrap approach. The resulting selection can then be converted into any supported target format.

Large models can also be cleaned up using filter lists based on component names, colors, attributes, and wildcards. A simple text file containing a definition such as *M8*, for example, can remove all components whose attributes contain that string. While the concept is simple, it is highly effective in practice: even multi-gigabyte models can be cleaned up quickly and reliably.

3.5 Restructuring Assembly Hierarchies for Simulation

Another common bottleneck in virtual factory planning is the mismatch between the BOM-based CAD assembly structure and the functional structure required for kinematic simulation. Kinematics describes the motion of bodies in terms of time, position, velocity, and acceleration. In traditional CAD systems, restructuring a manufacturing-oriented assembly into a functional simulation structure is often time-consuming, manual, and prone to error.

3D_Evolution addresses this with assembly functions that make it easy to transform an existing BOM structure into a functional structure for simulation. Virtual machine models can be prepared for kinematic applications with just a few clicks or fully automatically.
For project managers and engineers in robotics and plant engineering, this significantly reduces the time required to prepare models for simulation.

3.6 Protecting Know-How Through Controlled Simplification

Protecting intellectual property is a key concern across many of these industries. Automotive manufacturers, aerospace companies, defense contractors, and medical technology providers regularly exchange CAD data with suppliers, partners, and customers. Every time a fully detailed model leaves the company, there is a risk of exposing proprietary design know-how.

Envelope geometry directly addresses this risk. Internal details removed during the simplification process are permanently deleted and cannot be reconstructed. At the same time, specific elements such as mounting holes or flange components can be excluded from simplification based on colors, attributes, or component names.

The result is controlled data sharing: partners receive exactly the geometry they need to do their job nothing more, nothing less. For technical purchasing teams and management, this provides a clear way to reduce risk when exchanging sensitive CAD data.

4 Results from Practical Applications

The following figures highlight the typical improvements companies can achieve with automated CAD model simplification:

01

Up to 97% polygon reduction: Large assemblies that are difficult to visualize smoothly in their original form become fully interactive for VR, AR, and simulation applications.

02

Up to 95% fewer assembly elements: Automated simplification dramatically reduces the number of elements required for visualization, cutting load times from minutes to seconds.

03

42 supported 3D formats: Lossless conversion between CATIA, JT, Creo, NX, SOLIDWORKS, STEP, and 36 additional formats eliminates compatibility issues and the need for format-specific workarounds.

04

Fully automated batch processing: Large volumes of data can be processed without manual intervention. Integration with existing PLM systems is supported out of the box, allowing simplified models to be stored directly in the PLM system.

05

Permanent removal of internal details: IP protection during data exchange is enforced at the model level not just through company policies.

Real World Example: In the automotive and aerospace industries, complete robot cells, vehicle assemblies, and production line layouts can be simplified within a very short time and then processed efficiently in factory planning software. The Bounding Shape function reduces the data volume to a fraction of the original model size.

To put these figures into perspective, NIST estimates that seamless digital information transfer between CAD and CAM alone could generate savings of $8.9 billion. Companies that systematically optimize their 3D data workflows can gain an early competitive advantage in this evolving market.

5 Use Cases by Industry and Role

Automated model simplification addresses different challenges depending on the industry and use case. The following overview highlights where it can deliver the greatest impact:

By Industry

- Large assemblies that are difficult to visualize smoothly in their original form become fully interactive for VR, AR, and simulation applications.
- Aerospace and Defense: Extremely large assemblies, strict compliance requirements, and the need to protect sensitive intellectual property make controlled data exchange essential. Automated simplification ensures that partners and authorities receive only the information they actually need.
- Mechanical and Plant Engineering: Virtual factory planning, robot cell simulation, and data transfer to factory planning systems require simplified yet geometrically accurate models in formats such as DGN, JT, or STEP.
- Energy: Large plant models need to be prepared for planning, maintenance, and documentation. The Bounding Shape function is particularly valuable for reducing model complexity and data size.
- Medical Technology: Strict regulatory requirements for documentation and traceability go hand in hand with the need to protect proprietary design data.
- Robotics: Converting BOM-based design models into functional simulation structures is essential for preparing models for kinematic simulation.
- Architecture and Construction: BIM workflows and the integration of industrial equipment into building plans require high-performance 3D data in formats such as IFC.
- Virtual Reality Providers: Service providers creating VR applications for industrial customers depend on polygon-reduced models as input data. Faster model preparation means shorter project lead times.

By Role

- IT Managers and IT Teams: Reduced infrastructure load, fewer support issues thanks to more stable workflows, and standardized conversion processes instead of individual workarounds.
- Engineering Managers and Design Engineers: Less time spent preparing and cleaning up data, allowing engineers to focus on value-adding design work.
- Project Managers: Faster data preparation for simulation and VR applications, with fewer delays caused by oversized or inefficient 3D models.
- Executives and Business Owners: Lower interoperability costs, reduced IP risk, and faster time to market.
- Technical Purchasing: Controlled data exchange with suppliers and built-in protection of proprietary know-how during sourcing and procurement processes.

6 Conclusion and Next Steps

The growing complexity of CAD models is not a challenge that will solve itself. As Digital Twins, VR and AR applications, and Model-Based Definition become more widely adopted, the need for high-performance 3D data workflows will continue to grow.

Companies that address this challenge early and systematically can achieve measurable benefits: faster processes, more stable workflows, lower infrastructure costs, and better protection of intellectual property.

Automated CAD model simplification with tools such as 3D_Evolution Simplifier is no longer a niche solution. It has become an essential part of the infrastructure for digital product development. The technology is proven, integration into existing PLM environments is standardized, and its benefits have been demonstrated across a wide range of real-world applications.

Want to unlock the full potential of your 3D data?

In a free demo, our experts work with you to analyze how your CAD models can be simplified and what performance improvements you can realistically achieve.

Sources: NIST (National Institute of Standards and Technology), IBM Cost of a Data Breach Report 2024, MarketsandMarkets Digital Twin Market Report, G2 Virtual Reality Statistics 2025, Autodesk MBD Report 2025.