THE MECHANICAL 3D CAD SELECTION GUIDE

LIFECYCLE INSIGHTS

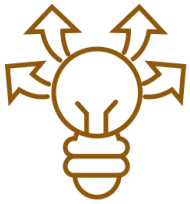
DOES YOUR SELECTION REALLY MATTER?

There's little doubt: Mechanical 3D CAD is a critical technology for the development of physical products. For many years, these solutions were a commodity. They all offered the same modeling approaches, drawing tools, and other functionality. Frankly, it didn't matter which one you used, as long as you used one.

Today, that story is far different. Solution providers are developing innovations for 3D CAD solutions on many fronts. And those innovations matter. They offer novel methods to build geometry. They bolster model-based documentation efforts. They ingeniously incorporate artificial intelligence and machine learning to aid designers and engineers. Right now, 3D CAD is experiencing a rejuvenation.

However, not all 3D CAD solutions are the same. Some solutions are expanding on certain capability areas, while others are innovating on a completely different front. Depending on the needs, you might have an innovative design solution that is a poor fit for your company.

All of this leads to a pivotal question: how do you select the right solution for your company? The purpose of this report is to help you do that. Here, you will find a selection process supported by capability definitions and a detailed worksheet. This guide helps you find the best solution for your company. It doesn't help you find best 3D CAD solution. It helps you find the best one for your company.



3D CAD is in a modern era of innovation. However, it is divergent innovation, as solution providers are developing new capabilities in different areas. Selecting a solution is no longer about finding the overall best but the best fit for your organization.

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HOW TO USE THIS GUIDE AND WORKSHEET

This guide and the accompanying worksheet will help you to assess and select a 3D CAD solution that best meets the needs of your organization. To get started, follow these 7 steps:

1. Read the Rest of This Guide: In the following sections, you will find criteria for assessing and selecting a 3D CAD solution. Read and understand each one so you can analyze its impact on your organization.
2. Assign Weights to Each Criteria in the Worksheet: In the worksheet, assign a value between 1 and 10 to each of the criterion based on its importance to your organization. These weightings are the same for all of the 3D CAD solutions assessed.
3. Assess the Fundamentals: Verify that each 3D CAD solution assessed fulfills your criteria under Fundamentals. Mark the presence of that capability in the columns labeled 'Avail.' (representing Available) in the worksheet. Lifecycle Insights suggests you only consider solutions that fulfill all Fundamental criteria. However, each company's needs are unique. Exempt criteria as applicable.
4. Score Each 3D CAD Solution on the Innovations: For each solution being assessed, assign a score from 1 to 10 on how completely it fulfills each Innovation criteria. This value goes into the 'Score' column of the worksheet.

This chapter details our seven step procedure to assess 3D CAD solutions. Use it in conjunction with the worksheet at the end of this document.

5. Calculate Each Criterion's Weighted Score: For each criterion, multiply its 'Weight' by the 'Score' you have assigned. Record these weighted scores in the 'Comp.' column of the worksheet.
6. Sum Each Criteria Category's Score: Next, sum the weighted scores for each criterion for each table. Record this value in the 'Aggregate' box at the bottom of the worksheet. This represents the 3D CAD solution's aggregate score for that category.
7. Sum the Category Scores for the Total Score: Finally, sum all of the category scores for the total score and record this value at the end of the worksheet. Compare these values across all of the 3D CAD solutions you are considering. The highest score is the best fit for your organization.

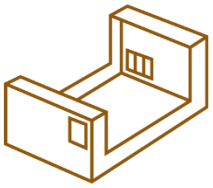
DESIGN MODELING

Building and modifying design geometry is a core 3D CAD capability. For many years, the primary focus was parametric, feature-based modeling. Yet, recent developments have furnished an array of compelling modeling capabilities.

This category of capabilities includes a range of modeling approaches for a variety of geometry types.

THE FUNDAMENTALS

- Sketching: Includes creating and modifying points, lines, arcs, and other simple geometries on 2D planes or in 3D space. These capabilities are key to both concept design and top-down design.
- Solid and Surface Modeling: Includes creating and modifying solid and surfacing geometry through parametric feature-based, direct, surface methods. This includes sheetmetal design. Modern design frequently uses these capabilities.
- Assembly Modeling: Includes spatially placing, constraining, and building relationships between components into assemblies. Also includes ability to define kinematic constraints for mechanism design.
- Performant Part and Assembly Modeling: Responsiveness while working with large, complex part models and assemblies with large numbers of components.
- Top-Down Part and Assembly Design: Includes capabilities to define space claims, interfaces, and other geometry to control collaboration between multiple simultaneous users in the same model.



3D CAD's core capabilities lie in modeling. The fundamentals of this category are broad and deep, covering 2D sketching, 3D solid and surface modeling, sheetmetal modeling, assembly modeling and even topology optimization.

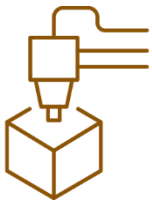
- Single Definition Associativity: Includes propagating automatic yet controlled updates anywhere a model exists. Almost all companies require this core capability.
- Capturing and Embedding Design Intent: Includes creating and modifying parameters, equations, relationships, and logical arguments to drive design geometry. This functionality is critical to intelligent parts, design automation, and configure-to-order approaches.
- Structures-Based Topology Optimization: Includes automatically removing non-load bearing material from design geometry based on structural analyses. This capability is highly applicable to cost out and light weighting initiatives.

THE INNOVATIONS

The innovations in this capability category allow users to work with new types of geometry, leverage higher levels of design automation, and prepare designs for new manufacturing methods.

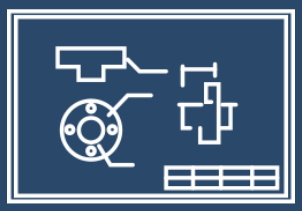
- Mesh Modeling: Incudes modifying facet geometry such as 3D scanned data, finite element meshes, tessellated point clouds, and STL models that lack parametric controls.
- Lattice Modeling: Includes ability to build lattice-filled geometry, offering controls over how the lattice varies spatially.
- Subdivision Modeling: Includes creating and modifying design geometry progressively and organically. This method is most commonly used for the aesthetic design of consumer products.
- Framework Modeling: Includes creating and modifying geometry built with members with standard cross-sections. This capability is applicable to machine design, heavy equipment, and plant design.

- Divergent Generative Design: Includes automatically creating design geometry to produce many divergent models using algorithms. Can yield a large number of unusual design alternatives for various fabrication techniques. Can be applied in concept design to generate innovative alternatives.
- Design for Additive Manufacturing: Includes geometrically preparing a design for 3D printing. Covers the analysis of the additive manufacturing process, adjusting the model sent to a 3D printer so that the final cooled part matches the original design. Also includes mathematical, parametric, and volumetric modeling for design geometry and support structures.



Another set of capabilities in this category enable Generative Design and Additive Manufacturing, which can be used together or separately.

DESIGN DOCUMENTATION



Another core 3D CAD capability is the production of design documentation. Engineering releases such deliverables to downstream consumers to drive the product development process. The traditional output of such efforts has been 2D drawings. However, model-based approaches are the new frontier in this category.

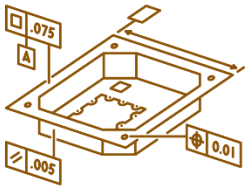
This category of capabilities covers the creation of drawing-based and model-based deliverables meant to be consumed by humans as well as software solutions.

THE FUNDAMENTALS

- Drawing Generation: Includes creating, detailing, and modifying 2D drawings based on design models. Many consider these deliverables as the specification for manufacturing and procurement.
- Model-Based Definitions (Human Readable): Includes adding Product and Manufacturing Information (PMI) to design models, augmenting or eliminating 2D drawings for human viewing and interrogating.
- Manipulating Legacy Drawings: Includes modifying lines, arcs, and other 2D entities on drawings that are not associated with design models. Companies often have a large number of legacy drawings in such conditions.
- Model Animation: Includes creating and modifying the spatial animation of design models in a series of sequenced steps. Users apply this capability to create instructions for manufacturing, service, or product operation.

THE INNOVATIONS

- Direct Sketching: Includes the application of direct modeling approaches to manipulate lines, arcs, and other 2D entities on large-scale drawings not associated with design models. Users apply these capabilities to large-scale drawings with thousands of entities with high performance.
- Model-Based Definitions (Machine Readable): Includes creating and modifying design models with semantic PMI that other software, such as CAM or inspection applications, can read to automatically create toolpaths.



Innovations in this capability category empower engineers to both work more efficiently with legacy documentation and automate downstream processes.

DESIGN COLLABORATION

No one designs in isolation. Modern product development requires the coordination of many companies and their employees. That demands the ability to share and collaborate on design models. This category is the focus of many recent innovations.

This category of capabilities covers a variety of methods used to communicate and collaborate with others, both in engineering and across the company.

THE FUNDAMENTALS

- Natively Opening Foreign Models: Includes opening design models originating from other 3D CAD solutions in native formats.
- Securely Sharing Models: Includes securely and directly sharing design models with those inside and outside your company.

THE INNOVATIONS

- Associative Foreign Models: Includes automatically updating design models once they have been changed in their original 3D CAD solution.
- Multi-User Real-Time Collaboration: Includes allowing multiple people to create and modify geometry in the same design model simultaneously. This can help resolve conflicting requirements and constraints.
- Augmented Reality (AR) Collaboration: Includes creating and sharing cloud downloadable AR experience of an interactive full-scale design model with one or more people.

Innovations in this capability category open up new methods of interaction with other users in real time that enable more effective and efficient collaboration.

DESIGN SIMULATION

All designs must fulfill some set of requirements within a given group of constraints. Given the flaws of physically validating such compliance, many companies are checking their designs virtually. This category captures those capabilities across form, fit, function, aesthetic, and other measures.

This category of capabilities covers the analysis and assessment of a design's form, fit, function, aesthetics, and connectivity to IoT platforms.

THE FUNDAMENTALS

- Geometry-Based Properties and Checks: Includes performing geometry-based checks such as mass, surface area, interferences, and clearances.
- Design-Driven Engineering Analysis: Includes preparing and conducting simple and fast simulations based on engineering physics such as structures and excitation, kinematics and dynamics, fluid dynamics, and thermodynamics.

THE INNOVATIONS

- Real-Time Rendering: Includes generating real-time interactive photorealistic images and animations in a lifelike environment. Such tasks often support sales and marketing efforts.
- IoT Inputs for Engineering Analysis: Includes applying physical sensor readings from an IoT platform as an input to engineering analysis. Used as a means to gain greater insight into performance beyond physical sensor readings.

- Virtually Prototyping an IoT Platform: Includes feeding virtual sensor readings from an engineering analysis to an IoT platform. Acts as a means to virtually prototype the data model and other traits of the IoT platform.
- Real-Time Engineering Analysis: Includes running a real-time engineering analysis during design model modification. Provides immediate feedback on design experimentation. Covers a range of engineering physics such as structures and excitation, fluid dynamics, and thermodynamics.

Innovations in this capability category focus on broader and more accurate assessments of how the product will look and operate in its final environment.

INTEGRATION

3D CAD solutions do not stand alone in a company's IT landscape. They must work with many other types of software to power product development. A number of innovations in this category are bridging gaps to other engineering domains.

This category of capabilities covers integration and interoperability with software solutions used inside and outside engineering.

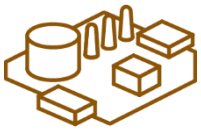
THE FUNDAMENTALS

- Data Management Solutions: Includes managing and tracking iterations and the interrelationships of all deliverables produced by 3D CAD solutions.
- Electrical CAD Solutions: Includes exchanging data between Mechanical and Electrical CAD solutions. Covers the interchange of board layouts to create 3D assembly models of boards. Encompasses sharing from-to signal information for harness design to route cables and wires in a 3D assembly of the product.
- Machining and Metrology Solutions: Includes intelligently exchanging a design model with machining solutions to generate NC toolpaths and metrology solutions to produce inspection toolpaths.

THE INNOVATIONS

- Branching Iterations: Includes branching multiple new designs off an existing. Important capability for companies that need to explore many alternatives to find better designs.

- Design Change and Difference Highlighting: Includes tools to automatically highlight differences between two or more versions of a design model. Applicable when exchanging design changes between organizations or comparing two or more designs.
- Electrical CAD Updates and Interactivity: Includes exchanging information with Electrical CAD solutions in real time, powering associative changes. Separately covers ability to interactively highlight items that correspond between the two solutions. For example, when a signal is selected in a wiring diagram, it highlights the wire carrying that signal in the 3D assembly model.



Innovations in this category focus on reducing the friction in exploring new design iterations and collaborating with other engineers, including support for the development of board and electrical systems.

PROVIDER AND SUPPORT CONSIDERATIONS

Functional capabilities are important when selecting a 3D CAD solution. However, many other criteria are vital. This category includes all of those other considerations. Study the implications of each of the following options, and select the one that best fits your organization. These are not scored criteria, but should be consideration factors when you select a solution.

- Solution Accessibility Considerations: Includes accessing the solution from any device at any time. Highly applicable to companies with engineers who spend time away from their desks.
- Training and Support Considerations: Includes training users to learn how to use the solution and logging software issues with technical support. Online access for both is critical.
- Cost-of-Ownership Considerations: Includes procurement options for upfront purchase or ongoing subscriptions for the solution. Take ongoing maintenance costs into account when considering total cost-of-ownership.
- Provider Stability and Solvency Considerations: Includes the overall company financial health and viability as a solution provider. Should also consider dedicated and continued development to the solution. Also assess whether the provider has a long-term vision for the solution.

This category of capabilities assesses non-technical aspects of these solutions.

Many additional solution provider considerations should contribute to the selection of the best solution for your organization. Many of these attributes directly affect the productivity of users and resolution of technical issues.

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LIFECYCLE INSIGHTS

worksheet for assessing solutions

Design Modeling

The Fundamentals		The Innovations			
Capability	Avail.	Capability	Weight	Score	Comp.
Sketching		Mesh Modeling			
Solid and Surface Modeling		Lattice Modeling			
Assembly Modeling		Subdivision Modeling			
Performant Part and Assembly Modeling		Framework Modeling			
Top Down Part and Assembly Design		Divergent Generative Design			
Single Definition Associativity		Design for Additive Manufacturing			
Capturing and Embedding Design Intent		Aggregate			
Structures-Based Topology Optimization					

Design Documentation

The Fundamentals		The Innovations			
Capability	Avail.	Capability	Weight	Score	Comp.
Drawing Generation		Direct Sketching			
Model-Based Definitions (Human Readable)		Model-Based Definitions (Machine Readable)			
Manipulating Legacy Drawings:		Aggregate			
Model Animation					

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Design Collaboration

The Fundamentals		The Innovations			
Capability	Avail.	Capability	Weight	Score	Comp.
Natively Opening Foreign Models		Associative Foreign Models			
Securely Sharing Models		Multi-User Real-Time Collaboration			
		Augmented Reality (AR) Collaboration:			
		Aggregate			

Design Simulation

The Fundamentals		The Innovations			
Capability	Avail.	Capability	Weight	Score	Comp.
Geometry-Based Properties and Checks		Real-Time Rendering			
Design-Driven Engineering Analysis		IoT Inputs for Engineering Analysis			
		Virtually Prototyping an IoT Platform			
		Real-Time Engineering Analysis			
		Aggregate			

Integration

The Fundamentals		The Innovations			
Capability	Avail.	Capability	Weight	Score	Comp.
Data Management Solutions		Branching Iterations			
Electrical CAD Solutions		Design Change and Difference Highlighting			
Machining and Metrology Solutions		Electrical CAD Updates and Interactivity			
		Aggregate			

TOTAL SCORE

Chad Jackson is the chief analyst and researcher at Lifecycle Insights, providing insights on a range of technology-led initiatives across mechanical, electrical, embedded software, system, and IoT engineering.

Lifecycle Insights is a research and advisory publishing firm. Our mission is to empower executive's ability to reap more value from technology-led engineering initiatives in less time, with more surety, and less disruption.

CONTACT | EMAIL contact@lifecycleinsights.com | SITE www.lifecycleinsights.com