

PLM Components

Leading technologies empowering the next generation of 3D engineering software solutions

18 April 2023

Abstract

Software developers face many challenges building a new application or tool including the need to satisfy technology and quality requirements. Many turn to licensing software components to gain an advantage. Siemens Digital Industries Software provides a full suite of component software including the proven 3D geometry kernel, Parasolid, and the visualization format JT which has become an ISO industry standard. Numerous companies license Siemens' PLM components to bolster their applications with proven, quality technology.

Introduction

"It's not the beauty of a building you should look at; it's the construction of the foundation that will stand the test of time."

David Allan Coe, American vocalist, and songwriter

Developing and delivering new product development software applications and tools to the market presents many challenges. Developers must satisfy complex technology requirements and quality conditions to build a leading-edge, commercially viable solution. While the developers would rather concentrate on their application expertise, they must support those applications with the fundamental building blocks needed for a competitive application. Applications focused on product development require 3D geometry to define product form and shape. They also require state-of-the-art graphic visualization capabilities.

Delays are costly. From a business perspective developers find themselves under pressure to deliver their solution quickly. Their solution must support interoperability with third-party applications, particularly with numerous computer-aided design (CAD) and PLM systems to expand their market reach.

For these reasons, many application developers turn to the use of component software for the foundation of their solutions. PCMag¹ defines component software as "Program modules that are designed to interoperate with each other at runtime." A number of technology companies offer software components for the product development industry. A leading supplier is Siemens Digital Industries Software (Siemens) with their PLM Components portfolio.²

Siemens PLM Components Portfolio

Siemens' PLM Components are a collection of 3D software development toolkits intended to increase the value of CAD, CAM, CAE, and related PLM applications by reducing the time, cost, and risk companies face when delivering 3D software innovation on their own. The flagship components within the portfolio are Parasolid for 3D geometric modeling and JT, the openly published data format developed for communication, visualization, digital mockup, and various other purposes.

Parasolid

Parasolid is a leading production-proven 3D geometric modeling component software or "kernel" modeler, providing core functionality that enables users to rapidly model complex products. Based on

¹ <https://www.pcmag.com/encyclopedia/term/component-software>

² Research for this whitepaper was partially supported by Siemens Digital Industries Software.

high-precision boundary-representation technology, Parasolid supports solid, facet, and freeform surface/sheet modeling within an integrated framework. Parasolid has evolved over a forty-year history in the product development industry. Siemens uses Parasolid in their own NX and Solid Edge design solutions.

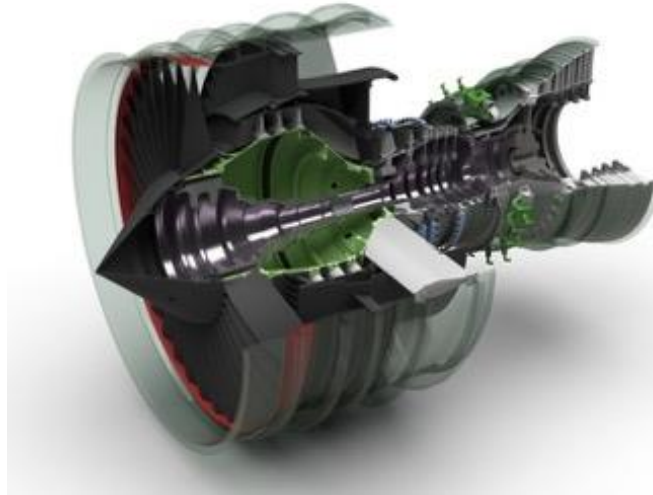


Figure 1—3D Parasolid Model
(Courtesy of Siemens)

Parasolid supports all major operating systems across Windows, Linux, macOS, iOS and Android platforms, allowing application developers to reach a wide audience of potential clients on a range of devices. The kernel is used by numerous independent software vendors (ISVs) for their applications, including Dassault Systèmes' SOLIDWORKS, PTC's Onshape, and Topsolid SAS's Topsolid in addition to CAM, CAE, and AEC software providers.

JT

JT is an openly published 3D CAD data exchange and display format developed by Siemens. It is widely used for communication, visualization, digital mockup, and a variety of other purposes. Many of the world's leading manufacturing companies, most notably in the automotive sector, collectively manage tens of millions of data files in the JT format.

JT has been accepted by ISO, the International Organization for Standardization,³ as an international standard for 3D visualization ([ISO 14306:2017](https://www.iso.org/standard/68811.html)). In addition to visualization, many JT adopters use JT as a process format for workflows such as data exchange, supplier collaboration, and long-term data retention.

The JT format can support any combination of precise boundary representation surfaces (NURBS⁴), approximated faceted data, product manufacturing information (PMI⁵), and metadata (textual attributes). Because JT files are inherently "lightweight" relative to the size of a full CAD file, they are ideal for internet collaboration with product development partners and the supply chain.

³ <https://www.iso.org/home.html>

⁴ <https://www.makeuseof.com/what-are-nurbs-curves/>

⁵ https://en.wikipedia.org/wiki/Product_and_manufacturing_information

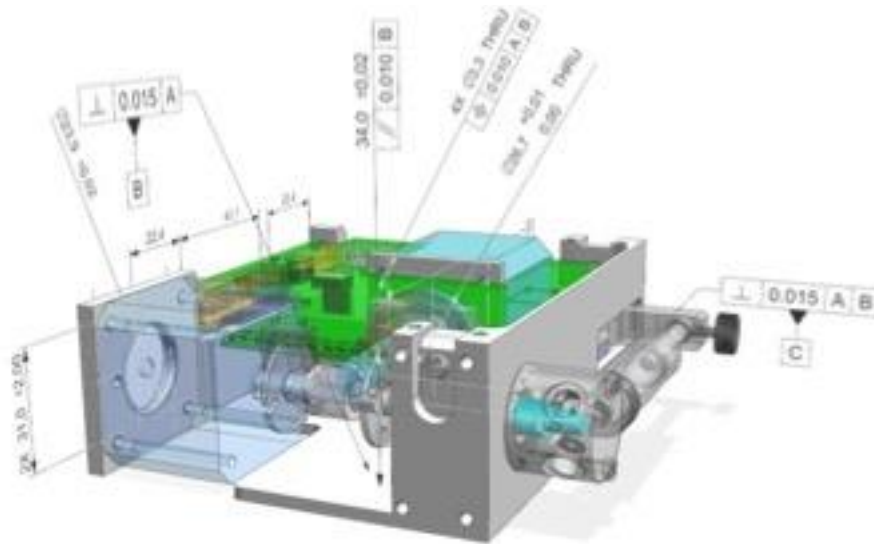


Figure 2—A JT Viewed Model with PMI
(Courtesy of Siemens)

The JT Open Program was formed by Siemens in 2003 at the request of a small group of corporations that saw value in the use of a common 3D format. The program has over 100 members, including Fortune 500 companies worldwide, software vendors, and leading academic institutions. Application developers interface to JT using the JT Open Toolkit, which provides support for 64-bit application development on Microsoft Windows and Linux. Purchasers of the JT Open Toolkit are automatically accepted into the JT Open Program as fee-based members.

JT Open Program accomplishments include the publication of the JT file format specification and the creation of the no charge JT viewing and collaboration tool, JT2Go . The publication of the JT specification was the impetus for ISO acceptance of JT as ISO 14306.

D-Cubed

While Parasolid and JT are undoubtedly the most notable solutions of Siemens' PLM Components, they are followed closely by D-Cubed components, a suite of technologies used by software applications to enhance the design, analysis, visualization, and manufacture of products from consumer goods to aircraft engines and commercial buildings.

Solutions that D-Cubed components provide include parametric sketching (2D DCM), assembly constraints (3D DCM), offset profiles (PGM), motion simulation (AEM), collision detection (CDM), and hidden line drawing (HLM).

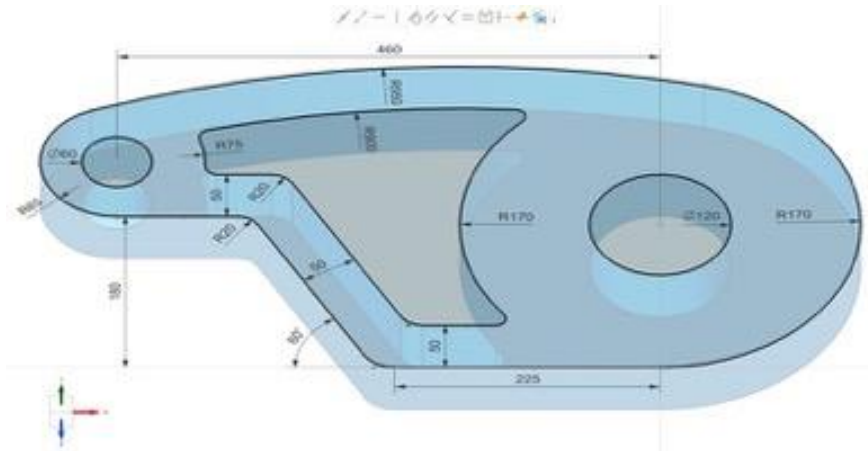


Figure 3—A DCM for Parametric Sketching
(Courtesy of Siemens)

Geolus Shape Search

One of the more problematic issues that engineering companies face is part reuse. An informed response to “Which parts similar to this one have we developed before?” is a step forward in making cost-saving decisions that support greater efficiency and productivity.

Cost saving that can be realized from eliminating part duplicates within a company’s model data repository only scratches the surface. Product designers can achieve significant gains in productivity on current projects by locating similar existing parts and reusing their associated simulation and manufacturing data.

Geolus Shape Search finds similar parts based on 3D shape no matter how they have been named and enables informed decisions in virtually every aspect of PLM, from design to process planning to procurement.

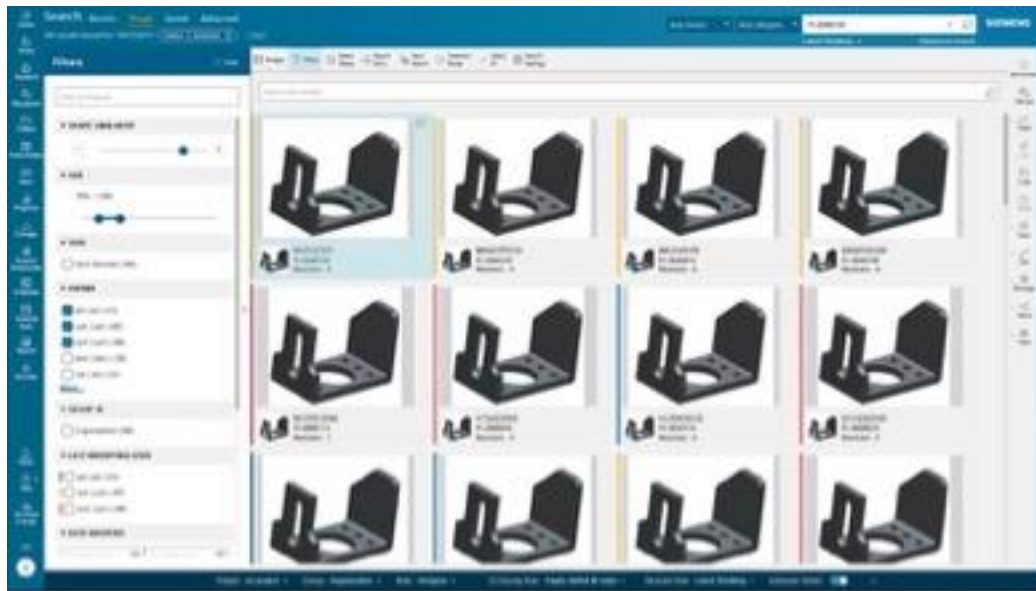


Figure 4—The Result of a Geolus Shape Search
(Courtesy of Siemens)

Kineo

Kineo software components offer a range of solutions for automatic path planning, high-speed collision detection, and predictive cable performance. These technologies are used by automotive, aerospace, energy, shipbuilding, and manufacturing industries most often in software applications for robotics and digital mock-up.

The KineoWorks path planning solution computes collision-free motion paths for robot/machine programming and simulation in manufacturing, and assembly and disassembly verification in digital mockup environments.

Kineo Flexible Cables simulates the behavior of flexible items such as cables, hoses, and electrical cords. It is well-suited to robot programming and simulation, where cables are subject to large deformations and high stresses in complex motion environments.

Kineo Collision Detector performs high-speed collision analysis on mesh surfaces (polyhedrons) and point cloud data to resolve collisions that would prevent the successful manufacture of an assembly or impede the intended motion of parts.

Visualize

Iray+, PLM Vis Web, and HOOPS Visualize meet the needs for photorealistic rendering or visualization with an engineering focus that requires 3D annotation, sectioning, and measurements over the web.

Iray+ is a high-end photo-realistic rendering toolkit. Software applications integrate Iray+ to endow their customers with easy access to impressive, photorealistic scenes of their 3D models.

PLM Vis Web provides visualization of JT format data over the web. It enables viewing, measure, and markup of models. The technology supports a variety of use cases, ranging from adding visualization to online catalogs to the advanced functionality needed to support collaborating engineers, all without needing to install any client software.

Developing mobile and desktop applications with HOOPS Visualize software development kit (SDK) enables a software team to quickly create visual applications. As the workhorse 3D rendering engine in hundreds of successful engineering applications, HOOPS Visualize accelerates application development, produces stunning graphics, and supports all major desktop and mobile operating systems.

Simcenter Femap OEM and Solid Edge OEM

Developers can license the full applications of Simcenter Femap or Solid Edge to private-label and extend/customize with their own special value-added capabilities.

Simcenter Femap OEM

Simcenter Femap delivers advanced mesh-based finite element analysis (FEA) simulation applications. Developers can easily add value to their engineering simulation software solutions without creating a new system from scratch. Simcenter Femap OEM provides an affordable, easy-to-use simulation engine for their engineering software, enabling them to bring value-added solutions to the market.

Solid Edge OEM

Solid Edge OEM Software Development Toolkit allows a developer to customize the Solid Edge interface to include their own set of engineering tools—and use their own images and logos to deliver a distinctive

branded product to the marketplace. Because Solid Edge is based on the widely used Parasolid modeling kernel, their application will have data compatibility with other applications using Parasolid.

The developers need only to license the capabilities they need. Unlike other OEM offerings, the Solid Edge OEM toolkit has a modular structure, which means developers only license and pay for the capabilities they need for their application.

Continuous Innovation & Quality

As validated by its market acceptance, Siemens has demonstrated their attention to software product quality and continuous innovation over the years. In a testament to the importance they place on their PLM Components, Siemens uses those components within their own software applications such as NX, Solid Edge, and Simcenter.

Quality is assured based on the immense effort Siemens places on testing the software. For example, with regard to Parasolid, over 4 million tests with 150 billion API (application programming interface) calls are run nightly across 200+ test machines, Siemens achieves 100% code coverage. Their automated test support covers system level, module, interface, and performance test suites. A similar quality approach is used across all PLM Component offerings.

Siemens maintains a solid pace of major innovation across PLM Components with alignment to technology trends as seen with Parasolid Convergent Modeling—combining precise 3D geometry and faceted data to enhance productivity in Generative Design, reverse engineering, and additive manufacturing. In addition, Siemens has added native lattice modeling to support new design initiatives that leverage additive manufacturing. Siemens is also integrating standard visual material capability with JT, adding further value for adopters of JT for visualization, including virtual and augmented reality.

These efforts testify to Siemens' status as a leading component provider and demonstrate the trust that other software providers put in Siemens Digital Industries Software as a stable, long-term supplier. Major Siemens competitors continue to license and increase their adoption of PLM Components to offer a richer set of integrated capabilities in their PLM applications.

Partnering

Siemens partners with other software component providers to deliver complementary software tools that are combined with PLM components to offer a rich set of integrated capabilities.

Siemens has a long relationship with Tech Soft 3D,⁶ a company that provides 3D software development toolkits and offers clients the graphics toolkit Hoops Visualize and the data access toolkit HOOPS Exchange, both of which are integrated with Parasolid and available from Siemens.



In addition, Siemens works with MachineWorks,⁷ a company that offers software development toolkits for 3D applications with software libraries for CNC simulation and Polygonica's libraries for 3D modeling.

⁶ <https://www.techsoft3d.com/>

⁷ <https://www.machineworks.com/>

Siemens also works with AMC Bridge⁸ to offer PLM Component adopters software development services and resources.



Market Penetration

Each year CIMdata surveys the solution providers in the CAD/CAM/CAE PLM market to determine their annual product sales and publishes a series of PLM Market Analysis Reports. To validate that Siemens is a leading supplier with their PLM Components portfolio, CIMdata relied on its most recent, complete set of Market Analysis Reports from 2021.

Based upon CIMdata’s understanding of the applications in the market, if a solution provider uses any of the Siemens PLM Components in one or more of their applications, their revenue was applied to determine Siemens’ penetration. Realistically, only a portion of a solution provider’s revenue should be assessed towards Siemens, but those numbers are impractical, and likely impossible to calculate.

The CIMdata method of counting does, however, offer an estimate of the level of penetration Siemens’ PLM Components has accomplished in the CAD/CAM/CAE and AEC sectors.

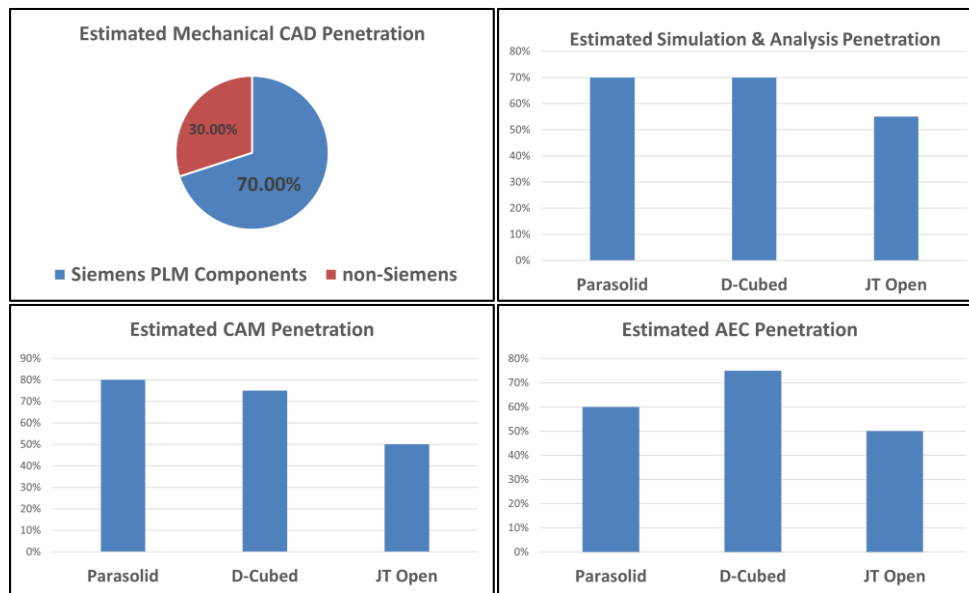


Figure 5—Siemens PLM Component Market Penetration

Based on this calculation method, it becomes apparent that Siemens’ PLM Components have significant penetration into the varied disciplines across the PLM market and hold a leadership position.

Openly licensing PLM Components to software vendors is aligned with Siemens Xcelerator, the company’s open digital business platform, and offers significant benefits for the software ecosystem. End-users want the freedom to choose their software tools and share data across applications, without a loss of fidelity. Sharing technologies like JT and Parasolid with other vendors drives an ever-expanding ecosystem in which many millions of end-users can create and share 3D data using open and compatible formats from Siemens.

⁸ <https://www.amcbridge.com/>

Customers



Shapr3D

Shapr3D⁹ develops 3D computer-aided design software with a unique user interaction interface. They chose the Parasolid 3D geometric kernel, HOOPS Exchange and D-Cubed 2D DCM for their development. Around 80 percent of Shapr3D customers are professional 3D designers, mechanical engineers, and industrial designers. The company focuses on conceptual CAD, allowing customers to develop and produce innovative ideas more quickly.

With respect to Shapr3D's use of the Parasolid kernel, Mr. István Csanady, CEO, states, "The application programming interface and documentation were of the highest standard and, with the collaborative support of Siemens Digital Industries Software, we brought a product to market within 12 months that was an instant success."

He goes on to say, "D-Cubed is extremely effective in geometric constraint solving so we didn't hesitate to build on our relationship with Siemens and integrate 2D DCM."



TopSolid¹⁰ is a global supplier of computer-aided design, computer-aided manufacturing, and enterprise resource planning (ERP) solutions. It is ranked the second top CAD/CAM supplier in France and is one of the top 10 suppliers worldwide. TopSolid chose Parasolid as their geometry foundation and has been using it as the geometry engine for its CAD/CAM applications since 1994.

A success factor for TopSolid is its broad line of vertical applications for mold tooling design, CAM, furniture design, progressive die design, sheet metal applications, and more.

"In terms of product quality and innovation, Parasolid has the latest advances in geometric modeling with excellent performance and reliability."—according to Mr. Richard Lamure, CEO, TopSolid.



Vectorworks, Inc.¹¹ is an award-winning design and Building Information Management (BIM) software provider serving the architecture, landscape architecture, and entertainment industries in 85 countries. Since its inception more than 30 years ago, Vectorworks has been a leader in incorporating advanced modeling functionality into its architecture, engineering, and construction (AEC) software.

Dr. Biplab Sarkar, CEO, Vectorworks, states, "Parasolid establishes Vectorworks as a best-in-class architectural 3D solution." Dr. Sarkar adds, "We believe the best way to build a strong modeling platform is to leverage the investment the manufacturing industry has made in software development. That is why we decided to build Vectorworks on the mature modeling software engine, Parasolid, from Siemens Digital Industries Software."

⁹ <https://www.shapr3d.com/>

¹⁰ <https://www.topsolid.com/en>

¹¹ www.vectorworks.net

Summary & Conclusion

Developing and delivering new product development applications and tools to the market is difficult with many challenges. The new application must provide definitive benefits using advanced technology. Quality is an absolute.

Software components provide the building blocks developers can use to create a foundation for their applications. Siemens' PLM Components is the market leader in advanced component software. Parasolid, their 3D geometry kernel, has a reputation to be of the highest capability and quality. The visualization JT format and supporting applications, have an honored place in the PLM industry. These two, together with the additional components provided by Siemens can easily offer developers a "step up" in providing powerful new applications and tools more quickly than building their own base capabilities.

For these reasons, many application developers turn to the use of Siemens PLM Components as "the foundation that will stand the test of time."

About CIMdata

CIMdata, an independent worldwide firm, provides strategic management consulting to maximize an enterprise's ability to design, deliver, and support innovative products and services by identifying and implementing appropriate digital initiatives. For forty years, CIMdata has provided industrial organizations and providers of technologies and services with world-class knowledge, expertise, and best-practice methods on a broad set of product lifecycle management (PLM) solutions and the digital transformation they enable. CIMdata also offers research, subscription services, publications, and education through certificate programs and international conferences. To learn more, visit www.CIMdata.com or email info@CIMdata.com.