Role of PLM in the electronics lifecycle

SIEMENS

White Paper

To address the needs of today's complex electronics lifecycle, high tech and electronics companies need an interdisciplinary solution for printed circuit board (PCB) design. This white paper describes how product lifecycle management (PLM) can be leveraged to break down the traditional divide between the mechanical, electronic and software domains, as well as between a company's functional boundaries. The white paper also discusses how PLM enables all of these participants to share information, collaborate effectively and manage the interrelated aspects of the electronics lifecycle from a whole product perspective.

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Executive summary

In virtually every industry segment, the use of electronics-enabled products is increasing. However, a recent study indicates that, over three years, electronic failure rates commonly exceed 15 percent. In addition, a recent Consumer Reports study found that laptops had failure rates of up to 43 percent.[1] Most product failures and the costs associated with those failures are caused by problems that arise from trying to manage globally dispersed design teams, control the product development process in its entirety, integrate multiple toolsets with separate databases and part libraries and understand how the whole product fits together.

To address the cost, quality and time-to-market issues that arise from these failures, electronics companies must:

- Capture product requirements and link them to product implementation
- Integrate MCAD and ECAD design tools and processes
- Manage ECAD design data and parts libraries on an enterprise basis
- Collaborate with their suppliers and coordinate their lifecycle activities
- Implement and maintain environmental compliance initiatives
- Share design and manufacturing data across domain and process boundaries
- Embrace digital prototyping
- Incorporate structured change processes
- Manage electronics projects in conjunction with the rest of the product lifecycle

Siemens PLM Software's Teamcenter® suite leverages the power of product lifecycle management (PLM) to address the issues impacting today's complex electronic products. Requirements management and mechatronics associativity provides all lifecycle stakeholders with a shared view of the product that breaks down the walls between participating groups, enabling them to visualize relationships and dependencies between requirements and data elements.

Teamcenter's multiple MCAD and ECAD tool integrations make it possible for disconnected tools and processes to operate as part of an integrated design solution that increases productivity while lowering product, warranty and repair costs. Collaboration tools make it possible for you to share data with suppliers and manufacturing, resulting in improved quality, reduced scrap, less rework and lower costs. In addition, Teamcenter's use of structured workflows, formal change processes and program and project management helps design teams to meet delivery and quality targets.

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Industry challenges

Today's increasing use of electronics

In virtually every industry segment, the use of electronics and embedded software is increasing. In fact, electronics and software drive most of the features and functions we come in contact with every day, including:

- Cameras that capture and store images electronically
- Home appliances that use electronic sensors to control washing/drying cycles
- Aerospace systems that rely on fly-by-wire based electronics
- Infotainment systems that turn automobiles into "electronic processors on wheels"
- Medical imaging technologies that are enabled through electronic processors
- Manufacturing machinery that relies on electronic processors and controls to achieve amazing levels of precision

To remain competitive in this world of "electronics-driven products," the effective management of the entire electronics lifecycle in the context of the whole product is crucial.

Results of an isolated electronics development process

While almost everyone recognizes the important role that electronics play in the delivery of innovative products, we too often forget that it is the integration with mechanical packaging, electrical interconnect and embedded software that determines how well the total product performs. As an industry, electronic failure rates over 3 years commonly exceed 15 percent.

Most of these failures are caused by difficulties that arise from managing globally dispersed design teams, uncontrolled product development processes, multiple toolsets with separate databases and part libraries, and inconsistent understanding of how the entire system (i.e., whole product) is to function. As a result, problems in the product development process are either discovered late in the design cycle, or worse yet, only appear after the product is released.

The initial release of a popular video game console experienced a 16.4 percent defect rate costing over $1 billion to fix. Similarly, in an attempt to provide additional cooling to the console's electronics processor and prevent recurring malfunctions, new models of the product had to include a second heat sink.

As we see in this example, design issues discovered late in the process can result in product delays, recalls, missed market opportunity and huge warranty costs.

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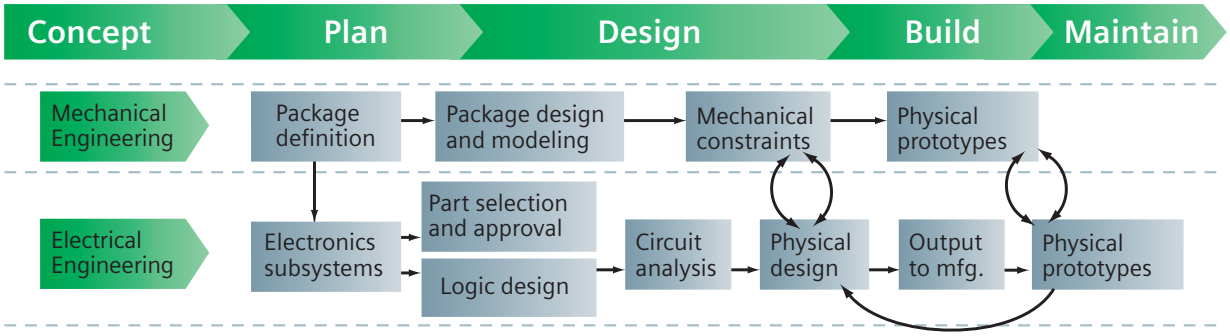
PCB design process

To highlight the root cause of these issues, we need to look at the typical electronics/PCB design process.



The process generally begins with the electrical engineer defining the overall system and then segmenting it into various electrical subsystems. The logical performance and physical characteristics of each subsystem has constraints and dependencies associated with the rest of the product, such as with the software to be embedded, the mechanical enclosure and the electrical interconnect required to tie the various subsystems together.

Once defined, these subsystems are assigned to other members of the team or farmed out to third-party suppliers located across widely dispersed geographic areas. Due to the number of domains involved and the multitude of toolsets required, each of these functions tends to work in isolation. As a result, the electrical engineer may not always be aware of what changes the mechanical engineer is making to the product packaging; or whether the software developers need to increase memory to accommodate all the additional software features.

Using schematic capture tools, the electrical engineer selects the parts and defines the logical behavior of the system. Here, many companies use ECAD tools from multiple vendors, each with its own unique parts library. Since the cost and availability of supplier-provided commercial parts are constantly changing, ECAD part libraries are continually being updated. When companies maintain multiple libraries without linking parts to supplier information, design teams often end up accessing obsolete, inconsistent or inaccurate part data.

In addition, many ECAD tool part libraries contain "approved" logical and physical part definitions. Too frequently these libraries contain obsolete parts, environmentally non-compliant parts, parts that can't be handled by existing assembly equipment/processes or parts that fail to meet engineering-required performance characteristics. In an uncontrolled environment, the electrical engineer might add or use parts that are unapproved, unavailable or have long purchasing lead times.

During the physical design process, the true interdisciplinary nature of the electronics design process is exposed. To begin the PCB layout process, the CAD designer requires the logic design, electronic parts definitions and electrical constraints data from the electrical engineer, as well as the board outline, mechanical parts and physical constraints data from the mechanical engineer. Here miscommunication between these domains and disconnects regarding the correct version of any of this data causes excessive rework, schedule delays and cost overruns.

Upon completion of the physical layout, the outputs required to fabricate the PCB substrate, acquire the parts and assemble product are generated. In many environments, it is difficult to identify, track and deliver correct versions of all of this data to third-party suppliers for review and bid costing. Once delivered, unforeseen PCB fabrication or assembly/test issues are frequently detected that require additional rework, resulting in schedule delays, increased scrap and higher costs.

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After the mechanical, electronic and software designs are complete, many companies begin the costly and time-consuming process of building physical prototypes. Since each domain works to optimize the design within its specific set of constraints, many of the cross-discipline design issues are discovered during this phase, including mechanical interferences, poor system performance and thermal and vibration issues. Because these issues are typically discovered late in the cycle and the costs for each physical prototype are so high, product teams are only able to investigate a few design alternatives or optimize a few cycles.

As an IEEE magazine article points out, we are getting pretty good at component engineering – but miserable on systems: "90 percent of electronics components function as designed, (but) 50 percent of them fail when integrated with their systems."

The key value drivers for electronics manufacturers are time-to-market, lower costs and improved product quality/reliability. The problems just identified are serious impediments to these goals. In fast moving markets like high-tech electronics, isolated teams, standalone design processes, uncontrolled part usage and the extensive use of physical prototypes must change. To address electronics' increasing complexity, interdependence and integration with other parts of the product, your company needs to:

- Capture and link requirements to physical implementation
- Create a system-level view of the product
- Integrate multi-MCAD/ECAD tools and processes
- Track and manage all ECAD design data in a single source
- Establish a secure, enterprise ECAD part library
- Manage and coordinate ECAD vendors and suppliers
- Support environmental compliance initiatives
- Collaborate and share data across multiple domains and processes
- Embrace digital prototyping
- Institute structured workflows and change management processes
- Manage projects in conjunction with the rest of the product lifecycle

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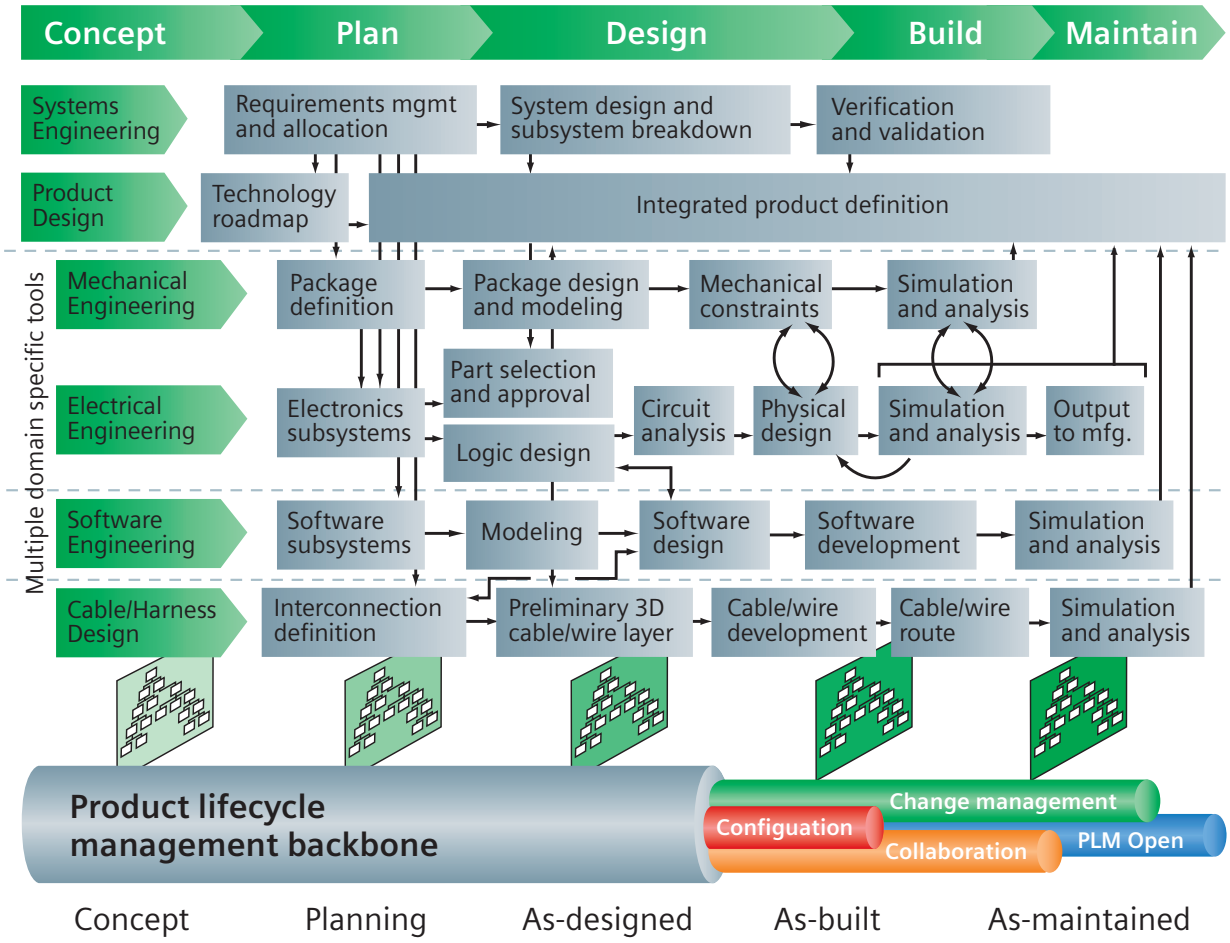
An Aberdeen Group research study found that companies implementing an integrated approach to whole-product design, as shown in this graphic, reduced physical prototypes by 37 percent, costs by $332,673 and development by 118 days.



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Managing the PCB lifecycle

To ensure you design, implement and maintain products that your customers want, Teamcenter provides the single-source of product and process knowledge that ties your enterprise's electronics, software and mechanical domains into an integrated whole. Teamcenter provides support for:

- Linking requirements to a system-level view of the product
- Multi-CAD design environments
- Integration with popular ECAD tools
- Powerful part library and vendor management capabilities
- Links to environmental compliance data
- Extensive supplier collaboration and management applications
- Broad spectrum of simulation and analysis tools for rapid digital prototyping

Teamcenter also provides the cross-domain applications required for configuration management, workflow management and change management, as well as for the product and project management activities that may spread out across the globe.

Capturing and linking requirements to implementation

To deliver high quality electronics, engineers must fully understand a product's requirements and share a common vision of the product with other members of the product team. Using Teamcenter, product requirements can be captured and imported from a variety of sources including Word, Excel and Visio as well as many other applications.

Requirements can be allocated, or linked to physical implementation, giving you complete traceability from the electronics module back to the original requirement. This level of traceability improves product quality and test coverage while eliminating the feature creep and unnecessary rework that leads to schedule delays and cost overruns.

Creating a system-level view of the product

To better understand what the entire product or system is suppose to do, how it will be constructed and the interactions among the various electronic, mechanical and software components, Teamcenter's systems engineering capabilities enable product teams to create high-level views of the system. These views can then be linked to customer requirements and program constraints, providing whole product visibility for cross-product optimization. Engineers can then associate the product's functional and logical requirements to the physical implementation of its electronics features.

To help developers separate product behavior from product functionality, Teamcenter integrates with UML and SysML modeling applications such as Sparx Systems Enterprise Architect and IBM/Telelogic's Rhapsody. Design teams can leverage this systems level view to identify how a potential change ripples across other parts of the system. This detailed level of system definition, modeling and simulation helps development teams create the well-defined, high-quality electronics modules needed to accelerate new product introduction processes.

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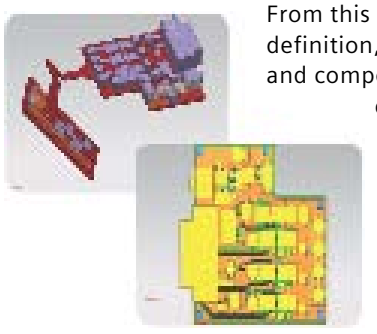
Integrating MCAD and ECAD tools and processes

The mergers, acquisitions and expansions that typify today's business environment have turned product development into a global enterprise. In this type of environment, design processes tend to employ multiple toolsets from a variety of vendors.

Teamcenter integrates with virtually all major ECAD and MCAD tools, managing all of the design, fabrication, assembly and visualization data produced during the electronics lifecycle. By combining these mechanical and electrical design tools with Teamcenter-provided best-in-class applications, product manufacturers can transform otherwise disconnected tools and processes into an integrated electromechanical design solution that enables them to lower costs and improve quality, while increasing design productivity.

Mechanical design Facilitating collaborative engineering across a multi-CAD-based enterprise or supply chain, Teamcenter supports today's most commonly used MCAD tools including the NX™ suite, the Solid Edge® suite, Catia, Pro/Engineer, SolidWorks and Inventor. Teamcenter enables design teams to use multiple MCAD design tools to perform industrial design and styling, generate digital mock-ups and define the mechanical package. Teamcenter's integrated development environment allows designers to work with model elements from any of these applications and share data across multiple domains, enabling your company to re-use product design knowledge and accelerate its development cycles.



From this mechanical definition, PCB configuration and component placement constraints are established. When environmental issues or packaging constraints preclude the use of rigid PCBs, a common option is to use flex-circuitry. Typically this approach is used to secure a connection in harsh environments or when multi-form versatility is required to conform to tight, irregularly shaped enclosures.

To place and route this type of board, PCB design systems require an accurate 2D representation of a board that by its very nature is three dimensional. Using MCAD design tools, an accurate representation of the 3D geometry is created. Here, support for multiple transition types is required to calculate and account for the end parameters, restricted areas, refold length and bend regions. Once the 3D design is defined, a flattened representation is generated and passed to the PCB design tool for physical layout and to manufacturing for fabrication and assembly planning.

Using a standards-based interchange format, mechanical and electrical design teams can leverage Teamcenter to easily share data. The mechanical designer passes information relating to board shape, keep-in and keep-out areas and the preplacement of critical components, such as connectors, switches, displays or LEDs. The preliminary PCB design is then transferred via an exchange file to the PCB designer for use in the PCB design tool.

The electrical engineer will use the same format to pass 2.5D/3D component and layout information to the mechanical engineer, who performs a variety of simulation and analysis functions, such as evaluating mechanical interferences, thermal, vibration, shock, dust and humidity. Using the interchange format, Teamcenter provides a common context for these two engineering domains to communicate and share data.

Integrated wire harness design Many everyday products include cabling or wire harness to physically connect one piece of electronic hardware to another. Wire harness design is a multi-disciplinary development process that requires electrical and mechanical design teams to share data in an integrated, collaborative environment. Tightly integrated with logic capture tools, the logical and functional aspects of the design are generated and stored in Teamcenter. Using the logic data stored in Teamcenter, the physical layout can be performed in NX or other third-party routing tool.

Using NX, design teams place physical components (such as connectors and stand-offs) and generate the routing pattern. Here, designers are able to accurately visualize the routing pattern and potential interferences, as well as trace the location of specific wires and connections. This eliminates the need to build a physical prototype and significantly reduces product development time.

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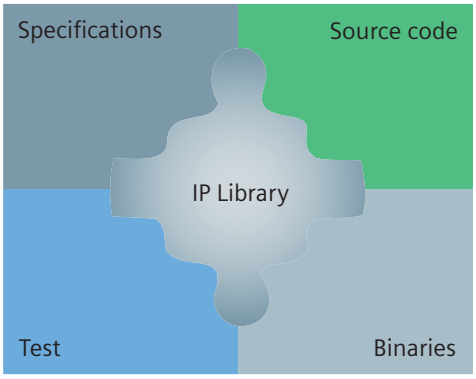
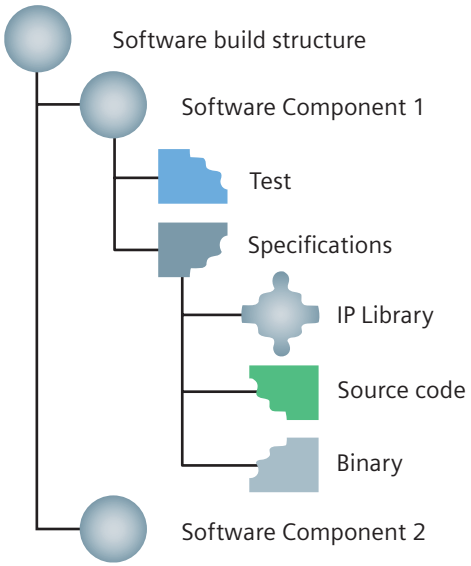
To reduce production costs and assembly defects, NX is preloaded with extendible design rules that are user-customizable. To reduce scrap and accelerate the manufacturing process, NX generates (and Teamcenter manages) all the data for accurate formboard drawings. By showing wire lengths and layouts, connectors and terminals, wire bundling, and the placement of structural components (such as clips, tubes and seals), these formboards aid manufacturing in accelerating the time-to-volume production.

Software design Software assets are the core of many companies' electronic products. The intelligent management of these assets – and the processes used to create them – has a direct bearing on a company's current and future competitive position. To manage and control your software assets, Teamcenter supports tools that have been developed by Siemens PLM Software; it also integrates with IBM Rational ClearCase, Orcanos' Qpack, Sparx Systems' Sparx EA and IBM/Telelogic's Rhapsody.





Teamcenter's software design data management capabilities enable product teams to store and manage all software design data that is used for component-based development, build management and defect tracking in a single secure location, including source code components, signals/messages, calibration and configuration parameters, binaries, build files and specifications. Integral to the software development process, these Teamcenter capabilities facilitate software configuration and integrated change management, as well as the use of build processes and product options and variants. Teamcenter's software design data management capabilities also foster the re-use of proven software modules that result in faster software development and higher product quality. In addition, they enable product teams to efficiently search for software components, which in turn helps them better identify, select and compare various components.

Teamcenter also supports signal and binary management. These capabilities allow design teams to define and track a multitude of generated signals, as well as to view and access software configuration processes and manage all dependencies that exist between software and hardware components. By tracking and managing software as a "part", design teams can lower warranty and repair cost.

Electrical/electronic design Teamcenter enables ECAD teams to increase productivity by integrating design tools from Mentor, Cadence, Intercept and Altium. It also provides an integration gateway to integrate ECAD tools that your company has developed internally or procured from other third parties.

On an enterprise level, these integrations allow widely dispersed design teams to align ECAD design implementation with product requirements, capture PCB design and manufacturing data, manage ECAD part libraries, coordinate with suppliers, foster environmental compliance initiatives, facilitate collaboration and concurrent engineering initiatives and quickly assess the impact of change, thereby minimizing change-related rework. At the user level, the integrations enable your designers to open and save native design files, access approved parts, generate visualization files, share fabrication and assembly data, create bills-of-material (BOMs) containing both mechanical and electrical parts and collaborate with other domains and suppliers.

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Enterprise-wide PCB design data management

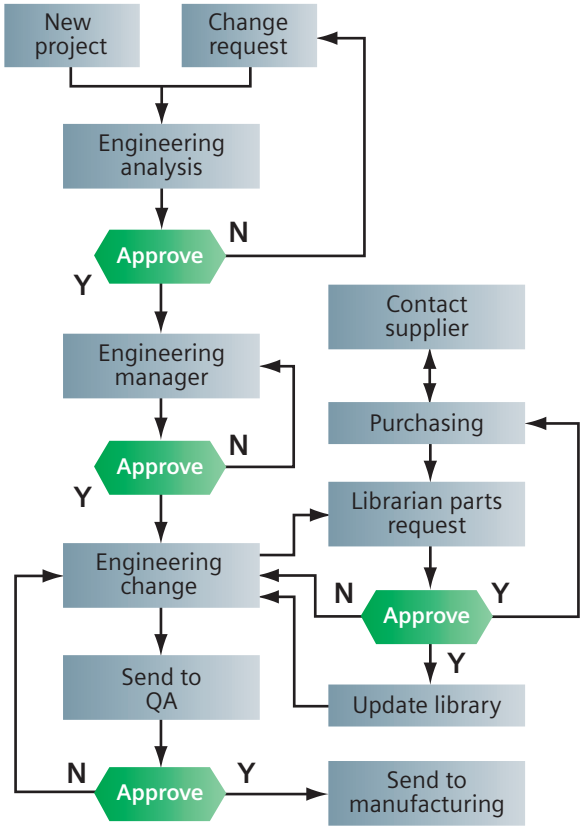
Using either the gateway for EDA or integrations that embed Teamcenter menus into the ECAD design tool, users can automatically log-in to Teamcenter and open, save, check-in and check-out design data. The ECAD tool data is stored as its native design archive. You can also store secondary data extracted from the ECAD tools, such as fabrication and assembly data, as well as Teamcenter-generated ECAD/MCAD interchange, visualization and BOM files.

By adhering to the Teamcenter mechatronics data model, design teams ensure their ECAD data is accurately captured and consistently managed in the Teamcenter environment. Adherence to the mechatronics data model also enables you to establish allocations and associations to ECAD data, which in turn allow you to link this data to product requirements, leverage it in workflow processes and tie it to specific product configurations.

Enterprise-wide ECAD part library management

In globally distributed design and supplier environments, multiple ECAD tools (each with its own parts library) are frequently used. Unfortunately, multiple part libraries cause data inconsistency, as well as organizational inefficiency. To address these problems, Teamcenter enables you to capture, track and manage all of the symbols, footprints, padstacks and attributes in your part libraries, as well as the relationships between these objects.

To prevent design teams from using unapproved, obsolete or out-of-date parts, you can establish specific access privileges, processes and procedures for incorporating changes. To ensure that accurate and consistent information is available throughout your organization, Teamcenter library data can be synchronized with each individual ECAD tool's local library. Using Teamcenter, your design teams can consolidate all of this disparate information into a single secure location, making it available for use across multiple ECAD tools.



During the synchronization process, Teamcenter automatically identifies any new or updated parts that need to be exported. By managing parts data in Teamcenter, product manufacturers can reduce part duplication, prevent use of obsolete or unapproved parts, assign compliance data and focus procurement from approved vendors.

Managing and coordinating vendors and suppliers

Part library administrators use Teamcenter's vendor management wizards to capture, track and manage all of the vital information that defines each vendor's location and points-of-contact. You can attach manufacturer's datasheets, or the materials declaration forms needed for environmental compliance, to this data to provide engineers with more detailed design information. Since the same commercial part is often supplied by multiple vendors, library administrators can establish relationships that identify a vendor as a "preferred" or "back-up" supplier. This information is especially useful when creating assembly bid packages for contract manufacturers.

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Vendor information captured in the parts library manager can also be leveraged by Teamcenter's supplier resource management (SRM) solutions. Teamcenter's SRM solutions enable you to use vendor and contact information to expedite your component proposal and quoting processes, analyze supplier and pricing data and foster product development and sourcing team collaboration. This dramatically reduces component sourcing cycle times, lowers part costs and facilitates more informed and equitable buying decisions.

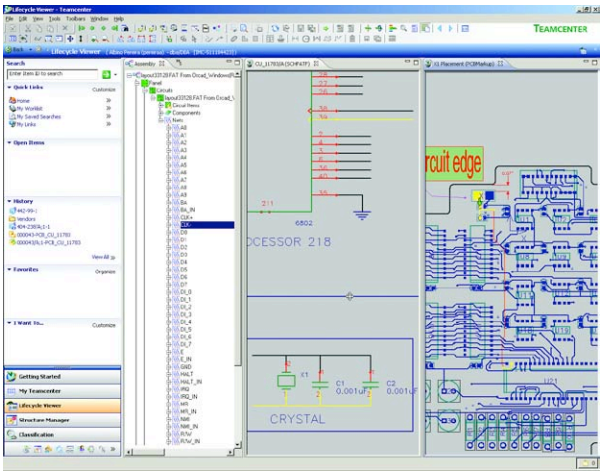
Supporting your environmental compliance initiatives

Environmental compliance directives, such as RoHS and WEEE, are constantly being updated. High tech and electronics companies can combine Teamcenter's part library management and compliance management capabilities to meet the compliance requirements established by these directives. Design teams can store and manage all of their environmental compliance information within a single secure location, including IPC-1752 material declaration forms for each vendor and part.

Using Teamcenter, compliance management teams can analyze an individual part, a product BOM, a group of BOMs or an entire library. Design teams can verify environmental compliance and investigate the root cause of any failures before costly mistakes make their way into the product release cycle. This integrated approach enables you to minimize risk and implement a uniform, long term compliance strategy for design, validation, manufacturing and reporting.

Collaborating across domain and process boundaries

ECAD visualization Teamcenter's ECAD visualization solution enables widely dispersed product teams to interactively share data, visually identify problems and graphically document issues. Using standards-based visualization formats that support a variety of commercially available ECAD tools, product teams and manufacturing partners can use Teamcenter to browse, highlight and cross-probe design entities within the schematic and PCB physical layout without having to employ a dedicated ECAD authoring tool.



When investigating the routing patterns of matched pairs or shielded nets, the electrical engineer can select nets in the schematic and have them highlighted in the PCB layout. To collaborate on placement issues, the PCB designer can select components and have them identified for the electrical engineer even if they are spread across multiple sheets. Using a variety of measurement tools for determining straight line, radial and Manhattan distances, design teams can quickly investigate and verify device geometries, component spacing, net lengths, trace width and conductor clearances.

In addition to facilitating viewing and data sharing, Teamcenter enables product teams to mark up design and fabrication issues with appropriate annotations. Commonly used annotations are translated and automatically displayed in the default language of the computer opening the file. These powerful ECAD visualization features enable product teams, as well as the entire design chain, to communicate design intent, shorten design validation time and reduce fabrication scrap and rework.

BOM generation and management BOM management is a critical part of designing and manufacturing any product. Teamcenter enables you to create a complete product BOM containing both the mechanical and electrical parts used on the PCB. The ECAD integrations automatically extract all of the electrical parts from the schematic or physical layout and combine the data with any mechanical parts that may be used, including heat sinks, sockets, mounting hardware and insulators.

BOM grading capabilities enable manufacturers to monitor and maintain control over the quality of the BOM being turned over to internal or contract manufacturers.

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Using BOM grading, users can define a set criteria against which the Bill-of-Material will be evaluated. At many companies the "grading" process may include evaluating information such as are all the parts approved, is a preferred vendor listed, manufacturability locations, compliance status, and much more. Different sets of rules can also be created that evaluate the BOM based on markets or regional compliance requirements.

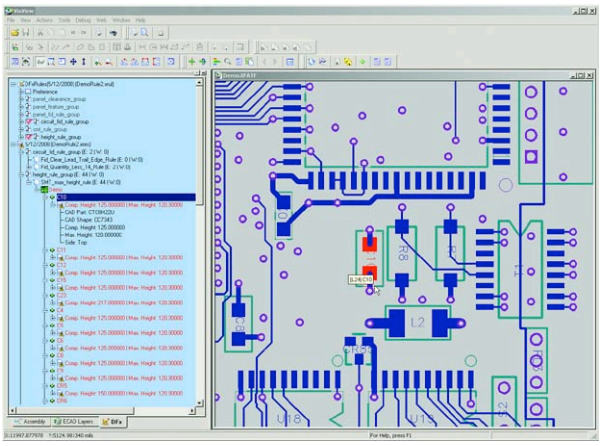
Multiple product assemblies are frequently created from a single PCB layout. To address this issue, Teamcenter enables you to manage product options and variants. The "circuit card assembly" (CCA) represents the top level assembly for a printed circuit board design. Unique BOMs, generated from the schematic for each product variant, are stored and managed in the Teamcenter ECAD data structure. They are readily accessible by all lifecycle participants.

Teamcenter's advanced context management capabilities enable product team members to view the product and its configuration variants in a perspective relative to each participant's lifecycle function. To reduce interpretation errors, users can display the BOM in "packed" or "unpacked" format. Product designers and purchasing agents might choose to display the BOM data in a "packed" format that identifies a part and groups all reference designators assigned to that specific part. Similarly, manufacturing engineers and service personnel might choose to display the BOM in the "unpacked" format so that each reference designator and its associated part are listed on a separate line.

As design changes are incorporated, it frequently becomes necessary to identify the differences between multiple versions of the BOM. Teamcenter's BOM compare utility helps users quickly identify these differences. The differences between the BOMs are highlighted, while a compare report dialog further clarifies the nature of these differences. Total and accurate visibility into the BOM, across multiple product configurations, enables design teams to meet cost, quality and delivery schedule targets.

Preproduction validation The PCB assembly/test process has a dramatic effect on product cost, reliability and time-to-market. Teamcenter's design for PCB assembly and test solution enables your design teams to analyze and verify a printed circuit board layout's conformance to your company's rules.

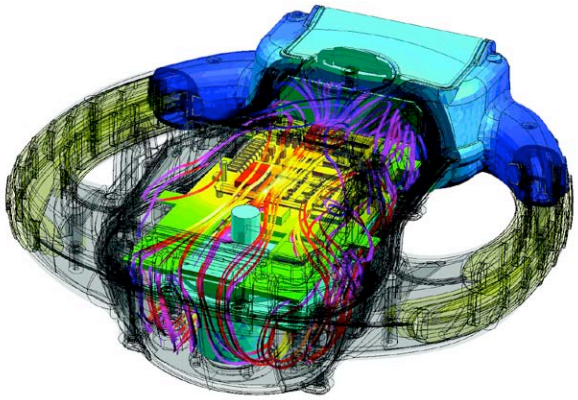
Using a host of configurable rules, Teamcenter flags non-conformance issues relating to panel dimensions, fiducial rules, circuit edge clearance, component-to-component clearance, test and probe point clearance, and height restrictions on placed components. Early identification of these issues helps reduce the scrap generated during preproduction and facilitates your company's transition to cost effective volume production.



By integrating design for PCB assembly/test processes into a standard electronics design workflow, product manufacturers can more readily implement and support the design-anywhere, build-anywhere model prevalent in today's electronics industry.

Embracing digital prototyping

Building better products faster and less expensively requires new ways of exploring product performance, such as simulating the product in a virtual world. "In fact, those companies leveraging three or more different types of simulations are able to reduce the number of prototypes by 37 percent. This leads to cost reductions of $332,673 and 118 days for complex products."[2]



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Use of Teamcenter's PCB.exchange IDF format enables electrical and mechanical engineers to quickly and easily share 2.5D/3D information required for cross-domain simulation, analysis and design optimization. An essential part of the PCB data exchange process is coordinating component part information between ECAD and MCAD systems. When IDF files are imported from ECAD, PCB.xchange will use detailed 3D component definitions available in Teamcenter part folders to populate the complete PCB assembly. If a 3D library representation for a part is not available, it will automatically create extruded component definitions and correctly position instances of these parts on the board assembly.

PCB design information is used for various simulation and analysis functions, such as evaluating component interferences, performing component-level thermal simulation, sizing heat sinks and assessing vibration, shock, dust and humidity conditions. By enabling design teams to share analysis data in a virtual environment, Teamcenter reduces your need for physical prototypes, shortens your development cycle, improves product quality and cuts development costs.

Implementing structured workflow and change processes

To consistently meet product delivery and quality targets, PCB design needs to be incorporated into structured workflows and formal change management processes. Teamcenter provides a best-practice solution that enables you to define workflows and initiate, administer, review, approve and execute product changes or new part requests on an enterprise basis. Within these structured processes, you can leverage change documents such as problem reports, change requests, change notices and approval cycles.

When issues are discovered, Teamcenter can distribute the change request to the appropriate "owner" for investigation. The owner can diagnose the cause of the problem, determine the nature of the fix and use Teamcenter's configuration and dependency management capabilities to identify what other parts of the product or library will be affected.

You can use Teamcenter to authorize changes, assign tasks, incorporate modifications and check in data. Once these steps have been completed, Teamcenter can notify the quality assurance group that fixes need to be tested and which parts of the system are affected. Finally, you can have Teamcenter inform the change review board that the change needs to be validated, close the request and automatically route appropriate notifications.

Teamcenter's structured workflows, end-to-end issue tracking and coordinated change management processes enable development organizations to meet delivery targets, eliminate errors, reduce costs and ensure total product quality.

Managing projects with the rest of the product lifecycle

Product configuration and variant management
Today's products often use one platform with multiple product options to facilitate mass customization and other business initiatives. Unfortunately, complex product structures often result in poor product quality and reliability problems as configuration mistakes arise. Teamcenter's configuration management capabilities address this issue by enabling product teams to relate electronic design data to the product, platform and model where it is used.

Using Teamcenter, product teams can define each product option and variant in the same product structure and establish all appropriate connections and dependencies. These connections and dependencies help design teams quickly search and identify relevant data for any product variant. These features are especially valuable for avoiding data duplication and facilitating the re-use of proven electronic modules and other intellectual property.

These connections and dependencies also help product managers identify what other parts of the product will be impacted when changes are proposed. Teamcenter enables you to facilitate whole product configuration management and promote efficiency across the development process, thereby improving product quality and lowering warranty cost.

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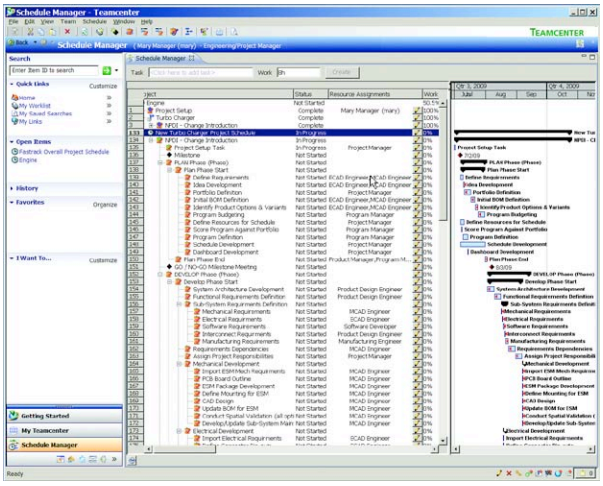
Program and project management To improve productivity and meet delivery targets, Teamcenter's program and project management capabilities tie project tasks and resources into schedules and managed workflows. Product managers can assign and track resource workloads (for both humans and tools), identify dependencies and resource constraints, and determine the progress and current status of each item defined in the project.

Through Teamcenter's integration with Microsoft Project Desktop, users can view the interdependencies among multiple projects and perform critical-path analysis, as well as examine costs and resources at the program level. Dashboards provide critical information that accurately reflects this data's interrelationships.

As a project proceeds and new requirements arise or unexpected issues appear, the product manger can quickly identify what impact these activities might have on the overall schedule and whether team members from other projects are available to assist with the development effort. By balancing and optimizing the project's time and resource constraints, these capabilities help mitigate project risks and eliminate last-minute surprises.



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Conclusion

To ensure you are designing, implementing and maintaining the products that your customers want at the lowest cost possible, Teamcenter's electronics lifecycle solution provides a single-source of product and process knowledge that ties electronics development with the rest of your product development processes. Addressing the electronics lifecycle, Teamcenter enables you to:

- Capture and link requirements to physical implementation
- Create a system-level view of the product
- Integrate multi-MCAD/ECAD tools and processes
- Track and manage all ECAD design data in a single source
- Establish a secure, enterprise ECAD part library
- Manage and coordinate ECAD vendors and suppliers
- Support environmental compliance initiatives
- Collaborate and share data across multiple domains and processes
- Embrace digital prototyping
- Institute structured workflows and change management processes
- Manage projects with the rest of the product lifecycle

By using Teamcenter to manage the electronics lifecycle, your company is able to meet delivery targets, lower costs, reduce scrap, minimize rework and improve product quality.

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Siemens PLM Software, a business unit of the Siemens Industry Automation Division, is a leading global provider of product lifecycle management (PLM) software and services with nearly 6.7 million licensed seats and 63,000 customers worldwide. Headquartered in Plano, Texas, Siemens PLM Software works collaboratively with companies to deliver open solutions that help them turn more ideas into successful products. For more information on Siemens PLM Software products and services, visit *www.siemens.com/plm*.

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