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Teamcenter electronic work instructions

Siemens PLM Software provides an end-to-end solution for work instruction authoring and publishing. The entire authoring process – from engineering design, through manufacturing planning to shop floor execution – is performed using Teamcenter® software. This white paper explains the benefits of electronic work instructions using Teamcenter.

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www.siemens.com/teamcenter

Contents

Terminology

EWI	Electronic work instruction
EBOM	Engineering bill of material
MBOM	Manufacturing bill of material
BOP	Bill of process
OOTB	Out of the box
MES	Manufacturing execution system

Executive summary

Electronic work instructions (EWI) refers to computerized visual tools to instruct shop floor workers to perform their jobs. Unlike paper-based work instructions, electronic work instructions may also include 3D models of the parts to be assembled, information about the tools as well as product and manufacturing information (PMIs). In addition, EWI may be interactive, allowing the reader to manipulate the 3D view, play animated assembly sequences as well as browse through a sequential list of steps to be performed per job order.

Example of electronic work instruction created by Siemens Rail Systems using Teamcenter.

Detailed, highly visual and up-to-date work instructions can improve product quality, reduce rework and save time. The ability to manage work instruction documents per product configuration provides significant added value not only for the initial generation of work instructions, but also the flexibility to manage changes quickly is expected from a good work instruction solution. While authoring of the initial work instruction may require some effort, being able to manage the engineering changes and to reconcile them into the manufacturing structure is the most time-consuming task in manufacturing planning.

Case Study – Siemens Rail Systems

Every regional and high-speed train built by Siemens in Germany passes through the doors of the Siemens Rail Systems plant in Krefeld. Siemens has taken advantage of this location by making its Krefeld facility one of the most important centers of competence for the railway industry. Every year, more than 450 car bodies are delivered by the plant, at which approximately 2,000 people work on the development and production of rolling stock, electrical systems and components.

The Krefeld plant's manufacturing engineering group was experiencing a number of obvious problems on the shop floor that were related to work instructions. Specifically, the work instructions were often difficult to understand and visually insufficient. In addition, it wasn't always clear if the instructions were up-to-date and consistent.

To address such problems associated with the work instructions, Siemens Rail Systems adopted the Teamcenter software manufacturing process planner application for work instructions authoring and publishing. Now with the help of Teamcenter, each work instruction, delivered in PDF format, includes a list of assembly steps sequence, the necessary tools required for each step and additional manufacturing information in a clear, visual and consistent format. Another big advantage of using Teamcenter is the ability to easily update documents. For example, if there is an engineering change to one of the parts, the changes can be automatically reflected in any related imagery in the work instructions. Previously, Siemens Rail Systems used to invest considerable time and effort to generate 2D assembly drawings for the shop floor personnel. This is no longer needed, due to the new work instructions solution.

How industries are using EWI solutions

Authoring electronic work instructions

There's no single way to author work instructions. Some manufacturers may use inexpensive Microsoft Office® software tools to author documents, while others implement integrated work instruction and routing planning tools (CAPP). In general, work instructions are tightly connected to the engineering design and manufacturing planning processes, therefore constituting a significant component of the communication flow. Authoring of work instructions requires the availability of engineering and manufacturing information, as well as the validity of assembly processes. In some cases, work instructions may include instructions for machine operators. Shop floor work instructions also have to satisfy intra-company formatting and layout standards. Therefore, customized template creation is a key requirement of any work instruction solution.

Usage and consumption of EWI

Electronic work instructions is in use by many manufacturers from various industry segments. Any production line that requires manual operations would require a certain level of shop floor documentation. Regulated industries such as aerospace and shipbuilding must invest significant efforts to define and implement high standard shop floor documentation. In many cases, government regulations mandate that shop floor documents meet certain criteria.

Traditionally, work instructions would be printed and distributed to the shop floor with accompanying 2D engineering drawings. Many manufacturers still use that method, at least partially. Electronic work instructions, however, may be embedded into the enterprise manufacturing execution system (MES). This allows manufacturers to combine all manufacturing execution tasks and information into a single backbone, and to link the work instructions to work orders, resources and parts stock. MES systems also allow data collection which is required for many processes (for example, nonconformance).

EWI formatting and delivery

There are various available strategies for the publishing and delivery of work instructions, including:

Document-based

Generation of a single document or work instruction package – for example, paper, PDF (2D or 3D) and/or HTML that captures all relevant information and is delivered to the shop floor terminal. This method is ideal:

- When a printed document is required
- When there is no MES (offline)
- When information is sent to suppliers or external manufacturing facilities

MES-based

Work instructions and metadata are loaded to the shop floor terminal and presented in a dedicated viewer – for example, HTML, etc. This method is ideal for enterprise data management, connection to work orders and change management scenarios. Work instruction viewers may also allow packaging of data for off-line use and collaboration.

Online versus offline

Work instructions can be directly sourced either from the authoring system (Teamcenter) or delivered in a packaged form to an MES or other repository such as a web server, ERP system, etc.

Many companies combine the above methods to address various corporate needs – for example, using the MES references or links to a work instruction stored separately.

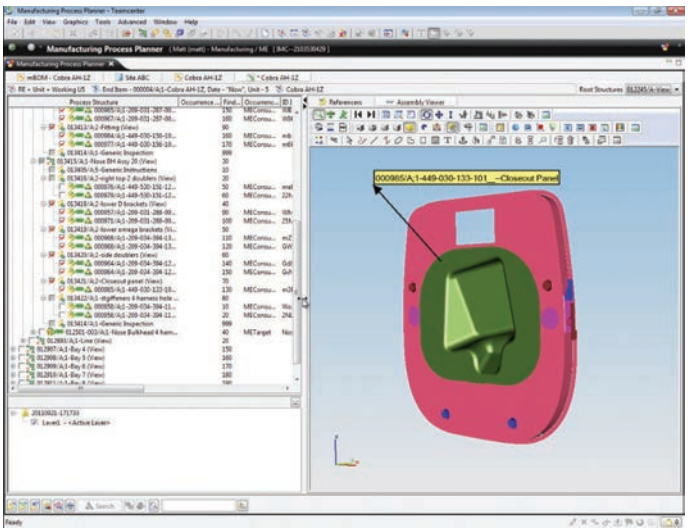
Technology to support the above methods varies. HTML, PDF, Word, Visio® software and other solutions are often used. Siemens PLM Software provides dedicated web-based viewers, as well as a document-based publication option.

The Siemens PLM Software offering

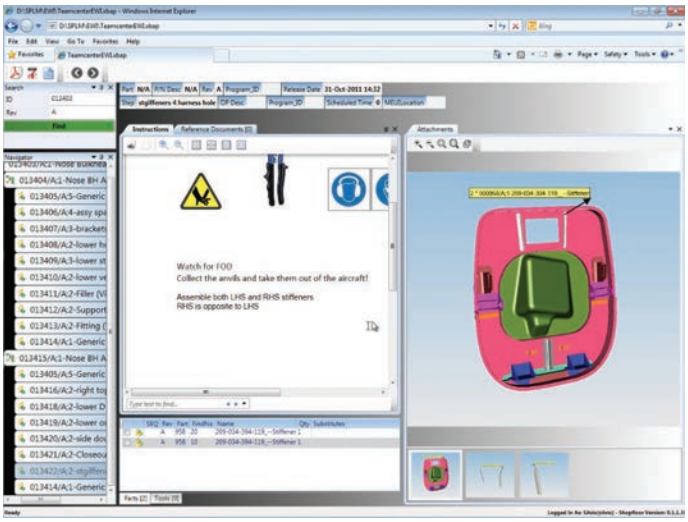
Siemens PLM Software provides an end-to-end solution for work instruction authoring and publishing. The basic concept is that the entire authoring process – from engineering design through manufacturing planning to shop floor execution – is performed using Teamcenter software. Different applications based on Teamcenter support the workflow and data is managed in one single source:

1. **Design** The CAD data, EBOM structure and PMIs are managed using Teamcenter. Product configurations and variants are applied.
2. **Manufacturing planning** The EBOM structure is aligned to the MBOM structure, representing the manufacturing view. The MBOM contains the assembly structure, as well as manufacturing-specific data such as disposables, datums and more.
3. **Process instructions planning** The MBOM information is propagated to a managed process structure (BOP) which contains the work instruction steps, assigned tools, part consumption, product views (3D view points), process animations and material flow. Textual instructions are authored using library text elements as well as free text. Hazards and icons are added to the textual section.
4. **Execution** The authored work instructions are sent to the shop floor directly from Teamcenter. A dedicated web-based out-of-the-box (OOTB) electronic work instruction viewer presents the specific process element (job order) with the relevant data. The data presented in the viewer is live Teamcenter data – there is neither a need for process publishing, nor data conversion. OOTB integration to the Siemens MES system – Simatic IT – is available. However, the viewer can be integrated with any commercial MES.

A major differentiator of Siemens PLM Software is that the entire engineering lifecycle process is managed using a single backbone – Teamcenter. This reduces the risk of quality escapes, increases engineering efficiency and eliminates the need for data conversion.



Process definition in Teamcenter manufacturing (part assignment, PMIs, routing planning).

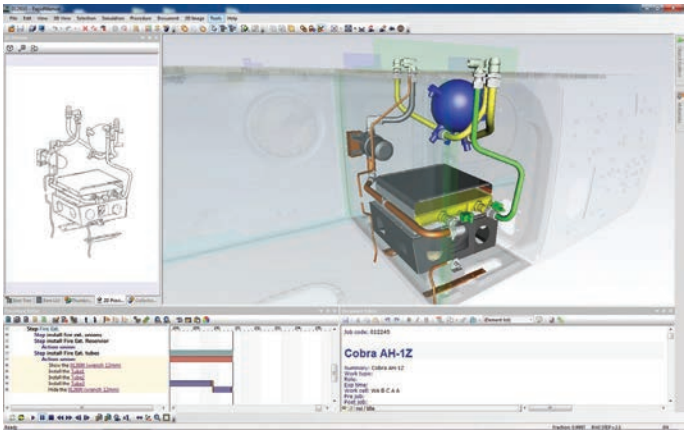


Teamcenter manufacturing electronic work instruction viewer including library text elements and product views.

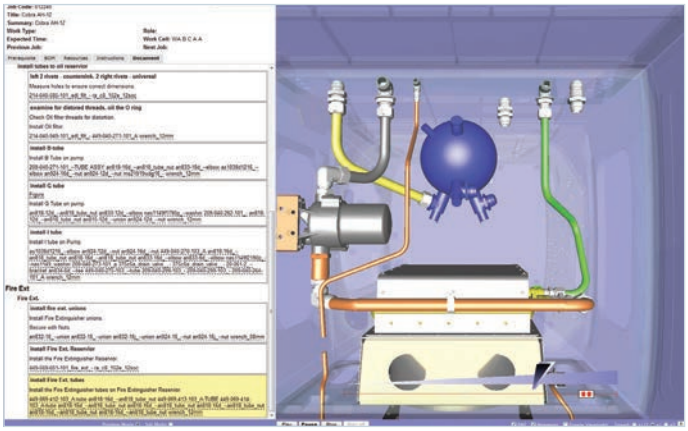
Integration to Cortona3D

Many leading manufacturers require embedding sophisticated text-enabled animations for exploded views, assembly operations and more. To answer this need, Siemens PLM Software has partnered with Cortona3D, a leading provider of technical documentation solutions. Cortona3D RapidAuthor software suite provides intuitive tools to enhance the process instructions (BOP) with text, 3D interactive animations, 2D graphics, etc. Cortona3D has developed a direct integration to Teamcenter, allowing synching with a BOP and publishing of an animated HTML package or other formats, including PDF, back to Teamcenter.

Another value of integration with the Cortona3D product is the efficiency gains from re-using as-manufactured work instruction information in the authoring of technical support documentation such as part catalogs, manuals and training material.



Cortona3D RapidAuthor – creating animated assembly sequence.



Cortona3D example EWI.

Cortona3D also provides the capability to deliver content to an iPad® portable electronic device and/or access via the Teamcenter Mobility™ mobile device application.

Importance of bill of process (BOP)

The bill of process (BOP) combines the design data, manufacturing data and shop floor data into a coherent structure. The BOP links parts, tools, plant data, assembly sequences, various types of operations (robotics, human, machines), process collateral (attachment), detailed instructions and more. The use of BOP in the automotive industry has become a standard, because repeated operations with short cycle time are present, while dependency on resources (fixtures, clamps, conveyors) is critical. Aerospace and shipbuilding processes have different characteristics, with less automation and longer release processes. In some cases, companies are using the MBOM structure to define their processes and assembly sequences; therefore adding a BOP structure may be less intuitive for them. Along with that, the introduction of BOP to these industries has a very significant value, providing an ultimate connection to the shop floor, while MES systems are process-driven and require detailed operation description.

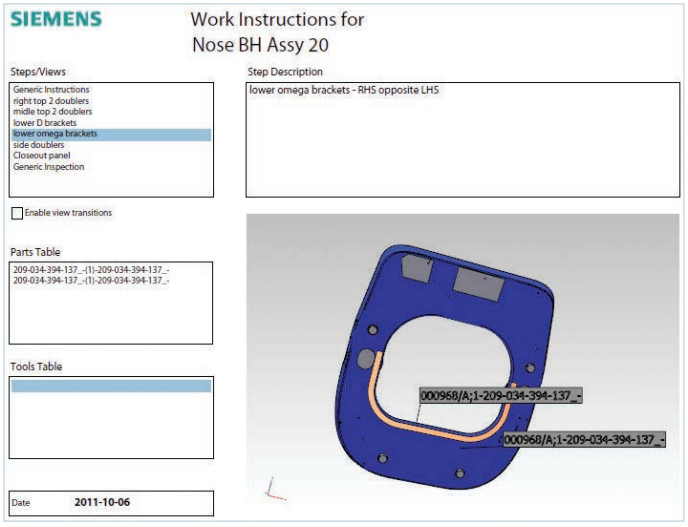
BOP allows change management at the level of the single operation and can save time by eliminating the need to re-create instructions from scratch (address only the changed operation). BOP also supports additional design for manufacturing applications, such as robotic simulation, plant simulation and human simulation.

Therefore, the best practice for all industries is to use BOP for EWI management.

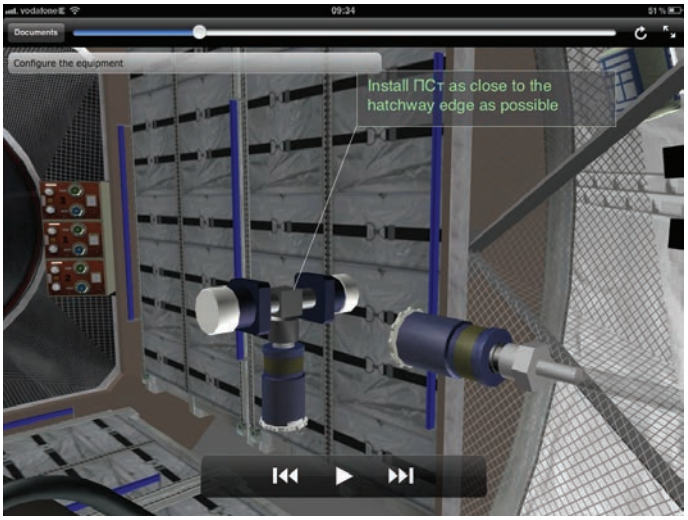
Offline versus online work instructions

While an online work instruction viewer is an optimal solution, some manufacturers require the capability to use work instruction data offline. This may be due to lack of connectivity to Teamcenter at the shop floor or other business reasons that require an offline document. Supported options include:

- Using the Siemens PLM Software EWI in offline mode
- Generating 3D PDF document using Teamcenter manufacturing
- Using the Cortona3D HTML-based solution or other publishing capabilities



Example of the 3D PDF solution.



Cortona3D example on an iPad.

The relevant option should be selected based on a company's specific requirements. In any case, it is important to emphasize that the authoring workflow remains the same for any selected format.

Differentiation

While various work instruction authoring tools are available in the market, Siemens PLM Software has several notable advantages including support of the entire engineering lifecycle with no data conversion.

Siemens PLM Software's solution was designed and optimized for change management scenarios, the most painful issue for industry. The solution publishes live engineering data to the shop floor – the best way to ensure accuracy.

The joint offering with Cortona3D positions Siemens PLM Software as one of the most advanced players in the documentation market, allowing both strong change management capabilities and great visualization.

Siemens PLM Software's visualization is based on JT™, a state-of-the-art open format that can be integrated to Simatic IT and other shop floor systems with dedicated BOP structures.

Benefits of using EWI

A leading aerospace company used the EWI solution from Siemens PLM Software to improve the visibility of build plans across teams. Prior to this, the company relied on homegrown tools that were designed to deliver printed work instructions to the shop floor workers. Since the tool was not connected to the design and manufacturing data, it caused enormous loss of productivity whenever changes were introduced. The company did not have enough confidence that the work instructions showed accurate and current information. After implementing the EWI solution, they can now confirm that production is reflecting the design intent. The company now has seen considerable improvements in meeting their first-time quality targets. The improved visualization inherent in 3D EWI provides the company much better integration between engineering and manufacturing.

Conclusion

Electronic work instructions has become a standard for many manufacturers. To get the most from this tool, companies should implement a reliable system that allows smooth change management, minimizes data conversion and provides state-of-the-art, 3D-based, interactive authoring. Various publishing strategies can be applied, according to the company's needs. Wisely implementing enterprise work instruction authoring tools may lead to significant savings in engineering time as well as minimizing time spent by manufacturing experts on the shop floor. Siemens PLM Software offers such a state-of-the-art work instruction authoring tool embedded in Teamcenter and powered by Cortona3D visualization capabilities.

Bibliography

Find more information about the Teamcenter and Cortona3D integration by visiting:
http://www.cortona3d.com/Products/Teamcenter-Integration.aspx

Learn how Siemens Rail Systems is using the Teamcenter work instructions solution by visiting:
http://www.plm.automation.siemens.com/en_us/about_us/success/case_study.cfm?Component=180543&ComponentTemplate=1481

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Siemens PLM Software, a business unit of the Siemens Digital Factory Division, is a leading global provider of product lifecycle management (PLM) and manufacturing operations management (MOM) software, systems and services with over 15 million licensed seats and more than 140,000 customers worldwide. Headquartered in Plano, Texas, Siemens PLM Software works collaboratively with its customers to provide industry software solutions that help companies everywhere achieve a sustainable competitive advantage by making real the innovations that matter. For more information on Siemens PLM Software products and services, visit www.siemens.com/plm.

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