SIEMENS
Ingenuity for life

GEOMETRIC SOLUTIONS

Automotive and transportation

Siemens Rail Systems

Digital manufacturing tools strengthen rapid organic growth

Products

Teamcenter, Tecnomatix

Business challenges

Deliver trains to customers on time and per quality requirements

Plan the production process for a highly complex product against significant time pressure

Support the production of products for different customers, with high levels of variation

Reduce shop floor production errors and scrap

Keys to success

Remove barriers between Product Design and Manufacturing Engineering groups through Manufacturing Process Planner

Define the M-BOM out of the E-BOM

Plan a production process, including operations sequence, needed tools and handled parts

Integrate Manufacturing Process Planner with existing engineering IT systems

Train manufacturer uses Manufacturing Process Planner and Process Simulate to ensure its products are manufactured at the highest quality standards against continuously shorter delivery times

All tracks lead to the Krefeld-Uerdingen plant

Every regional and high-speed train built by Siemens in Germany passes through the doors of its Siemens Rail Systems plant in Krefeld (Uerdingen district). Krefeld is strategically placed between the two major cities of Düsseldorf and Dortmund. 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, where approximately 2,000 people work on the development and production of rolling stock, electrical systems and components.

At the Siemens Rail Systems plant, the aluminum components for the body shells are fitted together, welded and painted. Individual parts are then put together, and the car bodies take on the form and shape that passengers will later see and use. Only when every seat and door has been correctly installed is the train rolled out the doors and ready for service. Regional trains like the Desiro and high-speed trains like the Velaro, both used in the United Kingdom (UK), are built in

The Siemens Rail Systems plant in Krefeld.

Krefeld, with some of them put through their paces at the company's own test center. The high-speed Velaro train is already operating successfully in Spain, China and Russia. The latest generation of the train is also due to run in its home country – Germany.

The Siemens high-speed Velaro train.

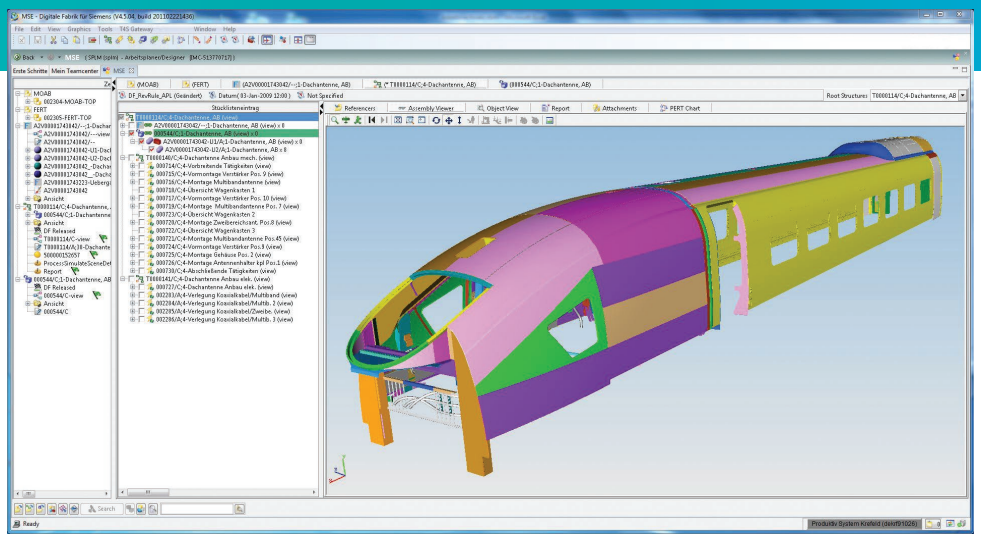
Results

Project delivery time is reduced

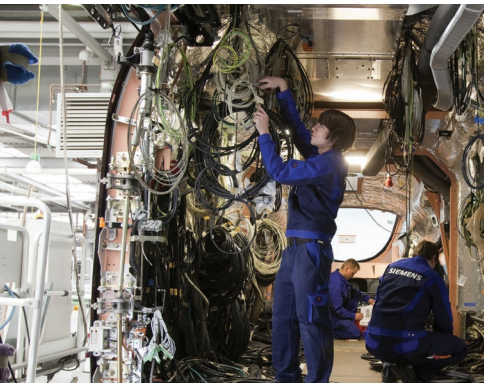
Product changes are systematically handled by manufacturing engineering through a controlled change process

Visualized and self-explanatory shop floor work instructions

Dynamic 3D simulations of complex assembly scenarios



Planning a train assembly process with Manufacturing Process Planner.



Train assembly is a complex process.

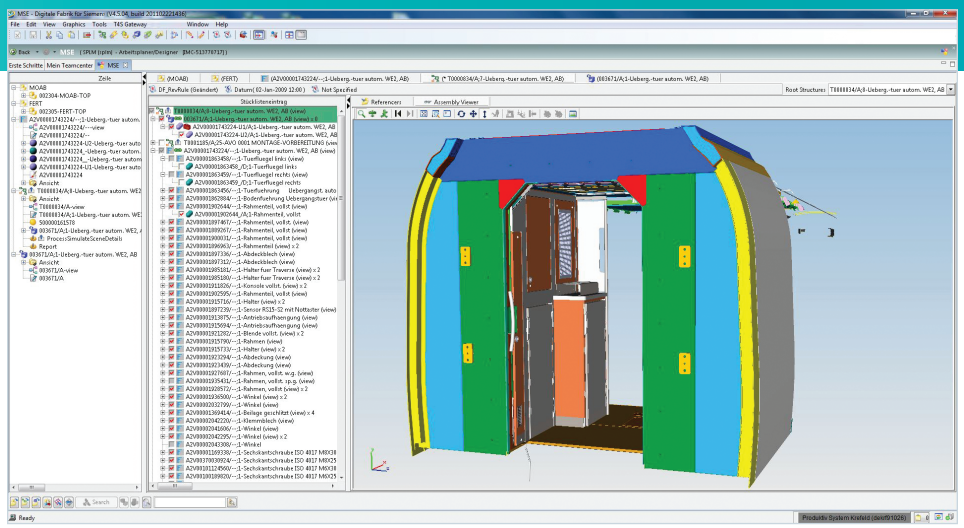
Planning the production of complex products requires dedicated tools

Ulrich Semsek, who manages the Krefeld Plant, describes the organization's business challenges, "We are now facing a huge pressure to deliver trains, due to our ever-increasing order book. The commercial trend we are experiencing is that the time from order to delivery becomes shorter, and the complexity of projects becomes higher. A typical train is a very complex product and includes 400,000 parts. The level of commonality among trains manufactured for different countries is sometimes as low as only 10 percent – so they are very different from each other. The bottom line is that we need a tool to manage this complexity. Therefore, we perceive the digital manufacturing project deployment – which uses the Manufacturing Process Planner solution in the Teamcenter portfolio as its foundation technology – to be a key element in our ability to deliver trains to customers on time and according to quality requirements."

Bridging the gap between the product design and manufacturing engineering processes

"One of the big benefits of Manufacturing Process Planner is that it helps to remove the typical barriers we have between the product designers and manufacturing engineers," says Semsek. "Manufacturing engineers are now exposed to product data during product development, and can immediately start to plan the needed production process. This clearly shortens product development time." Siemens Rail Systems' digital manufacturing capability includes a tight, bi-directional interface between its enterprise resource planning (ERP) system, SAP® software, and its manufacturing engineering backbone, Teamcenter® software. The engineering bill of materials (E-BOM) is imported into Teamcenter from SAP, and includes the structure (hierarchical information), relevant attributes (such as materials), transformational matrices and the associated geometric data (JT™ data format, which is used also within the ERP environment). The seamless integration of Teamcenter and SAP supports updating an existing BOM with a new version.

The process works as follows. The manufacturing engineers define the manufacturing bill of materials (M-BOM) out of the E-BOM. Dedicated functionality allows the engineers to easily change the hierarchy, as the M-BOM is structured the way the product will be manufactured, as opposed to the E-BOM, which is structured according to product design considerations. In addition, the manufacturing engineers add a number of manufacturing features to the M-BOM, such as lubricants, which are not



Analysis of the cabin rear part using Manufacturing Process Planner.

part of the E-BOM. Teamcenter is also used to obtain other information from SAP, including tooling data that is designed with Pro/Engineer® software and managed using the Windchill PDMLink® software environment.

At an appropriate time, the M-BOM is exported back to SAP to feed the shop floor systems. Martin Olbrich, who is responsible for assembly manufacturing engineering at the Krefeld Plant, notes, "We were impressed with the openness of Siemens PLM Software's manufacturing engineering solution. It enabled us to create seamless integrations between Manufacturing Process Planner and other commercial and legacy systems that we have in our engineering IT (information technology) landscape."

Digital manufacturing supports transportation network improvement

The transportation network in and around the city of Sochi in Russia, near the Black Sea, will go through a major improvement. To support this, Siemens has received an order from Russian Railways (RZD) to supply a total of 54 regional trains. The first 38 trains, similar to the Desiro, will be manufactured entirely at the Siemens Rail Systems plant in Krefeld. These trains are capable of top speeds of up to 160 kilometers per hour and are expected to enter service in the autumn of 2013.

The Sochi project demonstrated to the Krefeld crew the tremendous advantages of using Manufacturing Process Planner. In this project, manufacturing engineers defined both the assembly and the welding process using Manufacturing Process Planner by preparing the manufacturing operations, linking the train parts to the operations, and defining the tools that were required for each shop floor operation. The duration of each manufacturing operation was accurately calculated through an interface between Manufacturing Process Planner and a dedicated time analysis system, which is used by Manufacturing Engineering. The workflow is based on a high level of automation that saves notable time for the manufacturing engineers, as well as extensive consistency checks that ensure that no single part is left untreated. Eventually, the complete work packages are exported to SAP and consequently other systems are updated as well. Olbrich points out, "One of the clear benefits we have realized though the deployment of this train project is the ease and speed with which changes can be handled. A train is a complex product, with a high

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Manufacturing Engineering
Assembly Manager
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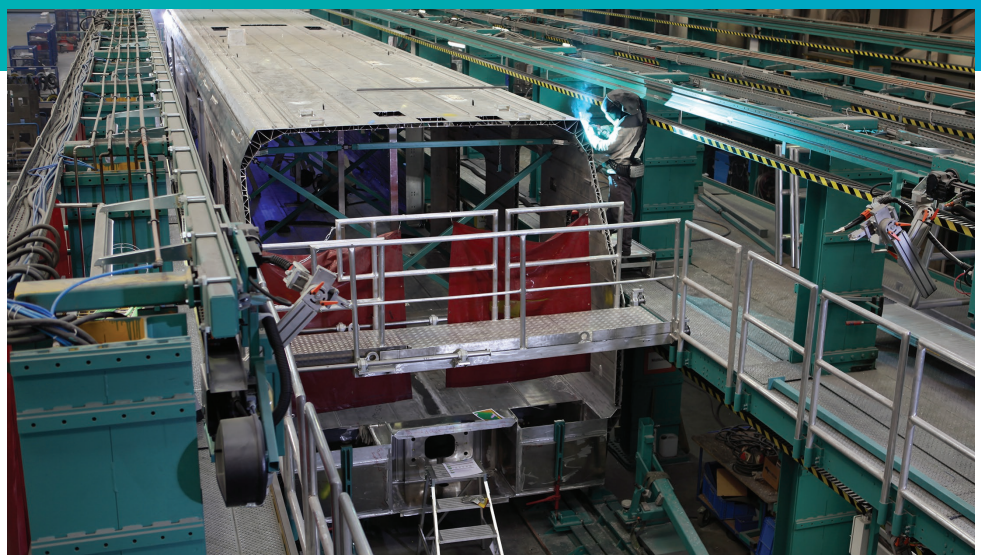


A Sochi car in the production line.

Aluminum ribs that form the car chassis on the production line.

level of customization per customer. Our group, Manufacturing Engineering, typically encounters extensive product changes throughout a project. With Manufacturing Process Planner, we have a clear methodology that readily identifies the changes, analyzes their impact, and carries them out in the process plan."

Strategic deployment demonstrates value across disciplines

"We don't calculate the benefits of the digital manufacturing project in the sense of saving manpower, as we treat this project as a much more strategic initiative," says Semsek. "In Siemens Rail Systems, our culture is to invest in innovative solutions, and push for real values." Semsek notes that this typically means taking some chances, pushing for practical benefits and, in many cases, exceeding expectations. He explains, "We now see more and more value in the digital manufacturing project – more structured methodologies and work procedures from engineering on the top floor down to production on the shop floor. What is interesting is that we now experience some benefits that we did not foresee in the first place; for example, in the Krefeld Plant, the perfect fit of the digital manufacturing tools to our lean assembly initiative."

Bernd Niesel, who manages welding across the manufacturing engineering environment at the Krefeld Plant, describes another benefit of implementing Manufacturing Process Planner: "When we first started the deployment, we planned to employ the software mainly in the assembly area, but as the benefits became more evident, it was clear to us that we would deploy the tools in the welding area as well. There are 1,500 to 2,000 parts in the chassis, and the majority of the welding operations are manual. Therefore, using Manufacturing Process Planner, we experience a big benefit in analyzing and defining the right welding sequence upfront, taking into account the physical constraints of the materials; for example, weld on one side, then balance with a weld on another side."

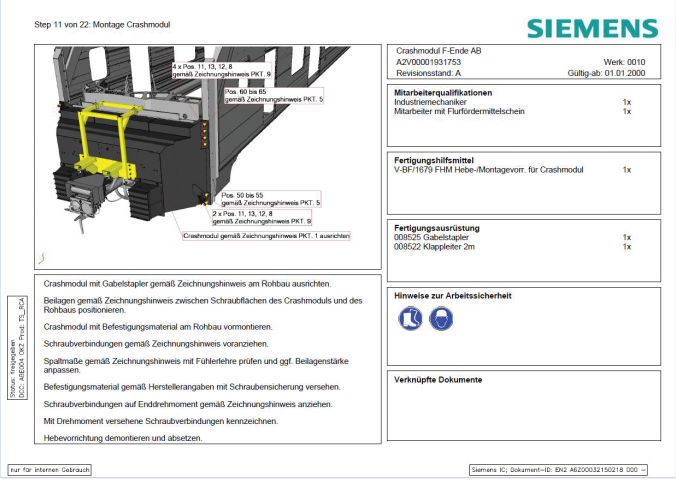
Using Manufacturing Process Planner to define the welding sequence is straightforward and effective.

Manufacturing Process Planner helps avoid shop floor mistakes

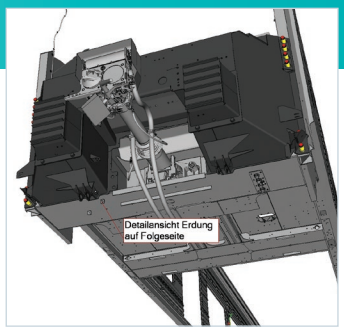
Highly visual, self-explanatory work instructions represent a key resource for avoiding assembly mistakes, which often result in costly rework and scrap. The Krefeld Plant's Manufacturing Engineering department was experiencing a number of obvious problems on the shop floor that were related to work instructions. Specifically, the work instructions were often difficult to understand and insufficiently visual. In addition, it wasn't always clear that the instructions were up-to-date. Ultimately, the shop floor workers' use of the instructions was inconsistent and less than optimal.

To address the problems associated with the work instructions, Siemens Rail Systems Krefeld engaged the 3D portable data format (PDF) Work Instruction application of Manufacturing Process Planner. Olbrich explains, "While looking for a solution that would support the reduction of shop floor scrap and rework, we became excited about the ability to create highly visual work instructions for our shop floor personnel. So we created a PDF template and used it to start generating work instructions in a format that could be easily loaded on any workstation throughout the shop floor. Each work instruction, delivered in PDF format, includes a list of sequenced production or assembly steps, the necessary tools to address each step, specific production values (for example, fastening torque), relevant security warnings such as needed protective equipment, and generic information like requisite worker qualifications and associated imagery. With such clarity of work instruction content, especially through the use of visualized processes, we have decided to optimize communication by purchasing 23-inch monitors and positioning them throughout the shop floor.

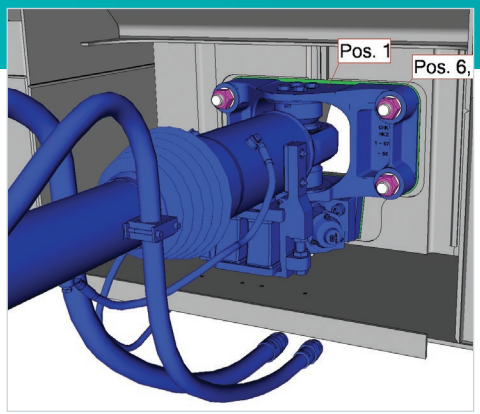
"Another big advantage of using Manufacturing Process Planner is the ability to easily update documents. For example, if there is an engineering change to one of the parts, the use of Teamcenter makes it easy to make that change and it's automatically reflected in any related imagery in the work instructions. As part of our previous process, we used to invest a lot of effort in order to generate 2D assembly drawings for the shop floor personnel. This is no longer needed, due to our highly effective, new work instructions solution."



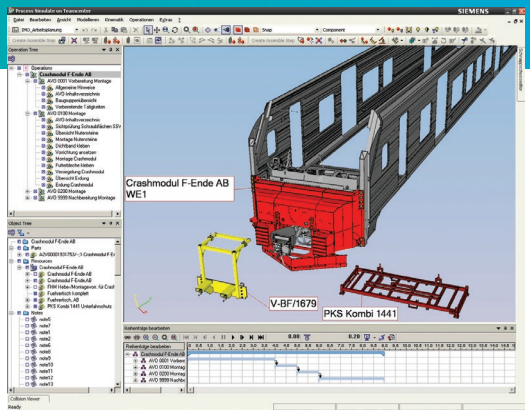
An example of a crash box assembly 3D PDF work instruction.



Coupling assembly after crash box – a Process Simulate analysis.



Coupling assembly – a Process Simulate analysis.



Crash box assembly (with the needed tools) – a Process Simulate analysis.

"Another important aspect of using Process Simulate is that Manufacturing Engineering now has a tool to carry out assembly analysis, whereas with our prior approach, this task had to be performed by Product Design. As we are dealing with a complex assembly process, the simulation (including animations and images acquired during this analysis) represents a valuable resource in training our shop floor personnel."

Martin Olbrich
Manufacturing Engineering
Assembly Manager
Krefeld Plant
Siemens Rail Systems

Dynamic 3D simulation of complex assembly scenarios

Siemens Rail Systems uses the Process Simulate solution in the Tecnomatix® portfolio to analyze any planned assembly operation that requires virtual validation. This analysis occurs in an entirely 3D environment. Process Simulate is integrated with Manufacturing Process Planner. Simulations typically include the product being assembled and the tools that are used for the assembly, fixtures and logistic jigs.

Olbrich explains, "When putting all this data into the context of an assembly, we can validate upfront whether a planned process is feasible for execution on the shop floor. For example, consider the assembly of the coupling and the crash box modules at the front-end of a train. This is a tricky assembly scenario, because whatever module you assemble first makes assembling the second module difficult. In the past, the assembly sequence for such modules was determined by the product designers. Now, manufacturing engineers use Process Simulate to analyze the optimal assembly sequence of the train modules. Using Process Simulate, we combined product data with tools and fixtures, and we found that the coupling had to be assembled after the crash box to avoid additional assembly steps and unnecessary shop floor complexity.

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The future – capacity planning and disassembly

Siemens Rail Systems has realized significant benefits from the deployment of Siemens PLM Software's digital manufacturing tools. The organization is now evaluating additional digital manufacturing applications that are well-suited to deliver significant process advantages, including Plant Simulation in the Tecnomatix portfolio. "We already did an evaluation of the Plant Simulation tool," says Olbrich. "We built a discrete-event simulation model for one of the pre-assembly lines in order to support resource capacity planning. The manufacturing process and resources are defined using Teamcenter and populated to Plant Simulation. This is a big benefit. The planned scheduling is imported from Excel. The initial outcome shows the potential for notable productivity advantages, so the deployment of Plant Simulation appears imminent."

Solutions/Services

Teamcenter
www.siemens.com/teamcenter

Tecnomatix
www.siemens.com/tecnomatix

Customer's primary business

Siemens Rail Systems combines comprehensive urban, interurban and logistics mobility expertise to deliver integrated mobility solutions – precisely tailored intermodal technologies for rail, road, and air traffic – that enable its customers to transport people and goods more efficiently.
www.mobility.siemens.com

Customer location

Krefeld
Germany

"We now experience some benefits that we did not foresee in first place; for example, in the Krefeld Plant, the perfect fit of the digital manufacturing tools to our lean assembly initiative."

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Krefeld Plant Manager
Siemens Rail Systems

Intercity trains production hall.

Another promising area is engineering disassembly analysis, which is needed for maintenance and service tasks. "Maintenance and service are part of the overall solution we provide to our customers," says Olbrich. "It is clear that with the Process Simulate tool, which is integrated within the Teamcenter environment, we can simulate disassembly activities in order to define the best disassembly methodology and effectively train maintenance personnel."

Semsek concludes, "Our train manufacturing business is doing extremely well. We recently received an order from Deutsche Bahn (German Rail) for the ICx train – the biggest single order in the history of our company. To support such growth, we must be technology leaders, and an advanced digital manufacturing deployment is another reflection of our leadership. Additional plants in our division are already looking to learn from our plant, and adopt the digital manufacturing tools and methodology we have developed using the tools of Siemens PLM Software. Luckily for our other plants, they will get the system production-ready to support their unique needs."

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