Factories of the Future | Rail Systems

Comprehensive 3D simulations. At Siemens, new trains are developed and tested down to the last detail by international teams in virtual reality before a single physical component is assembled.

**Trains of Bits and Bytes**

To make high-tech products you need a high-tech development environment. That's why Siemens in Krefeld, Germany, relies on a purely virtual product and production development system that allows it to design entire trains on computers. What's more, it expects to digitize the complete production process by 2009.

**High-speed trains can now be developed and produced within two and a half years.**

The engineer running a Velaro high-speed train adjusts the controls on his instrument panel. Suddenly a flap opens in the floor, the angle of vision swings to the space under the train, and components fly apart. Miraculously, however, the train reassembles itself.

Welcome to the virtual reality laboratory at Siemens Transportation Systems (TS) in Krefeld, Germany. Neither the train nor the engineer are real — they're animated virtual objects. There are no flip charts in the conference room. Instead, there's a power wall on which true-to-scale prototypes in a spatial environment generated by a computer can be observed with the help of 3D glasses and discussed. "This is a big help, for example when we're planning installation, analyzing ease of maintenance, and conducting ergonomic studies," says Reinhard Belker, head of Engineering Process Management at TS.

The Virtual Reality (VR) system is an integral part of the development process at TS. Here, designers meet regularly to study new trains in virtual space as they are being developed and discuss them with their colleagues from adjoining units. They also meet in "collaboration meetings" with their unit's sister production plant in Prague, the Czech Republic, where the same system is used. At the moment, the systems are the only ones of their kind in the world.

But the VR system is only one of the innovative tools that support the purely virtual product and production development process at TS. Today, rail vehicle design proceeds from start to finish in an unbroken 3D CAD (computer-aided design) process chain. Every step, from the initial concept through development, production planning, manufacture, assembly, and documentation, is worked through in three dimensions using CAD systems.

What's more, it makes the entire development process faster and less prone to error because every developer knows exactly what his or her colleagues are doing. Of course, data provided by suppliers and external design partners has to be reviewed, converted, and integrated, because in some cases partners work with different systems. But here too, TS's technology specialists are working on solutions.

On the basis of 3D data from the development team, production preparation experts can plan and simulate manufacturing and assembly processes by, for example, visualizing different assembly sequences. The production units, in turn, use the 3D data as a basis for various work steps.

Despite the comprehensive use of 3D data in all units, 2D drawings are still required in the production and assembly areas. That's because in some cases the drawings contain information that is too complex to be incorporated into 3D models without a great deal of time and effort. According to Belker, "we've proved that in principle we can do without the 2D drawings. However, there's still no IT tool that effectively supports this process. We're now working on reducing the time and effort required to create the 3D models."

Animated assemblies make it easier for workers to do their jobs, "because they can in-
As of 2009, product life cycles will be simulated — from design to service and maintenance.

The 3D data are also very valuable for product descriptions and maintenance instructions at the end of the product chain. But 2D drawings are used here as well, first because 2D vehicle documentation is customary, and second because as yet there is no recognized format that makes long-term implementation of 3D data possible. However, one of the priorities at TS is to convince everyone involved of the advantages of 3D vehicle documentation.

Taken together, TS’s system allows the entire process chain to be depicted in virtual form. “Our customers are impressed by the way we’ve integrated these innovative technologies into our development processes,” says Belker. Andy Neuschutz from trams regis Deutsche Regionbahn GmbH agrees. “Virtual product development makes the production process easier to retrieve and monitor. As a result, at an initial vehicle presentation we were able to offer visiting politicians a fairly realistic and very impressive picture of our trains at a very early stage of production,” he says.

Currently, trams regio operates 20 trains running on three lines in Germany. After its next change of train schedules, it will begin to operate along the route from Cologne to Mainz via Koblenz, for which it will use a total of 16 Desiro ML trains manufactured by Siemens.

Back in Krefeld, Reinhard Belker walks through the TS production hall, past rows of railroad cars draped with cables. Everything in the hall is clean and tidy. “Now that we’ve mastered virtual product and production development,” he says, “the next step is what we call the digital factory. We’ve been rolling it out since last April.” Plans call for TS to be ready by the end of 2009.

Simulating Entire Life Cycles. The digital factory is a concept of a production facility in which not only the physical plant is visualized and simulated on a computer, but also its processes. The concept includes the entire product lifecycle, from planning, development and production to service, maintenance, sales and marketing.

TS’s goal is to integrate development and production even more closely, make cooperation even more efficient, and align even larger portions of product and process development along parallel paths. The digital factory is an ideal way to coordinate process and layout planning and capacity analyzes. Here, all planners have access to the same database as the basis of their work. That enables them to significantly reduce errors and associated costs in production startup processes, as well as the time required for coordination.

Unlike the automotive sector, which has embraced the digital factory concept, other industries have generally avoided it because of their low production volumes, which did not seem to justify the large investments that are needed to realistically simulate processes. But in this sector in particular, comprehensive simulation of a product’s life cycle is crucial. This point is made very clearly by Dr. Robert Neuhäuser, Director of Manufacturing & SCM at Corporate Supply Chain and Procurement at Siemens, who heads a company-wide program on the future of manufacturing. “For products that are manufactured in large numbers over a period of years, we can steadily improve and optimize production processes over long periods of time. By contrast, the project and small-batch business is characterized by short startup times and short manufacturing runs. That means everything has to work optimally the first time around, because the manufacturing process will be over before any significant optimization can take place. Simulation makes it possible to run through all the possible optimization measures digitally before production. That way, we can detect problems long before they reach the real world.”

Simulation also benefits the Krefeld plant, which produces an average of 450 rail vehicles per year. A preliminary study and an efficiency analysis carried out by Siemens Transportation Systems in cooperation with the Fraunhofer Institute for Manufacturing Engineering and Automation (IPA) demonstrated the advantages of the digital factory. Its potential benefits include faster and better-quality planning, integrated tools relieve planners of routine activities and give them more time to plan less expensive and qualitatively more sophisticated products and to make their production as cost-effective as possible from the very start.

Belker is looking forward to the advent of the digital factory. Surveying a long row of gleaming trains that are ready for shipment, he predicts that, “in the future we’ll be able to deliver them to our customers even faster.”

Asobi of 2009, product life cycles will be simulated — from design to service and maintenance.

Simulations are replacing paper diagrams of assembly instructions. 3D graphics of individual work steps make assembly work simpler, faster, and more precise (left). Right: Velaro trains in the assembly hall.

Optimizing Throughput

In 2008 the heavy-ion therapy center in Heidelberg will begin treating cancer patients. Siemens configured the facility and optimized its workflows using simulation expertise gained in designing manufacturing processes for factories.