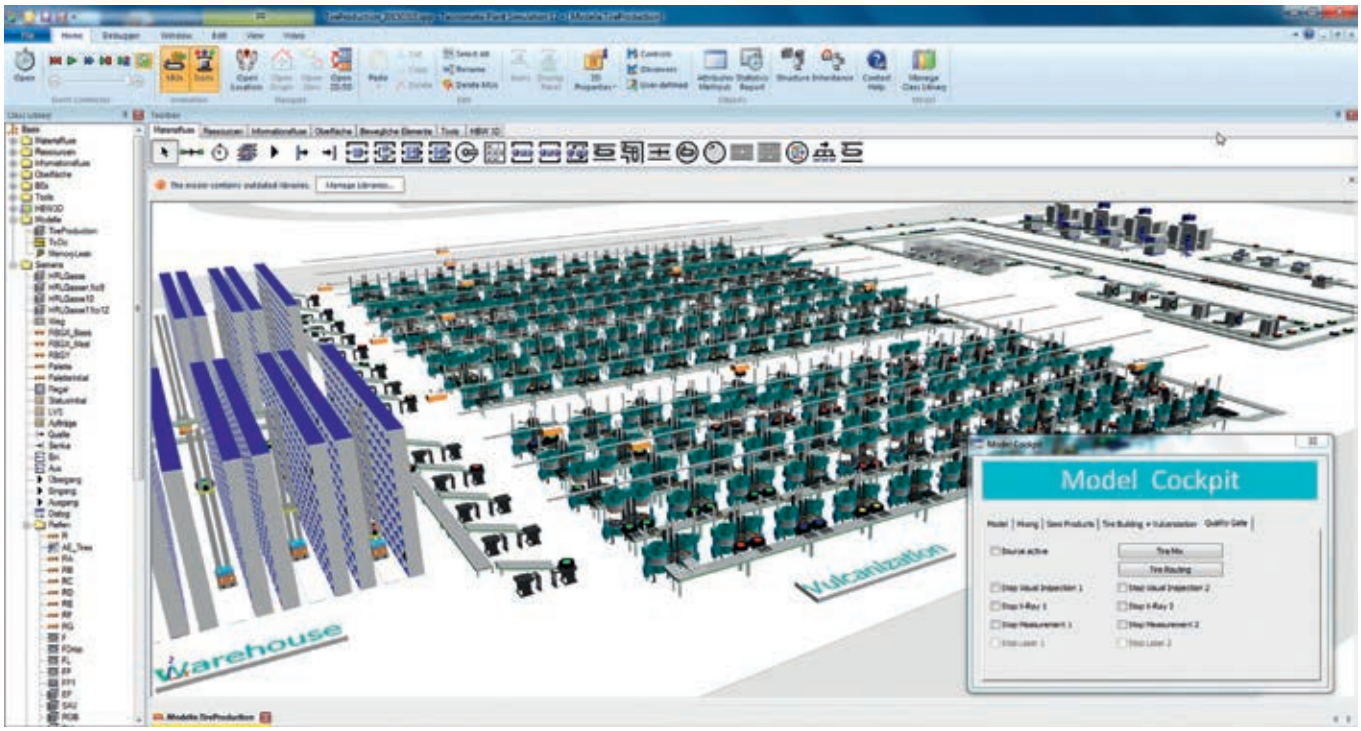

Source: Siemens

Virtual tire plants becoming a reality

Virtualisation can significantly enhance many aspects of the tire production process, explains Gert Nomden, an expert in digital manufacturing and process simulation

Modeling and simulation tools are nowadays available for most aspects of manufacturing processes. With these so-called digital manufacturing tools, engineers can connect tire manufacturing parameters and dynamic influences to the performance characteristics of tire production plants.

The virtual tire plant provides a concise reflection of the real-world system, including its performance metrics, and a basis for plant optimisation.

In Europe, several equipment suppliers in the tire industry apply digital manufacturing tools on a routine basis. Tire producers are now beginning to take their first steps in this direction. By contrast, most major automotive brands, their equipment suppliers and many component manufacturers have already adopted the technology to cut inefficiencies, reduce time-to-market and at the same time ensure delivery capability.

Plant managers and engineers in the tire industry have to fulfill potentially conflicting objectives: demand rates have to be attained, product yield maximised and yet operational expenses and capital investments must be minimised.

At the plant level, tire manufacturers are required to make numerous decisions with these corporate objectives in mind. Typical decisions include investments in manufacturing capacity, workforce, improvement projects, stock levels and so on.

The scale and dynamics of a typical tire plant makes it difficult to pinpoint the effects of these decisions on the corporate objectives. The manufacturing process of tires encompasses a range of technologies, which introduce many internal dynamics by their own. The combination of batch processes, assembly and serial processes leads to discontinuous material flows.

Quality issues and equipment failures cause unforeseen disruptions of the material flow. Also the demand for products is dynamic, not least due to the large product portfolios that are common in the industry.

As a net result, tire producers need to rely on forecasts and maintain buffer stocks to decouple the major processing stages. These stocks do not only require space and effort, but also represent a quality and efficiency risk on their own. What is more, stocks tend to hide underlying problems in the manufacturing processes.

Every change and investment in a tire plant represents a business risk. The more these risks can be mitigated at the outset, the better. However, commonly used tools and approaches to support the plant design, such as spreadsheet-based calculations cannot account for the dynamics and interactions of real tire plants. Experiments on the

Simulation models can provide 3D visualisation of tire plant processes

shop-floor are costly and time-consuming processes with local, sub-optimal results.

Digital manufacturing technology addresses many of these plant engineering challenges, offering a comprehensive set of software tools to:

- Define, simulate and optimise manufacturing, logistics and maintenance operations through virtual models.
- Capture and exchange information about those operations, both simulated and real-life, thereby closing the feedback-loop between planning and execution.

As simulation tools rely on virtual models, they allow people to experience the possible future states of a real operation, without the need for its existence, nor for disrupting it. Thereby many aspects of such an operation can be verified, tested and optimised in a relatively short time, well before irreversible decisions and investments are made.

Simulation technologies are used for various applications, such as the optimisation of material flows, off-line programming of industrial robot systems, to study human performance and ergonomics, machine tool development and for debugging control logic. Ideally, these simulation tools work in concert with corporate information systems, such as ERP, MES and PLM.

The tire industry, its equipment suppliers and consultancy companies may benefit significantly from material flow simulations of their production systems and logistics processes. These simulation models reflect the typical dynamics and constraints as they occur in real-life, such as product-dependent batch sizes and the limited availability of workers or materials. The systems' working and their performance are communicated through 2D and 3D visualisations of the plant layout as well as charts and reports.

Material flow simulation can be applied throughout the complete tire plant's life cycle. But they are mostly used to support the detailed engineering of a tire production facility: helping to verify assumptions, optimise capacities and control rules, and to assess the sensitivities of the proposed design.

An upcoming application area is called virtual commissioning. Here monitoring and control functions are connected to a virtual factory model, such as a material flow control system or an MES. These systems are then tested and debugged before, or in parallel with, the construction of the real physical factory. This not only brings savings in lead times, but also reduces costly changes and last-minute work.

Lastly, in existing tire production facilities, imminent changes and suggested improvements, such as a shift in product mix or investments in equipment, may be tested against the virtual tire plant. In addition, simulation-based planning and scheduling can support tactical and operational planning.

Experiences and results

Material flow simulation is being applied across many industries around the globe. Surveys among end-users indicate benefits including: 15-20 percent higher productivity within existing production facilities; reduced investment in planning new production facilities by up to 20 percent; and reductions in inventory and throughput times by as much as 20-60 percent.

Early feedback

To insiders, and companies with experience of using virtualisation and simulation technologies, these results do not come as a surprise. Simulation models give very early feedback about how a manufacturing system works, its performance and where problems occur. Problems are detected earlier so that counter-measures can be taken before any irreversible decision is made.

As simulation models are accurate representations of the real-world, they also allow plant managers to make decisions of a higher quality. The models allow for a great range of scenarios to be tested in a relatively short time, resulting in optimised systems. Lastly, building a simulation model forms a great learning experience, during which a lot of knowledge about the real system is obtained and communicated.

With material flow simulation many aspects of tire production can be verified, tested and optimised in a relatively short time, well before decisions and investments are made. Simulation is versatile and has a low implementation cost; therefore it offers a valuable, cost-efficient and risk-free test bed throughout the entire plant life cycle.

Not surprisingly, digital manufacturing is an up and coming technology for the tire industry.

About the author

Dr. Gert Nomden is a senior consultant and expert on digital manufacturing software at Cards PLM Solutions BV, a Dutch-based solution and technology partner of Siemens Industry Software that has been active in the tire industry for several years. Nomden received his PhD from the University of Groningen, The Netherlands. In his research, he has applied a combination of case research and simulation studies to show the effects of product-oriented planning in low volume-high variety industries. As a consultant he has been active across many industries, serving automotive, aerospace, high-tech, machinery, logistics and many other businesses. He and his team are now focusing their efforts on the rubber and tire industry.