

SMS group GmbH

Simulations, Virtual Reality and Augmented Reality in mechanical engineering

Time-saving, cost-cutting and exciting

Dr. Mark Haverkamp

Plant Simulation Tube Rolling,
Section Rolling and Forging
SMS group GmbH

Every plant operator or mechanical engineer would be thrilled about being able to move freely about a factory and look into the interior of all the machines. How exciting would it be to be able to watch what exactly is happening inside a machine processing, for example, red hot material. Taking a bird's eye view of a works' entire logistical activities is another fascinating experience, the simulation team of SMS group can offer their customers. Not less appealing is the idea of being able to see one's new plant or machine in operation before it has actually been built. All this has become possible thanks to virtual reality technology.

Four types of simulations and what benefits they provide

However, all this is not just done for the sake of excitement. It rather provides our customers, developers and engineers a number of important economic and process-technological benefits. Dr. Mark Haverkamp, Head of the SMS group's RDLP Unit, explains: "We save a lot of valuable time through what we call simultaneous simulation. This allows us to examine important functions, processes or logistical flows at a very early stage in a virtual plant set-up and make use of the thus identified optimization potential in our planning and design processes. All subsequent activities down to the commissioning of the plant will be accelerated as a result. Moreover, preliminary technical discussions with the customer become much more effective as we can explain technical solutions based on the realistic look of the virtual machine. With digitalization becoming increasingly widespread in industry, digital cloning or the generation of digital twins of a plant are becoming key issues also in the operation of existing plants. For some of our customers, we have already implemented digital clones of their plants. This allows them to test new processes, new products and process opti-

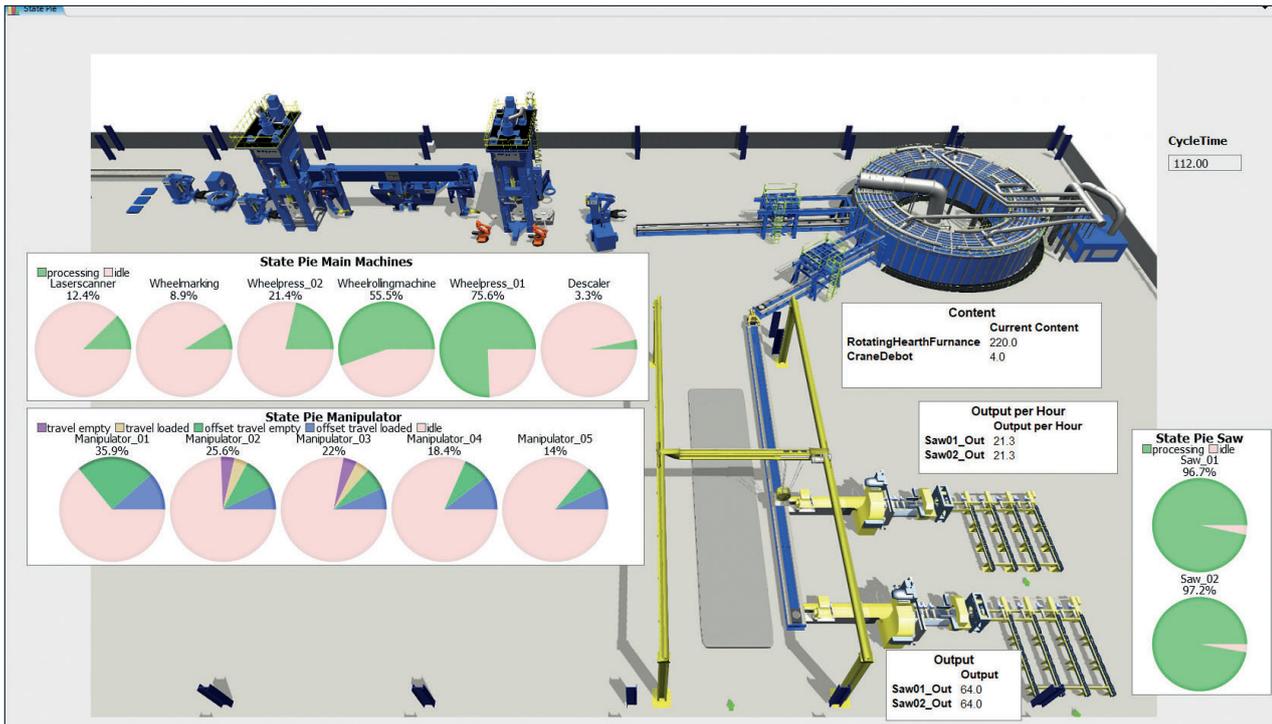
mizations very cost-efficiently and transfer those variants that have turned out to be successful in the tests to the real plant. Additionally, digital clones are excellent training means for the operating and maintenance staff."

Within SMS group, the RDLP Unit is responsible for simulations in connection with forging, tube making and long product processes and plants. "We focus on four types of simulations, and four corresponding packages, which our customers and our own departments may use in support of their activities," states Mark Haverkamp.

- Package 1 includes physical process and plant simulations.
- Package 2 relates to simulations of logistics, which we perform to analyze and determine the layout of our plants.
- Package 3 covers HIL (Hardware in the Loop) simulations, which relate simulations to real automation systems in order to optimize the process and establish trigger parameters for controls.
- Package 4 comprises the areas of virtual reality, augmented reality and digital cloning. Here the main objectives are to provide the customers state-of-the-art digital support during running operation and new interactive approaches to maintenance and repair procedures.

Physical process and plant simulations

The process and plant simulations performed by the RDLP team are, simply put, representations of our plants and the processes they perform. They support the experts of SMS group, for example, in determining the appropriate drive layout for a plant, trying out up to which maximal forces the process chains would still work properly and understanding under which conditions it would be necessary to install higher-power motors. Mark Haverkamp: "Our models make cost-intensive experiments redundant. There is no risk of damage and we can examine and test out each individual process parameter separately."



Capacity utilization analysis of a wheel rolling plant as part of a simulation of logistics.

The simulations can be used for a wide range of tasks: feasibility studies, identifying resource and energy saving potentials, process chain optimization and trouble shooting. Simulations are often used to find answers to specific questions arising in the works.

Simulation of logistics

If the task at hand is to analyze the logistics processes within a plant, tools capable of simulating the material flow are needed. In this case the simulation process entails the definition of individual events by time and distance covered, and their interconnection via networks. The simulated period can be freely defined. The calculation of a plant's annual production, taking into account the product mix and the shift schedule, is a matter of minutes. In this way, bottlenecks limiting the yield can be identified and optimized until, for example, the simulation results are in line with the performance data specified in a plant offer. The simulation tool also allows to integrate the 3D data of the planned plant. In this way, it is possible to recognize in the realistic 3D model of a plant very early whether the planned cycle times will collide with the identified logistics flows. Simply put, one can watch on a monitor, projection screen or via VR goggles as a product is travelling through all machines and process stages from A to Z and whether the process runs smoothly all the way through. Already at that stage, any problematic areas or bottlenecks in the production flow will

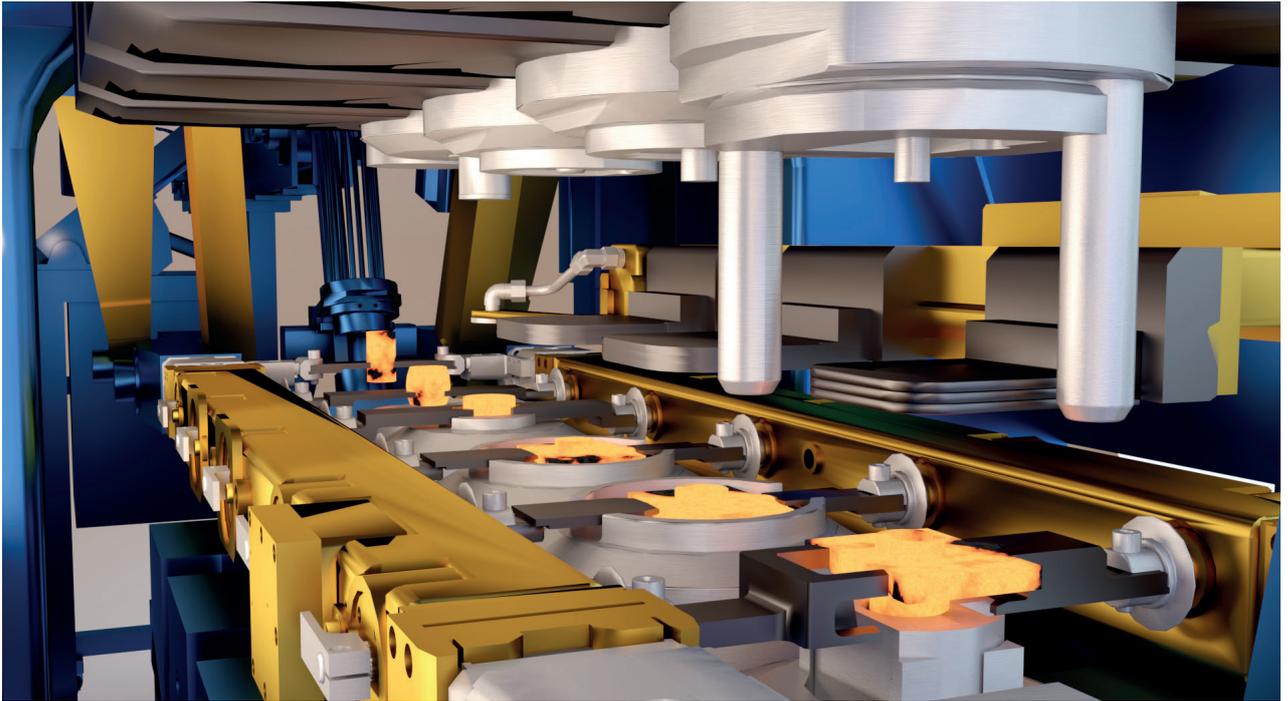
become obvious – early enough to adapt the plant layout without running into significant extra costs.

HIL simulations

Simulations are not only planning tools. They also render support during running operation. In this area of application, SMS group mainly uses HIL simulations. HIL means 'hardware in the loop'. In other words, here real elements, such as the automation soft and hardware and the control equipment, are linked with the simulation process in order to examine and check their performance.

Mark Haverkamp explains this by way of an example from practice: "At a customer's forging press, the spray heads for cooling the dies used to collide with the upper die. This caused the mechanical parts of spray heads to warp, causing new problems later on when the press was to be set up for a different product. The customer tried everything possible to change the set-up of the machine and made all kinds of adjustments – but without success. We reconstructed the affected components of the press in the simulation model and analyzed the processes. The simulation revealed that the collision between the die and the spray head was a matter of a fraction of a second. Based on this finding, we were able to solve the problem."

Additively manufactured, 3D printed spray heads made of plastics or metal weigh ninety percent



HIL simulation for collision analysis in a drop forging plant.

less than conventional spray heads. This dramatic weight saving allows the spray heads to be retracted and moved out much faster, increasing the overall productivity of the press. In order for this to work without a hitch, it is crucial to simulate beforehand the movements of the articulated support arms to find out how exactly the support arms should move to achieve the shortest possible cycle times. The thus determined optimal values can be readily implemented into the process control systems of the real plant.

Simulations using virtual reality and augmented reality

With digitalization being meanwhile omnipresent in industrial plants, digital cloning has become an increasingly important issue. Digital clones of a plant are used, among others, for virtual reality simulation. They may play a key strategic role in determining a company's future competitive standing and result in a significant competitive edge. Virtual reality simulations create a 3D model of the plant which can be viewed via VR goggles, on a monitor or a large screen.

Mark Haverkamp: "The customer uses digital clones to test out plant and process optimizations on a virtual model of the plant without interfering in any way with running production. We have also set up digital clones for training purposes, which the customer uses especially for their maintenance and

operating staff. A digital clone also allows plant operators to train their personnel on a new plant long before it will be started up."

In addition to experiencing the virtual 3D space of a plant as a passive observer, SMS group enables those watching a plant process via VR goggles to also actively intervene. In the 3D simulation of a plant, it is possible to modify the operating process by pushing the virtual buttons of the automation environment or of the control pulpit. Marco Koepe, Plant Simulation Developer at SMS group, explains why everything looks so astonishingly real: "For many VR applications, we use high-end gaming engines. This has the advantage that features of the physical world, such as gravity or simulation of movements, have already been implemented in this type of software, which is extremely powerful. It relieves us from work and makes our activities more efficient. However, wherever physical phenomena play a crucial role, we cannot rely on that software alone. In such cases, we develop our own models which will run in the background and feed their data into the computation in parallel to the runtime."

A second development, also applied at SMS group, is AR (Augmented Reality). Projections on AR glasses connect the real world with the virtual world. Animated images, 3D models or machine data can be projected onto the lenses, supporting the technician or the maintenance staff with augmented reality



Clones of plants used in operator training.

information as they perform their respective activities. Marco Koepe: “With our augmented reality solutions and AR glasses, a maintenance specialist may look, let’s say, at a pump and call up an image showing the interior of the pump with the filter in place. With the image projected onto the glasses, it feels as if was actually looking into to pump. If he desires so, he may call up instructions guiding him through the individual steps of the filter changing process.

Partnering with the customer in the digital age

Process and logistics simulations, HIL simulations, and applications using virtual reality or augmented reality features are not a new arena for SMS group. In many areas, they have become daily routines. The engineers use such high-end simulations for their work, and in discussions with customers they are extremely helpful when it comes to explaining technical details. However, this is no reason for Mark Haverkamp and his team to sit back. On the contrary. Taking advantage of the new opportunities provided by digitalization, SMS group is currently pursuing a host of new developments and innovative fields of application.

Mark Haverkamp: “For me, our slogan Leading Partner in the World of Metals means that we discuss key technologies at eye level with our customers. I believe that we are excellently positioned to live this motto.”

SMS group GmbH

Ohlerkirchweg 66
41069 Mönchengladbach
Germany

Tel: +49 2161 350 0
Fax: +49 2161 350 1667

communications@
sms-group.com
www.sms-group.com