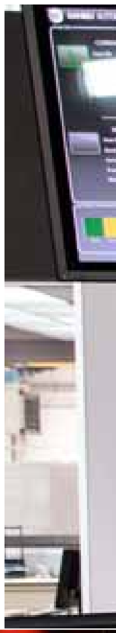
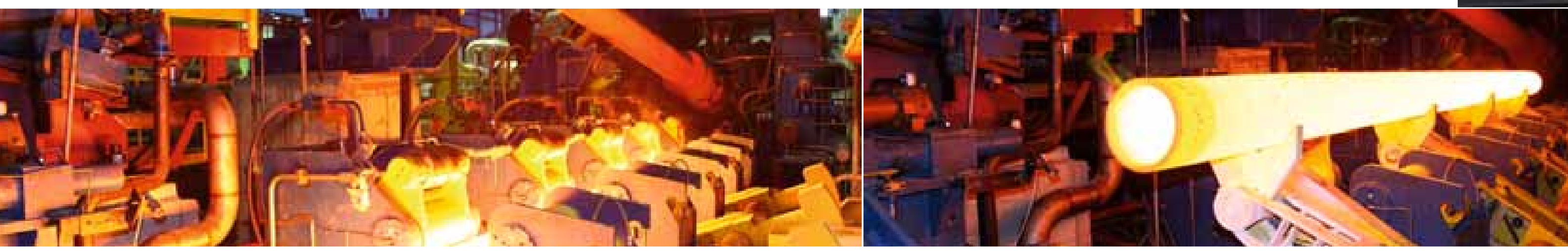
Virtual commissioning of production plants for semi-finished products



Virtual Commissioning enables 3D simulation and validation of native control system programs of a plant. We present the benefits for a plant for manufacturing semi-finished steel.

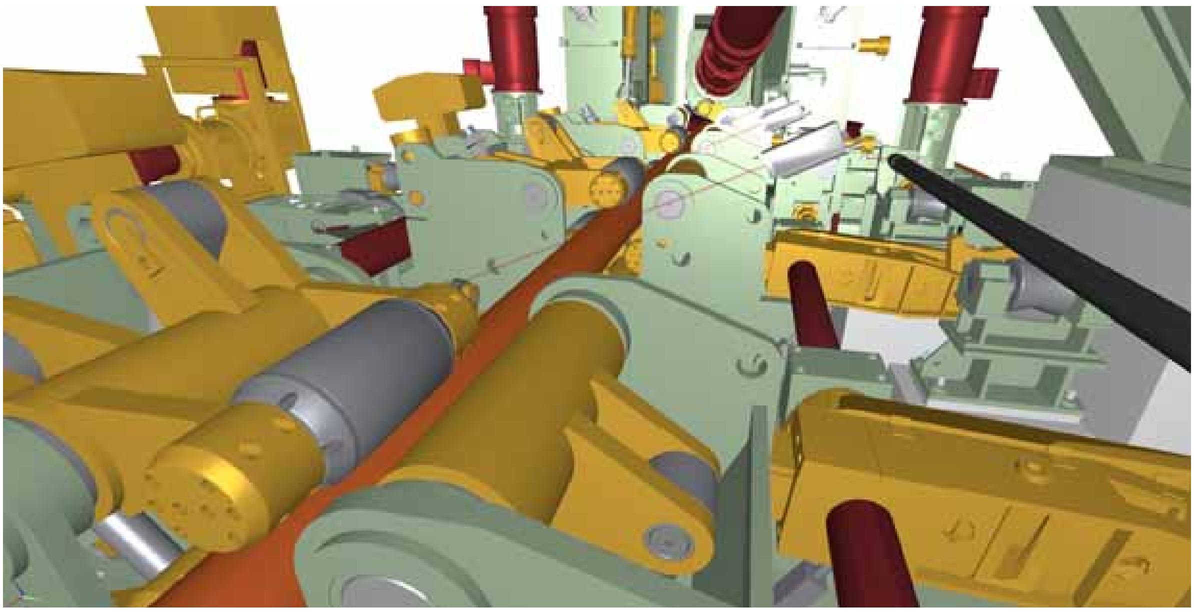


Mannesmann principle: a look at the core of the Danieli Automation seamless tube plant

Production systems for the manufacturing of semi-finished steel products are remarkably large facilities. The material flow is closely coordinated with the technical processes and extends linearly over the production processes through the entire facility. Important aspects are, for example, compliance with the time-dependent temperature sequences for moving steel, from heating through the thermal, forming and rolling processes to cooling.

Here, automatic systems relieve people from control of the technical processes. This reduces the risk of accidents and raises the process quality to a stable level.

Once a product is in processing, it has to pass through all the process steps to the end without any interruption, therefore all technical processes must be closely coordinated with each other. A stop at any step in the process usually leads to termination of the entire process. Stops are only possible at defined points otherwise damage to machines can occur. In a worst-case scenario, the defective goods cannot be removed quickly enough, leading to a backlog at the beginning of the process as well as the loss of output at the end of the process. The result is reduced output and therefore poorer return on the plant investment.



Source: Danieli

3D model for real-time simulation of a seamless tube plant according to the Mannesmann principle including the forming process for a product

Pictures (3): Danieli

Manufacturing companies have a lot of experience in designing and implementing a wide variety of mechanics-based active principles, such as the Mannesmann principle which is used here for the creation of seamless pipes (1).

From mechanics to software

Of course, in such plants, control software plays an increasingly important role. In the first instance it is used for the control of the power supply within the drive amplifier. This allows the realization of a variety of configurable features and in hindsight, not least, flexible adaptation of loads or process flows during operation. A crucial difference between mechanical and software application is that you cannot recognize the underlying complexity that comes with the software. Even experienced operators cannot see at a glance whether everything is working well in the system or not. At the end of the day, the quality is given providing the process is running stably.

Critics say software development works according to the principle of hope: A programmer writes a code hoping it will work. Certainly, he has debugging capabilities to test his own piece of software, but only when all parts are put together is it possible to check whether the system actually does its job or not.

This means that every condition that may arise during operation must be tested in advance and, strictly speaking, this testing must also be done after any change to the software of a subsystem. The required testing, which can only be performed when the real system is completely assembled, substantially delays commissioning and the start of production.

This leaves machine builders and operators facing a dilemma: If you turn off the system remains, while the mechanics is of the size of a football field with technology of the software no more than just a few devices and screens. The effort that goes into the software, and therefore the costs are comparable or even higher than those for the mechanical units.

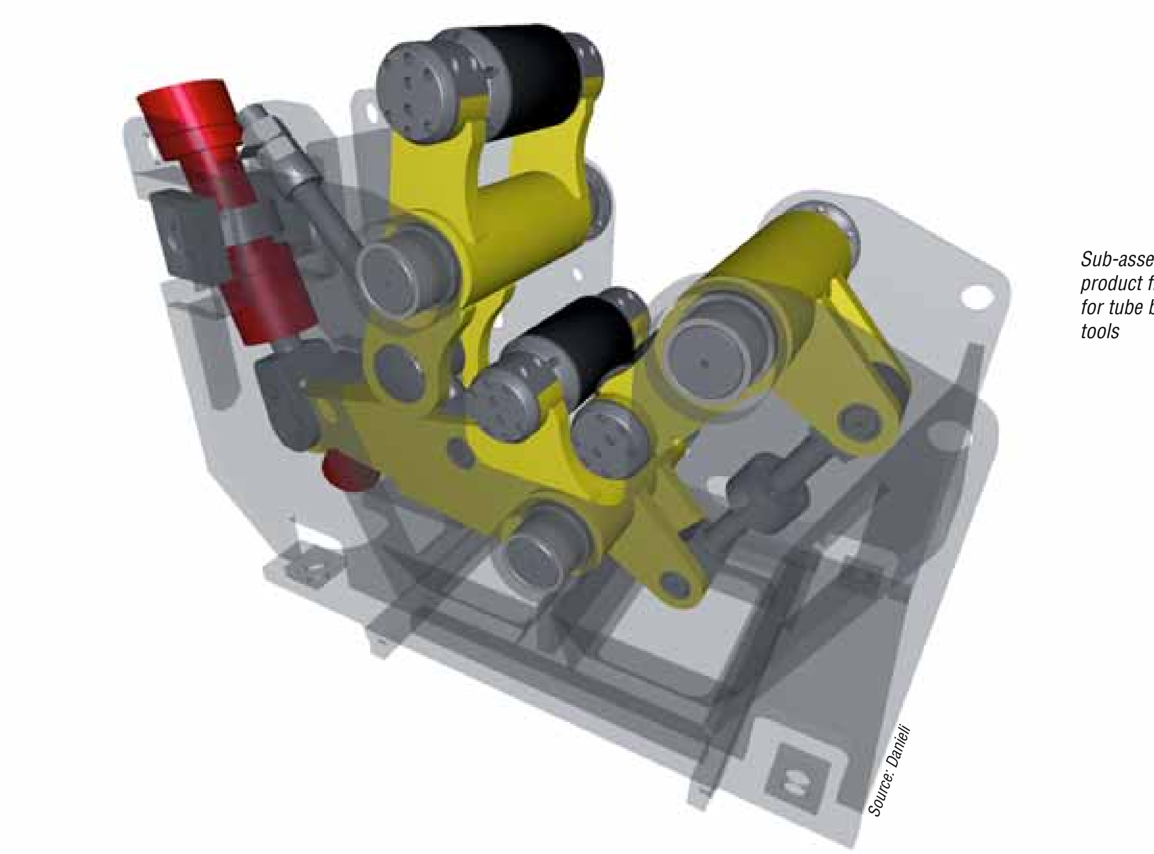
The software quality, and thus the performance of the production plant, can only be improved from the full system, and therefore stands in opposition to a quick start of production after completion of the mechanical assemblies.

The dilemma can be resolved with the ap-

Danieli Automation has developed a 3D process simulation system for seamless pipe mills that provides a representation of all plant parts and a realistic simulation of material flow, drives, sensors and actuators.

One of the most relevant success factors of the Danieli Automation's system is that the 3D simulation follows the physical principle of rigid bodies based on the parametrization of geometry, mass, inertia, friction, gravity. This leads to a real-time model of material flow and objects movement, helping engineers, for example, to place sensors (e.g. hot metal detectors).

3D simulation works with all PLC offerings such as those from Siemens, Rockwell, or CoDeSys and consists of a powerful virtual run-time environment for control engineers to reduce the development time of PLC software programming, debugging and validation. The system is also used to create different default and emergency scenarios in order to check and validate how the PLC program would react to such conditions, resulting in a significant improvement in the quality of the designed PLC programs. Moreover, before the delivery of the real plant, the system allows the implementation and testing of software modifications in the virtual equipment without the risks that may occur in reality, ensuring faster set-up of the plant.



Sub-assembly of a product flow system for tube blanks with tools

plication of virtual commissioning. This can be used to animate all the machines, including processes, drive technology and sensors, completely mapped into the digital world. It allows software tests without the real world machine equipment. This can be performed with modern computers and state-of-the-art CAE solutions, such as IndustrialPhysics from Machineering GmbH & Co. KG based in Munich, Germany.
Machineering's client Danieli Automation presented such a virtual prototype at the last Tubes trade fair in Dusseldorf, Germany: A complete PLC ensemble in a seamless tube plant was entirely simulated in a real PLC environment. It was based on the original Inventor 3D-CAD data from the mechanical design.

Virtual commissioning with Machineering

High-performance simulation technology in combination with intelligent modelling techniques make things possible which, up to now, were not feasible in special machine production. The corresponding 3D models must be efficiently processed internally to associate a design of tens of millions of polygons (envelope geometries) with the controls in real-time. Here, the Bavarian vendor works in close cooperation with its clients around the world in order to push the boundaries ever further.

High-performing algorithms

If the automation technician is facing a detailed machine layout with tens of thousands of individual moving parts, many of which are connected through an axis, a holistic simulation may seems totally impossible at first glance. However, the intelligent modelling of IndustrialPhysics allows a "bottom-up" strategy in which simulation data is already assigned at an individual component level in the Inventor CAD model.
With the combination of sub-models that are already enriched with mechatronic data in the MCAD system and the derivation of simulation models from any status of CAD model just by pushing a button, maximum data reusability is ensured.
The high quality of the physical models of IndustrialPhysics means that in many cases it is sufficient to define properties at component level. The overall behavior of the system is a result of the combination of the individual components. The code calculates the interference based on the combination of drive technology, physical behavior of machine and product as well as of the sensors during the operation. The output is the virtual commissioning of the plant with realistic control system data, e.g. from Siemens S7-400.
So, the automation technician can start to develop his own application under real conditions at a very early stage and can test it directly against a simulation model of the plant. So, the development and testing loops are reduced and shortened, and, if a change to a mechanical system becomes necessary, this can be triggered before the system is assembled. This saves money and time, and in particular reduces effort at the construction site.

Getting it right from the very beginning

The close link between CAD design, simulation and control system allows optimization of project processing in advance. Using a simulation model, you can test all the cycles of the designed machine parts and evaluate performance, in particular under different loads, with different types of products. Based on comparison of alternatives, you can find the optimal solution in a technically sound cost-benefit discussion with your client.

Reality confirms the simulation

During the automation of a galvanization system with approximately 200 drives, Robert Simla, Managing Director of AEM August Elektrotechnik, realized that the software development time of the project had been reduced by 20 percent and commissioning on site reduced by 35 percent using IndustrialPhysics from Machineering.

References
(1) www.fundinguniverse.com/company-histories/mannesmann-ag-history
For further information concerning virtual commissioning visit
www.machineering.de