SIEMENS

Press

Vienna, June 2023

Pilot factory Vienna: Siemens is an important digitization partner of the TU Wien pilot factory Industry 4.0.

- **The TU Wien Pilot Factory Industry 4.0 is a demonstration factory for Smart Production and Cyber-Physical Production Systems with several industry and research partners.**
- **The focus is on discrete, variant-rich series production and manufacturing in very small quantities (lot size 1, "high-mix and low-volume").**
- **As an example product, individualized 3D printers are produced in the pilot factory.**

Siemens is involved in this pilot factory in the virtual commissioning of the machine tool, in human-robot collaboration, in edge computing at the machine tool and in product lifecycle management (PLM); in addition, in the interconnection of all three pilot factories to form a virtual joint factory via MindSphere.

Showcases

- Virtual commissioning
- Human-Robot Collaboration
- Edge Computing
- Condition-based scheduling
- Hybrid cell
- Maintenance management
- Closed-Loop Manufacturing
- Automatic programming
- Multi-Factory

Virtual commissioning: The digital twin enables "virtual commissioning" even before the machine is built

The so-called digital twin is crucial for efficient production. This allows processes to be simulated and tested virtually even before real components are used. At the pilot factory in Vienna,

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Siemens demonstrates the added value of a digital twin using the example of a milling machine. There are two very different views on the digital twin:

View of a machine builder

The focus is on testing the designed machine mechanics or preparing the NC and PLC data. Furthermore, machine-specific cycles can also be optimized, for example for the tool change: the goal is to minimize non-productive time later in the real machine. Many of the commissioning tasks can already be completed with the digital twin before or while the real machine mechanics are set up or the control cabinet is wired. Many optimization measures can thus still be incorporated into the real machine before expensive changes are necessary in reality.

View of a machine user

A machine user, on the other hand, is usually more interested in the production of his components and less in how the machine is designed in detail. The user is therefore more likely to ask questions such as: Does my NC program run without interruption and, more importantly, without collision? How long will the processing take? Is there still room for optimization? When can new operators be trained without disrupting ongoing production? Answers to all these questions can also be found with the help of a digital twin. The real machine is not required for these optimizations. This minimizes necessary machine downtimes to a minimum.

The digital twin is commissioned with a real SINUMERIK. This is called hardware-in-the-loop. The real SINUMERIK controls the digital twin of the milling machine with the new SINUMERIK ONE control unit. Alternatively, a virtual SINUMERIK is also available, making the software-in-the-loop solution possible – an important step for the Digital Native Factory.

Human-Robot Collaboration: Human-Robot Collaboration (HRC) Research

The pilot factory takes a holistic approach and also incorporates people into digitization. Humans are not to be replaced in production. Robots are supposed to give them a hand and relieve them. Digital assistance systems aim to perfect the collaboration between human experts and artificially intelligent machines, thus creating new planning and production processes.

In cooperation with the Institute of Management Sciences at the Vienna University of Technology, a practical use case for the Siemens SIMEA plant in Vienna is being implemented in the pilot factory. In the course of a human-robot interaction, power transistors are assembled for the SITOP power supply production. Humans and robots work together and share the tasks. The goal is to explore how the customer can determine which tasks are assigned to the robot, which are done by the human, and which can be done by either the human or the robot depending on workload and availability. This also explores how the interaction should take place.

Edge Computing: Edge Computing for Monitoring Aging

The Siemens Industrial Edge app Analyze My Machine Condition (AMMC) can be used to save a typical motion sequence with all its data (e.g. current consumption) when the machine tool is in a healthy state and then check from time to time during the same motion sequence whether the machine still behaves as it did in a healthy state. For an accurate diagnosis, this requires the highly dynamic data of the machine. For this purpose, the data is captured 500 times per second.

Condition-based scheduling: production runs through

When there are many different orders to be processed in a factory, sequencing is an important productivity factor.in this showcase. Fraunhofer Austria demonstrates how the machine condition can be taken into account in sequence planning. The machine is continuously monitored via Siemens MindSphere and visitors can manually induce aging effects to it: by applying a brake or switching on a vibration motor, wear is simulated and the machine data changes. The change in data indicates that a maintenance interval or tool change will soon be required on the corresponding machine. This is taken into account in the sequence planning: larger or particularly important jobs are scheduled on other machines

Hybrid cell: programmed like a single machine

A hybrid cell consists of three machines:
1) A welding robot that creates the rough product structure with Wire Arc Additive Manufacturing (WAAM). 2) A robot that deposits the workpiece from the welding cell for cooling and then places it into the CNC machine. 3) The CNC machine, which mills away the excess material to finish the high-precision workpiece.

All these machines must be programmed to produce the workpiece correctly. Programming takes place uniformly in Siemens NX CAM and is translated into the respective machine language by post-processors. Only in this way it is possible, with reasonable effort, for the three machines to work together efficiently and behave together as a single machine. To this end, a digital twin is created of the machines and also of the workpiece. This is the way to know where to mill away the excess material from the welding process before.

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Optimized use of resources

Local production has the advantage of keeping the carbon footprint of a product small, as long transport routes are eliminated. The prerequisite for this is flexibility, because the local factory must be able to produce many different parts in small quantities. This is only possible with digitization if price and quality are to be similar to mass production.

The digital blueprint for a particular product and the steps needed to produce it, can be created in one place and then used in a hybrid cell in multiple factories to manufacture the product. The combination of additive and subtractive manufacturing makes it possible to have standard parts ready and then add the respective customer-specific or application-specific adaptations - this is called "platform strategy".

Maintenance Management: Maintaining Globally Distributed Machines and Identifying Causes of Failures

When errors occur in a production line, it is important that they are systematically documented. However, it is equally important to record how they were remedied. If the fault cannot be solved immediately with on-site expertise, the central service hotline is contacted. If all troubleshooting of the globally distributed machines is documented via the Siemens MindSphere App Asset Operations Analytics, the central service hotline can benefit from previous experience in troubleshooting. Recurring errors are detected and can be reported back to the development department. In this way, the machine builder has the opportunity to continuously improve their machines.

Closed-Loop Manufacturing: Automatically Use Production Data to Improve CAM Machine Programming

If each product is customer-specific, i.e. only one of each type is to be produced (lot-size one), then it is uneconomical if the required product quality is only right after 5 pieces of scrap. "First time right" is the claim. Closed-loop manufacturing helps to achieve this goal: Production data is collected in order to feed back findings to the CAM program. There, production is planned in detail and the control programs for the CNC machines are created. This continuous learning from the acquired data is called “closing the loop” from planning to production and back again to improved planning.

In a current research project on closed-loop manufacturing, the Siemens technologies SINUMERIK, SINUMERIK Edge, SINUMERIK Integrate, NX Open, NX CAM, and also the intelligent tool holder developed by TU Wien for the Schunk company are being used to research how the measured production data can be used to automatically adjust CAM programming. Prof. Friedrich Bleicher, head of the Institute of Manufacturing Engineering and Photonic Technologies, says: "In the future, we will only program roughness and not feed rates."

Specify precisely, program automatically: If the desired result is specified in a 3D CAD model, machine programming runs automatically.
In a good 3D design drawing, a workpiece can be specified precisely in Siemens NX CAD. This is called Model-Based-Definition (MBD): This is a 3D CAD model with all the necessary product and manufacturing information (PMI), such as tolerances and surface specifications. Automatic Feature Recognition (AFR) can then be performed in the NX CAM tool where the machine is programmed. The Siemens NX Machining Knowledge Editor (MKE) records how each of these features can be implemented with the CNC machine. Automatic programming is based on this.

<u>An example</u>: If the design drawing shows a borehole with a standard screw thread, then the Machining Knowledge Editor defines which drill must be used to predrill the borehole and which tap must be used to cut the screw thread. The location and direction with which the CNC machine performs these machining steps is determined from the design drawing.

The TU Wien showcase goes one step further: since the desired result is precisely defined in the design drawing, the coordinate measuring machine can also be programmed automatically in NX CMM at the same time, which checks and documents precisely these specified workpiece properties for quality assurance. But this is only possible with a seamless digital thread. If you build a unified tool landscape in which the individual components communicate with each other in such a way that no important design details are lost, you will be rewarded with an increase in productivity.

Multi-factory: Three factories act together as one large factory
For large corporations with factories around the globe, it is desirable to interconnect the factories so that the manufacturing of a product can be distributed to different locations. With Siemens Teamcenter, such solutions are already in use at customers today. It becomes more challenging when different companies want to connect to a common factory, because usually different data management systems are in use.

Using the example of the three Austrian pilot factories in Vienna, Graz and Linz, it is demonstarted how factories of different companies are interconnected via MindSphere to form a common factory. The scenario: a gearbox, such as is used in robot joints, is to be manufactured. The first step is to examine which factories are needed to produce the gearbox or how the carbon footprint can be minimized. The so-called knowledge graph contains the knowledge about the skills of each individual factory. It is linked across the pilot factories and an optimization algorithm determines that combination of the three factories that is best suited for production. The production carbon footprint and/or the process costs, transport costs, production time are minimized.

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