

EDUCATION

TU Graz

Empowering future engineers to manage industrial automation and control challenges via a closed-loop environment

Portfolio

Siemens Xcelerator

Business challenges

Teach industrial automation and control as it will be in the future

Educate future engineers on product data management

Impart the ability to cover the entire product origination process

Keys to success

Provide engineering courses spanning the entire product origination process

Set up agile processes in an Industry 4.0 assembly line

Use NX for CAD and CAM

Leverage Tecnomatix for plant simulation, robot programming and virtual commissioning

Results

Provided a closed-loop engineering and production environment

Taught students how to operate and maintain future production facilities

TU Graz uses Siemens solutions to teach digitalized product creation with production in a smart learning factory

Educating future creators

Companies require graduates who are open-minded and familiar with the digitalized technological environment they will encounter in their later professional careers. This applies to those currently studying, who will work in engineering and production, creating the products and systems that will shape the future.

At Graz University of Technology (TU Graz), the faculty of mechanical engineering and economic sciences combines mechanical engineering and economics.

“Our mission is to develop innovative, interdisciplinary and holistic solutions for the complete lifecycle of products in the fields of automotive, power and production engineering,” says Dr. Franz Haas, professor and dean of the TU Graz faculty of mechanical engineering and economic sciences. “This ranges from applying model-based systems design at our digital lifecycle lab, run by the Institute of Machine Components and Methods of Development, to designing and

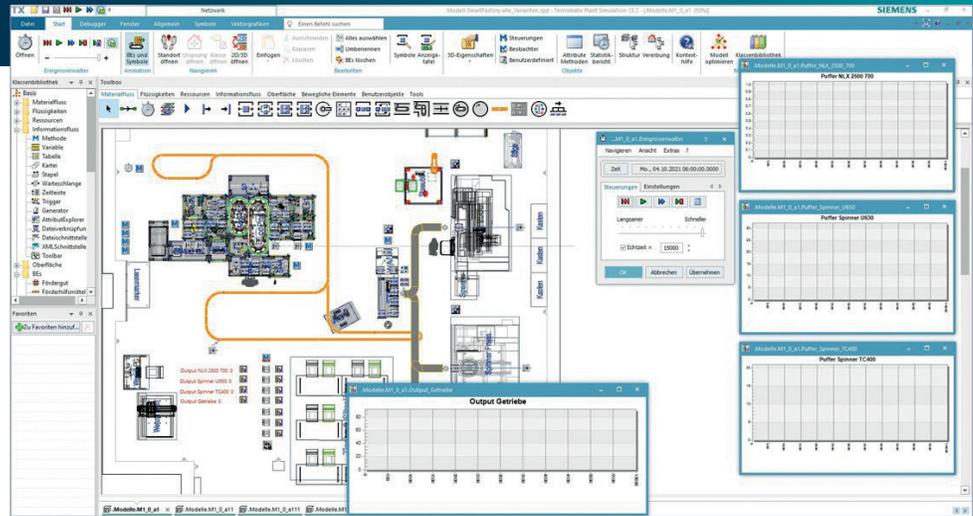


TU Graz smart factory is equipped with state-of-the-art machining, additive manufacturing centers and industrial robots from various manufacturers arranged in mobile, self-sufficient workstations.

Results (continued)

Educated engineers on future-oriented, comprehensive systems design

Developed methods for implementation in future industrial production facilities



Students and assistants at smartfactory@tugraz use Plant Simulation to design and verify material flows within the factory.

using agile, autonomous production methods in the smart factory of our Institute of Production Engineering.”

From the first bachelor’s courses through master’s programs in production science and management to the doctoral program in technical sciences, TU Graz provides students with a curriculum that acquaints them with computer-supported development and production methods, including a variety of simulation methods. They use the Siemens Xcelerator business platform

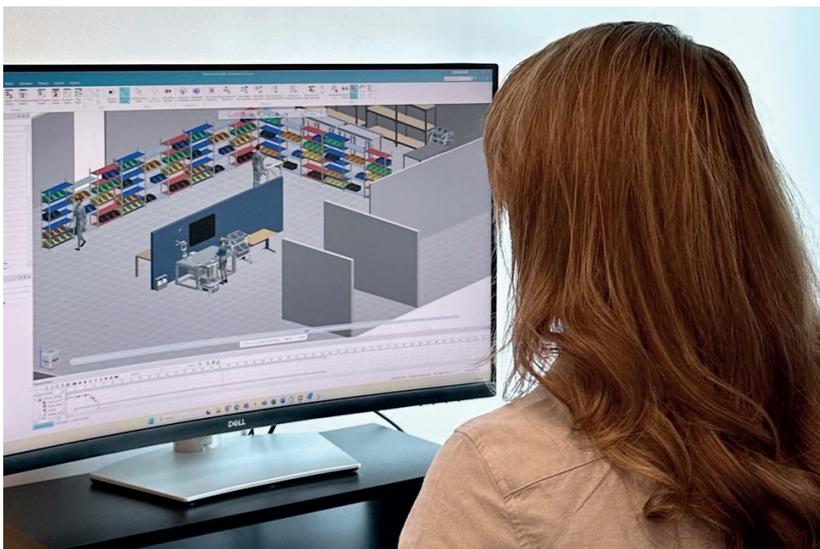
of software, hardware and services for digitalizing all stages of product creation.

Leveraging smart factory automation

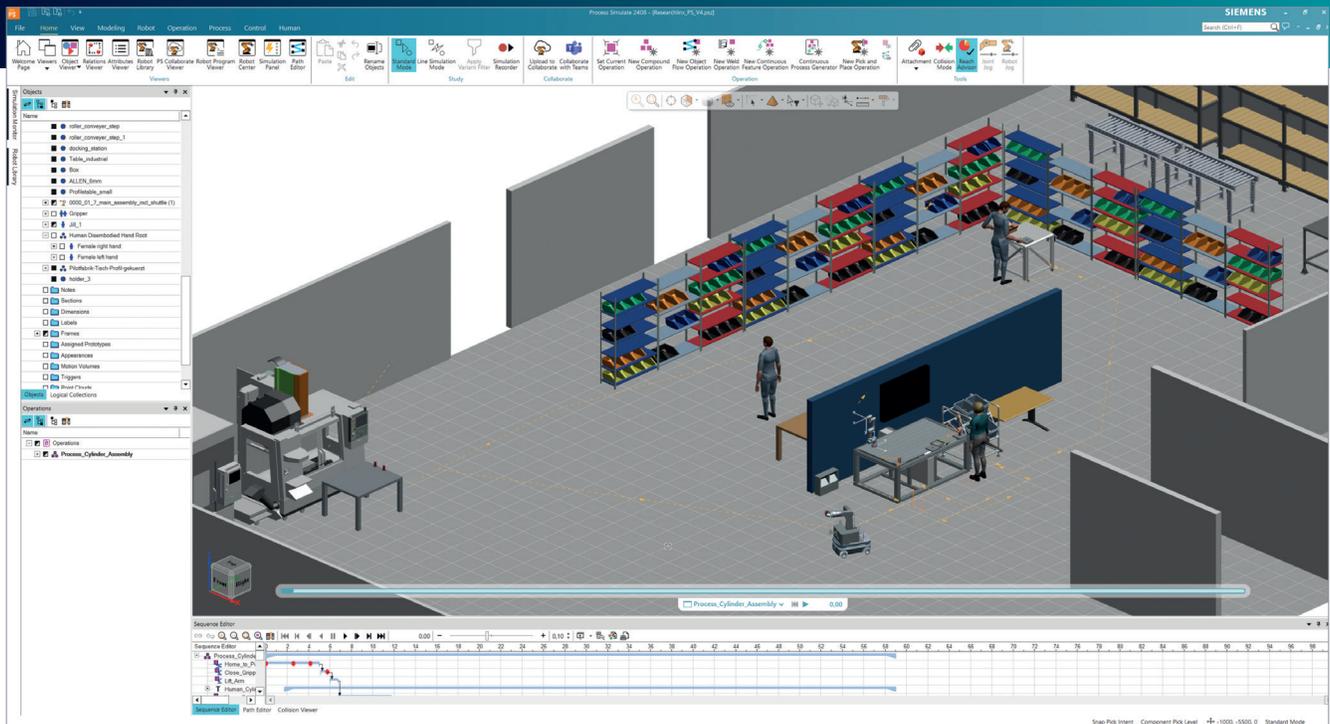
The TU Graz smart factory (smartfactory@tugraz) is part of the faculty’s Smart Production Graz initiative, which aims to improve sustainability and resource protection using innovative and efficient production technology. This advanced research and learning factory also serves as a safe environment for companies to test their attempts at digitalizing manufacturing and acts as a showroom for external guests, such as school classes learning about modern working environments.

The factory is part of the Institute of Production Engineering and is equipped with an infrastructure not commonly found in production halls. In addition to state-of-the-art machining and additive manufacturing centers, it features mobile, self-sufficient workstations with industrial robots from various manufacturers. These workstations can autonomously rearrange to form new production lines, physically implementing agile production processes to react to changing requirements.

To provide fast, high-volume transmission capacity between the many internet-based applications, smartfactory@tugraz is equipped with a secure local fifth-generation (5G) cellular network.



During a recent funded project, research assistants and students developed a mobile manipulator to transport tools between workstations.



Since functional safety is essential on the shop floor, research assistants and students use Process Simulate Human Advanced to define and verify the safety functionality necessary to prevent collisions between workers and the mobile manipulator.

“Supported by our industry partners, including Siemens, we developed the entire infrastructure from scratch,” says Dr. Rudolf Pichler, head of smartfactory@tugraz. “Now we can explore, teach and present various aspects of the advantages and challenges of digital manufacturing processes.”

Using software-based manufacturing

In this pilot factory, a gearbox for robot arms serves as an example product for several use cases for agile, digitalized production. To research and employ disruptive technologies, students, teachers and researchers use Siemens Digital Industries Software solutions to maintain data consistency across the entire value chain. They use Teamcenter® software for product lifecycle management (PLM), NX™ software for computer-aided design (CAD) and computer-aided manufacturing (CAM) and Simcenter™ NASTRAN software for finite element method (FEM) strength analyses. Various showcases demonstrate how these tools can enable manufacturers

to make their production and products more efficient, resilient and sustainable.

They also use the Tecnomatix® portfolio of digital manufacturing solutions to design, simulate and program robotics and automation operations offline. Integrated simulation capabilities allow them to connect either a virtual or a real programmable logic controller (PLC) to test and optimize control, automation, material transport and the entire operation all the way to virtual commissioning.

According to Pichler, simulation and virtual commissioning of production equipment are vital for the industry to remain competitive. “Using Tecnomatix to build and simulate the digital twin of the production enables us to find errors at an early stage,” says Pichler. “This greatly reduces the time initial commissioning requires at the customer’s site.” It also minimizes the work and time necessary to get safety-relevant approvals from certified bodies.

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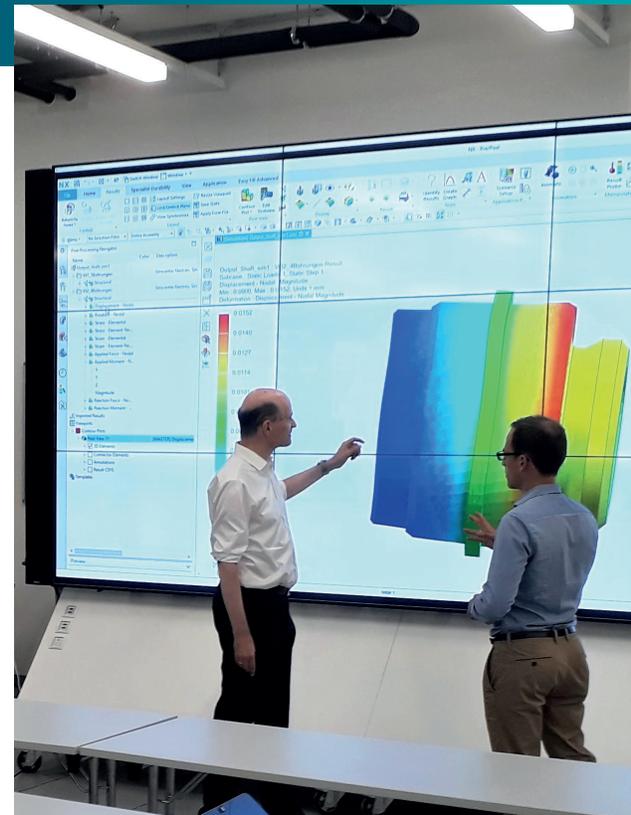
TU Graz also uses Process Simulate in the Tecnomatix portfolio to identify hazards when collaborating between people and the machine. This allows students to optimize the ergonomics of human work, identify safety hazards and correctly program safety equipment.

Automatically updating the product design, including strength verification, and the manufacturing process, which includes modifications to the numeric control (NC) programs for the machine tools, allows manufacturing to respond quickly to late customer requests. Using the digital twin of the machine tools prior to transferring the programs to physical machines leveraging Teamcenter X Part Shop Floor Connect Machine Client software ensures successful production from part one.

Teamcenter, NX, Simcenter and Tecnomatix are part of the Siemens Xcelerator business platform.

Benefitting from full vertical data consistency

At smartfactory@tugraz, students, teachers and researchers explore the smooth interaction of PLM, enterprise resource management (ERP) and manufacturing execution system (MES) software, which



At the TU Graz smart factory, tutors and students use a comprehensive range of Siemens Xcelerator solutions like NX.

they term the “golden triangle.” Unlike many companies, they manage all data in a single system connected via an enterprise service bus.



Siemens software covers the entire product lifecycle, which is key to closed-loop manufacturing.”

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Head of smartfactory@tugraz
Graz University of Technology



The innovative research and learning factory is a place for education and training and serves as a showroom for external guests such as school classes.



Using Siemens Xcelerator solutions helps us educate broad-minded and versed creators of future products and systems.”

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They also use a consistent value chain of Siemens software spanning higher-level applications to edge computing, PLC and robot programming and program execution. This allows them to unify programming for PLCs and robots, regardless of their individual programming language. Additionally, it facilitates automatically modifying existing programs based on on-site manual corrections made by machine operators. It feeds these modifications back to the students in the design studios via the NX Open interface to facilitate closed-loop manufacturing.

This vertical integration with full data consistency is crucial for locating mobile equipment in real time, ensuring autonomous guided vehicles know where to pick up or deliver their freight. Additionally, by leveraging usage data from machines, it can detect and react to material defects often hidden inside a workpiece during processing. It also facilitates predicting tool breakage before it occurs, saving machine time and preventing costly rejections.

Solutions/Services

NX

siemens.com/nx

Teamcenter

siemens.com/teamcenter

Simcenter

siemens.com/simcenter

Tecnomatix

siemens.com/tecnomatix

Customer's primary business

Founded in 1811, Graz University of Technology is a public research university and is the oldest science and technology research and educational institute in Austria. At seven faculties, the university offers 19 bachelor's and 36 master's study programs, 14 doctoral schools and has over 17,000 students.

www.tugraz.at/en

Customer location

Graz

Austria

The fully networked infrastructure at the TU Graz smart factory automatically creates a digital twin of tools in Teamcenter X Resource Management (MRL) software. Users can scan physical tools using a laser presetting machine, and the resulting point cloud is transformed into an NX CAD model, which is stored in the database for use in NX CAM.

As one of three academic pilot factories in Austria, smartfactory@tugraz uses Teamcenter to interconnect them via Insights Hub, forming one large factory, even though they use different data management systems.

Achieving closed-loop manufacturing

Cyber-physical production systems come with a host of challenges and require considering all aspects of manufacturing at an early stage of product development. At the TU Graz Institute of Machine Components and Methods of Development (IME), students and lecturers use Siemens Xcelerator

solutions for interdisciplinary model-based systems engineering (MBSE), while at smartfactory@tugraz they use them for all aspects of manufacturing planning and execution. This close collaboration gives students the ability to cover the entire product value chain, from initial concept to scrapping or recycling.

At smartfactory@tugraz, students and lecturers turn holistic, human-centered, sustainable and resilient manufacturing solutions into reality, creating a model for future commercial factories. TU Graz graduates gain deep insights into manufacturing methods and technologies that future employers may not yet be familiar with.

"Siemens software covers the entire product lifecycle, which is key to closed-loop manufacturing," says Pichler. "Using Siemens Xcelerator solutions helps us educate broad-minded and versed creators of future products and systems."

Siemens Digital Industries Software

Americas 1 800 498 5351

Europe 00 800 70002222

Asia-Pacific 001 800 03061910

For additional numbers, click [here](#).

siemens.com/software

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