

The background of the slide features a digital visualization of a factory. It includes wireframe models of industrial buildings, towers, and robotic arms, all rendered in a glowing blue color. A person's hand is visible on the right side, holding a tablet that displays a dashboard with various charts and graphs, including a line graph and a pie chart. The overall scene is set against a blurred background of a real factory floor.

Usecases aus den Österreichischen Pilotfabriken: vom Digitalen Zwilling zum Industrial Metaverse

August 2023

Prof. Dr. Michael Heiss

Was ist Digitalisierung / Digital Enterprise?

Gesamtheitliche Optimierung der Arbeitsabläufe

(unterstützt durch digitale Technologien)
mit dem Potenzial die Geschäftsmodelle zu disruptieren

English: Digitalization (nicht: Digitization)



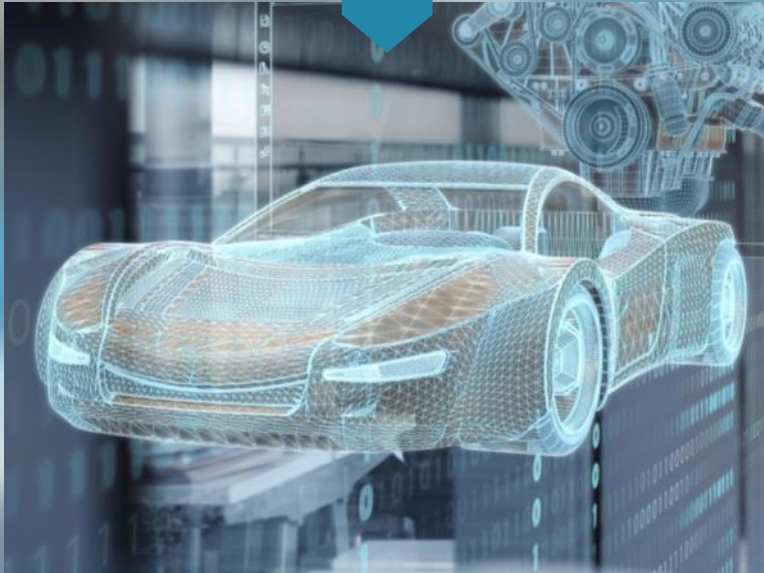
Automatisierung ≠ Digitalisierung

English: seamless digital thread

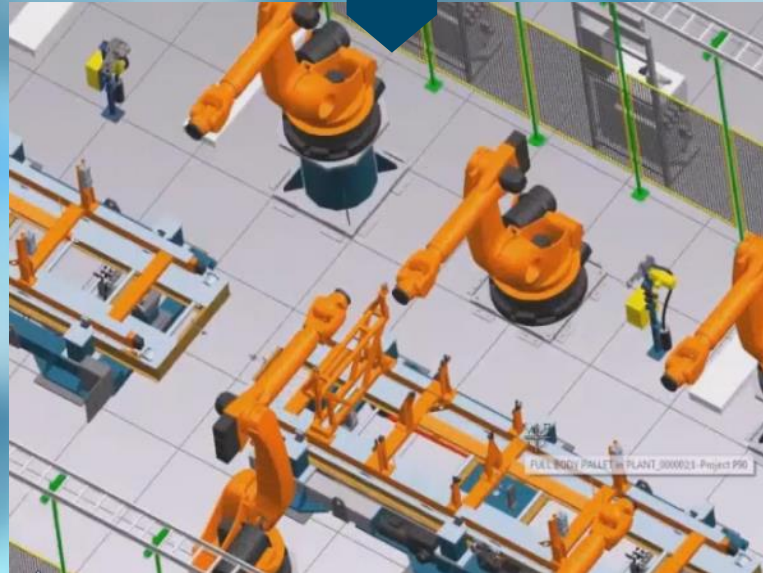


Erst die Datendurchgängigkeit
ermöglicht die holistische Optimierung

kontinuierliche Optimierung des Produktes und der Produktion



Digitaler Zwilling vom Produkt



Digitaler Zwilling der Produktion



Digitaler Zwilling der Performance

Digitaler Zwilling der Infrastruktur



Real

Digital

Pilotfabriken „Industrie 4.0“ in Österreich: Innovation mit Kunden



Wien Aspern Pilotfabrik Industrie 4.0

Produktionsprozesse und Logistik
Seit 2019 in der Betriebs-Phase



Graz smartfactory@tugraz

Agilität & IT-Security
2018-2020 Installations-Phase



Linz LIT factory

Produktion von karbonfaser-
verstärkten Kunststoffen & Recycling
2018-2020 Installations-Phase



Innovation mit Kunden

Forschung
zu Kundenthemen

Ausbildung
der zukünftigen Kunden

Innovation
mit Kunden

Kollaboration
mit den Experten der Kunden

Living Labs
unter realen Industriebedingungen

Siemens engagiert sich bei vielen Innovations-Showcases: siemens.at/pilotfabriken

SIEMENS



Virtual Commissioning Machine Tool Builders 3



Virtual Commissioning Assembly Cell / Safety 2 4



Edge Computing: tool breakage detection 4



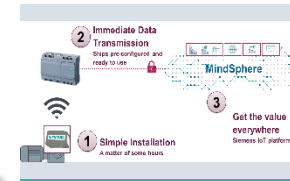
Shared Tasks: Human/ Robot Collaboration 3



Multi-Factory Case: 3 pilot factories like one 3 4 5



"Blockchain": Secure Blackbox 4



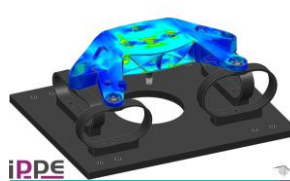
Smart Condition Monitoring 1



Real-Time Location System & Agile Safety 2 4



TIA-Portal: Multi-Vendor Robot Control 4



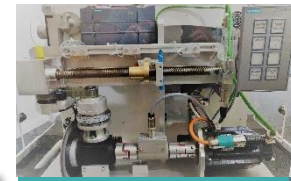
Generative Design FEM Simulation 5



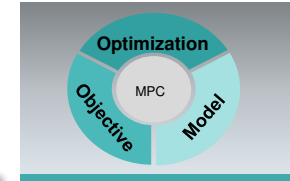
Energy Efficiency Optimization 2 5



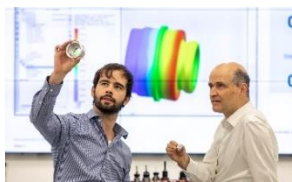
Predictive Maintenance of Drives (Edge Comp.) 2 5



Condition Based Scheduling 3



Process Simulation and Optimization 1



Late Customer Intervention 4



MindSphere: Asset Operation Analytics 3 4



Digital Twin: FiberSim Fiber Draping 5



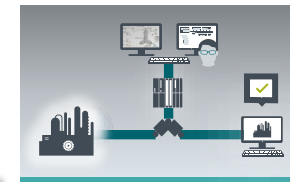
Closed-Loop Manufacturing 4



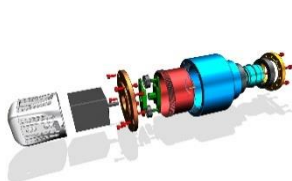
Digital Twin: Virtual Numeric Control 4



Artificial Intelligence: Edge-AI on AGV 2



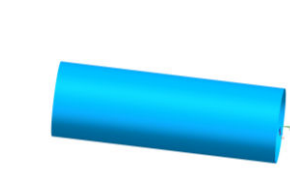
Operator Training System 1



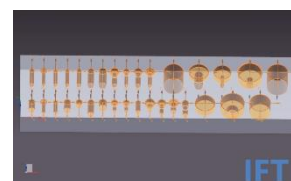
Golden Triangle: PLM / ERP / MES 4



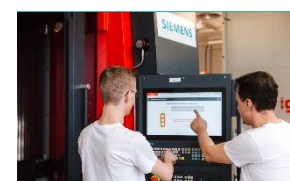
MindSphere: Signal Search via TimeFuse 4



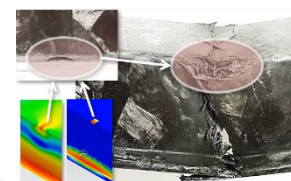
Digital Twin: StarCCM+/NX Co-Simulation 5



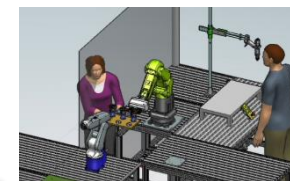
Automatic CAM Programming 3



Analyze My Machine Condition (Edge) 3



Digital Twin: Durability-Simulation 4



Digital Twin: Process Simulate Human 3 4

1 LivingLab Vienna

2 DigiLab Vienna

3 Pilotfactory Vienna

4 Smart Factory Graz

5 LIT Factory Linz

Der Aufbau der smartfactory wurde vom BMK über das Programm „Produktion der Zukunft“ als Projekt „Pilotfabrik Industrie 4.0 – Smart Production“ FFG Nr. 852105 in den Jahren 2016-2019 gefördert



Showcases Pilotfabrik Industrie 4.0 Wien

© Siemens AG Österreich 2023

[siemens.at/pilotfabriken](https://www.siemens.at/pilotfabriken)



Showcase: vom Digitalen Zwilling zum Industrial Metaverse Pilotfabrik und IFT @ TU Wien

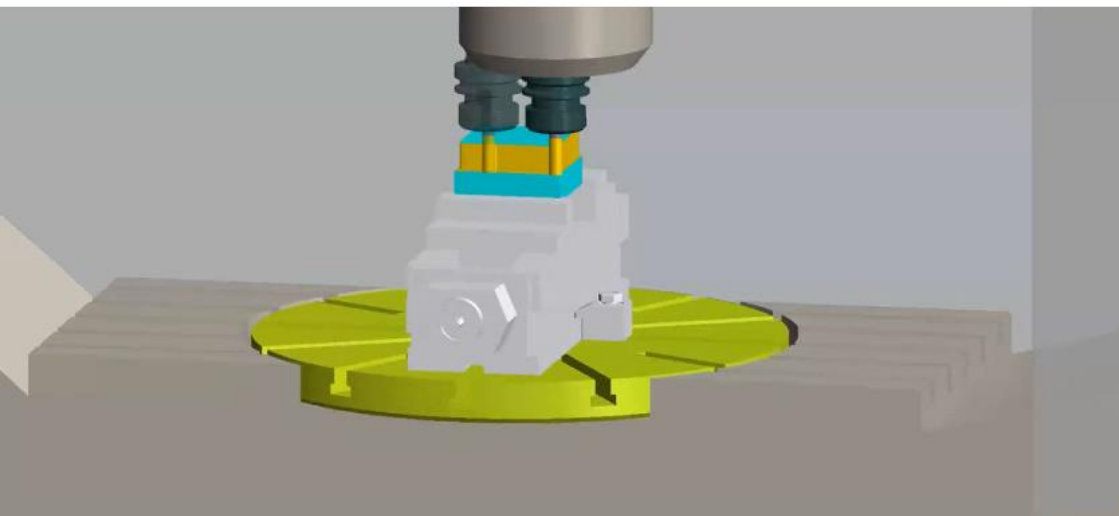
© Siemens AG Österreich 2023

[siemens.at/pilotfabriken](https://www.siemens.at/pilotfabriken)

Digitaler Zwilling mit Ein-Sekunden-Vorausschau zur Kollisionsvermeidung

SIEMENS

Ohne Kollision



Mit Kollision

Job Preparation → Operation

Machine Setup → Tool Setup → Activate

The screenshot shows the Siemens 3D simulation interface. The top bar indicates the current phase is 'Operation'. Below this, a progress bar shows 'Machine Setup', 'Tool Setup', and 'Activate'. The main window displays a 3D simulation of the machine tool head and workpiece. A red alarm message is visible: 'External collision avoidance: Stop due to collision (L1)'. The interface also shows a table of machine parameters and a list of G-code blocks.

Machine	Position [mm]	Dist-to-go	T,F,S	TSCH AC
MX1	-18.625	-0.304	T 22	Ø 10.000 L 100.000
MY1	-44.574	-0.134	D1	
MZ1	261.956	0.000	F 0.000	1191.000 mm/min 120%
MA1	0.000	0.000	S1	7492
MC1	0.000	0.000	Master	6243 120%

DEV_5/MACHINING_3D-1

External collision avoidance: Stop due to collision (L1)

Step Alarm active with Stop

G functions
Auxiliary functions
Basic blocks
Time / Counter
Program levels
Act. values
Machine

Over-look
Prog. edit
Block search
Simult. record
Prog. edit

ACTIVATING
CALL TO PROTECTIVE

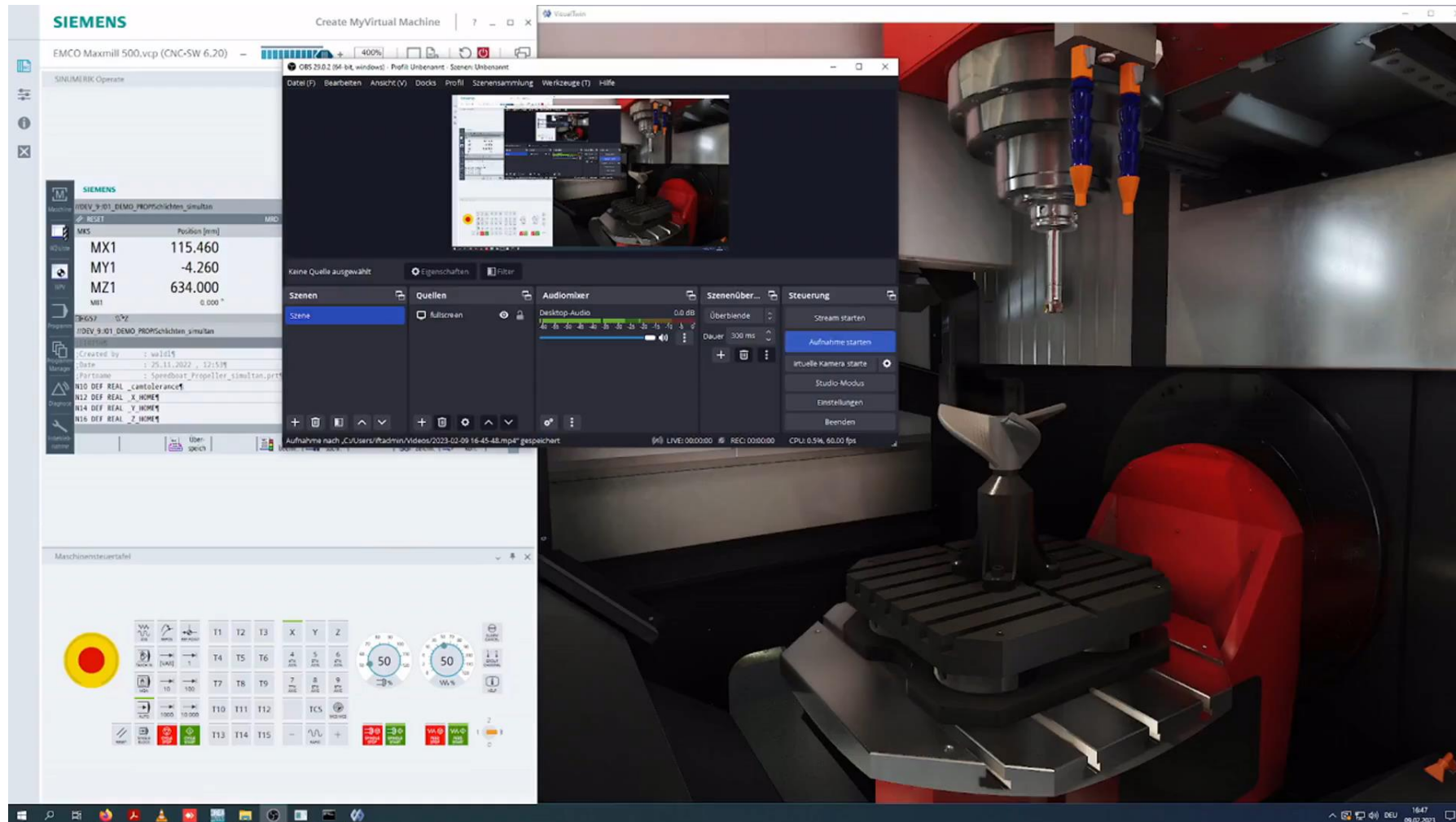
- In active collision avoidance, possible collisions are detected in advance, visually displayed in the 3D simulation
- Machining is stopped before the collision.
- Collisions that have been avoided are color-coded in the 3D simulation.
 - Orange: Safety clearance of the components violated, but no has occurred
 - Red: Components have collided

Verwendete Produkte: SINUMERIK ONE, Create My Virtual Machine, Protect MyMachine /3D Twin

Frei verwendbar © Siemens AG 2023

Fotorealistischer Digitaler Zwilling mit Bearbeitungsgeräuschen und Späneflug und virtueller Steuerung

SIEMENS



Ort:

- reale Maschine: Pilotfabrik TU Wien
- Digitaler Zwilling:
TEC-Lab des IFT@TU Wien
(15 km entfernt)

Verwendete Produkte:

- EMCO MaxxMill 500,
- Siemens SINUMERIK ONE,
Create My Virtual Machine
- MolduleWorks

Vision Industrial Metaverse: Business Trip ins Metaverse

SIEMENS



Der Aufbau der smartfactory wurde vom BMK über das Programm „Produktion der Zukunft“ als Projekt „LIT Factory – Die smarte verfahrenstechnische I4.0 Forschungsfabrik“ FFG Nr. 861798 in der Jahren 2018-2021 gefördert



Showcases LIT Factory Linz

ENGEL



UV-Strahlung SP2



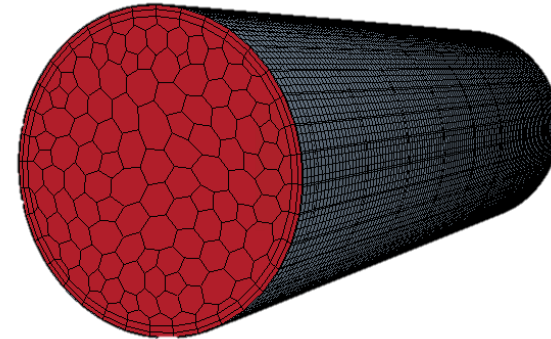
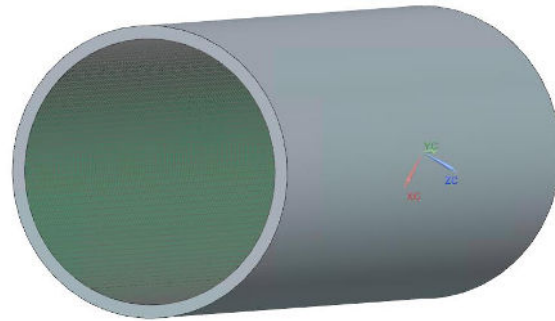
Showcase: Datendurchgängigkeit beim Digitalen Zwilling I: Co-Simulation (Multi-Physics)



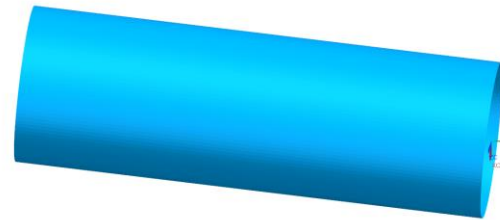
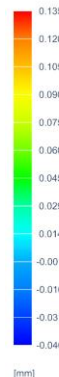
1) Eine Druckwelle durch die Kompositmaterial-Leitung ändert ortsabhängig den Durchmesser und damit die Fluid Dynamics

NX/Nastran

Star CCM+




rohr_mesh_sim1 - Solution 1 Result
Subcase - Statics 1, Increment 1, 0.001s
Displacement - Nodal, R
Min = 0, Max = 0, Units = mm
Coord sys : Selected Cylindrical - 1 - csys
Deformation : Displacement - Nodal Magnitude
Animation Frame 1 of 20



Realistic loading

Ohne Co-Simulation wird die maximale Belastung um einen **Faktor 2 unterschätzt!**

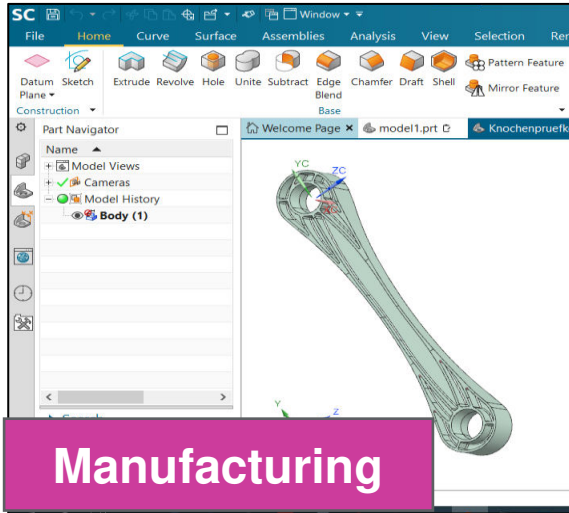
The background of the entire image is a blurred industrial setting with a digital overlay. This overlay consists of a blue wireframe grid and various 3D models of industrial components, including pipes, tanks, and robotic arms, representing a digital twin of a manufacturing process.

Showcase: Datendurchgängigkeit beim Digitalen Zwilling II: Spritzgießen von recycelten Kunststoffen (Multi-Scale)

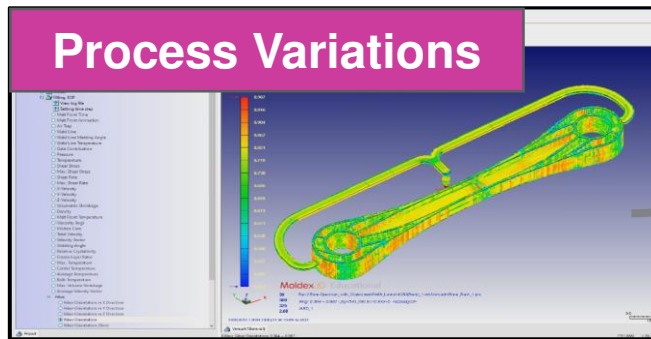


INTEGRATIVE SIMULATION

SFRP Injection Molding Workflow – *Simcenter 3D* integration

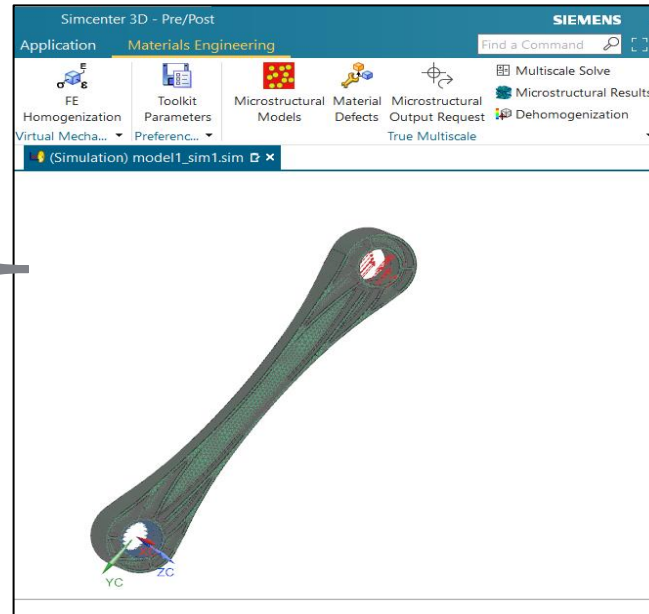


From CAD...
Siemens NX

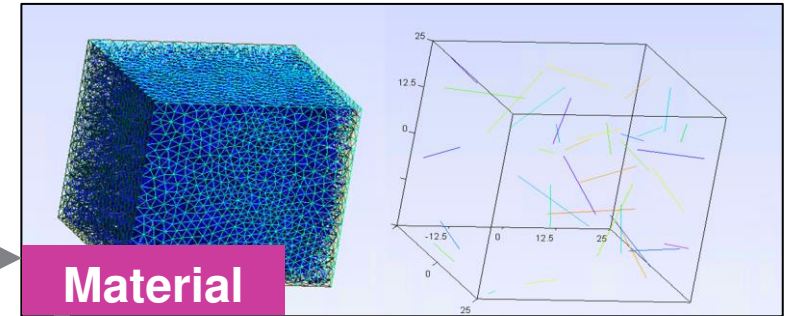


Injection Molding Simulation
Moldex3D

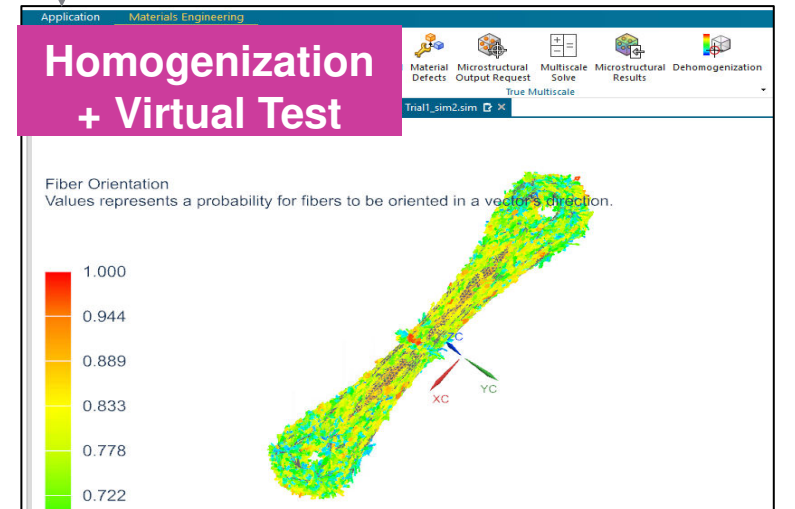
Automatically map
Manufacturing Simulation
results to structural mesh



Structural mesh and loading
condition
Simcenter3D



Microstructure Definition
Simcenter – Multimechanics



Multi-Scale Simulation
Simcenter - Multimechanics

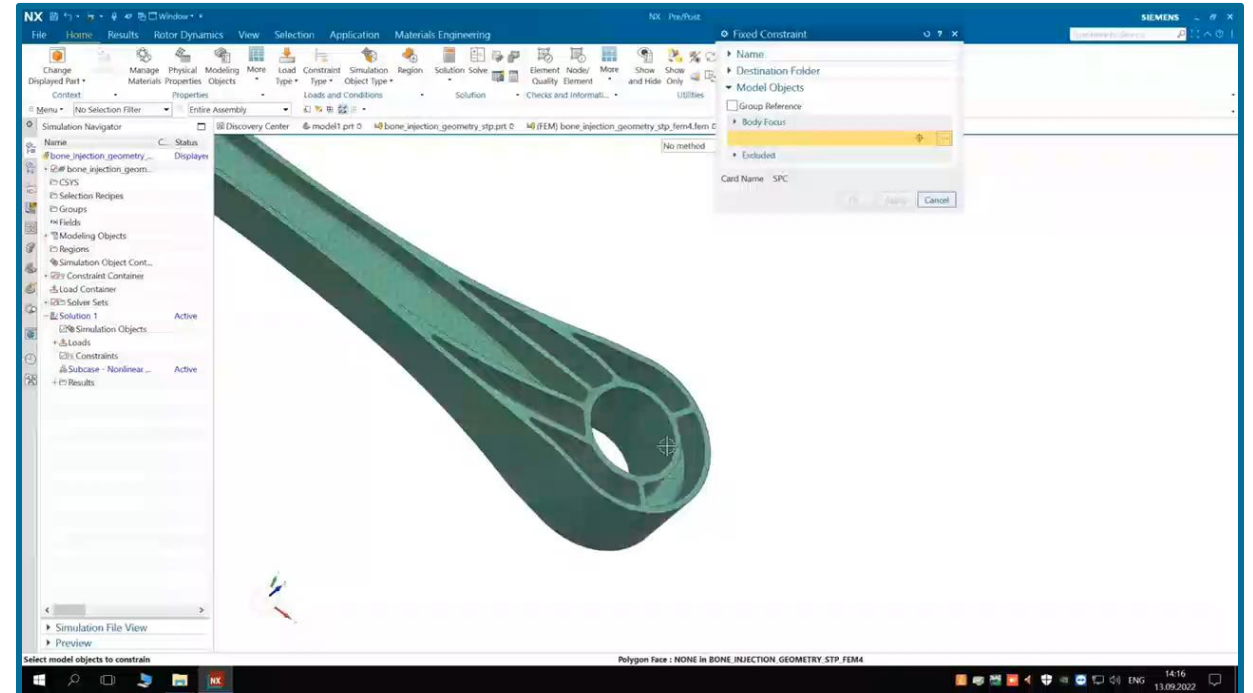
INTEGRATIVE SIMULATION

SFRP Injection Molding Workflow – *Simcenter 3D integration*

Simcenter 3D / NX Module

Step 1:

- Create 3D CAD model of bone specimen using **NX module**.
- Import the file in **3D Simcenter** module and create a **new FEM and Simulation Analysis**
- **Mesh** the geometry
- Assign **Load and Constraints**



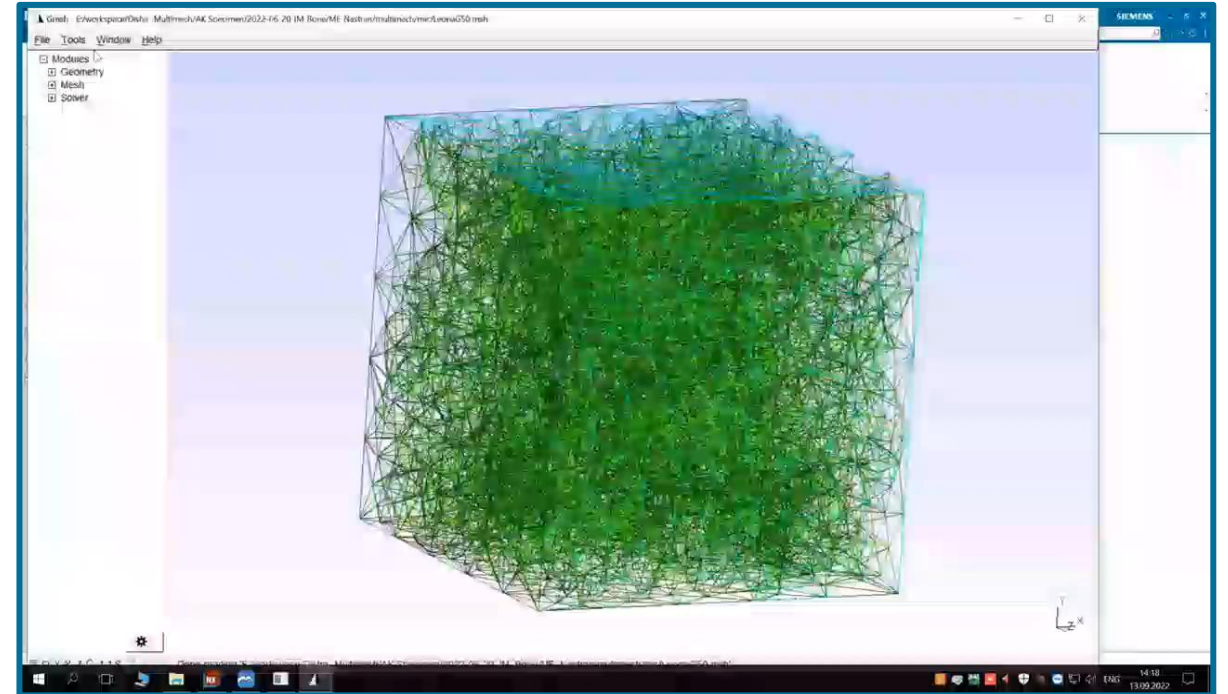
INTEGRATIVE SIMULATION

SFRP Injection Molding Workflow – *Simcenter 3D integration*

Multimechanics Module

Step 2:

- Define materials & microstructures of various shapes, sizes, orientations and volume fractions e.g. short & long fibers, particles. Also voids & defects can be defined.
- Here, short fibre reinforced composite of Polyamide with 50 wt.% glass fibers is defined



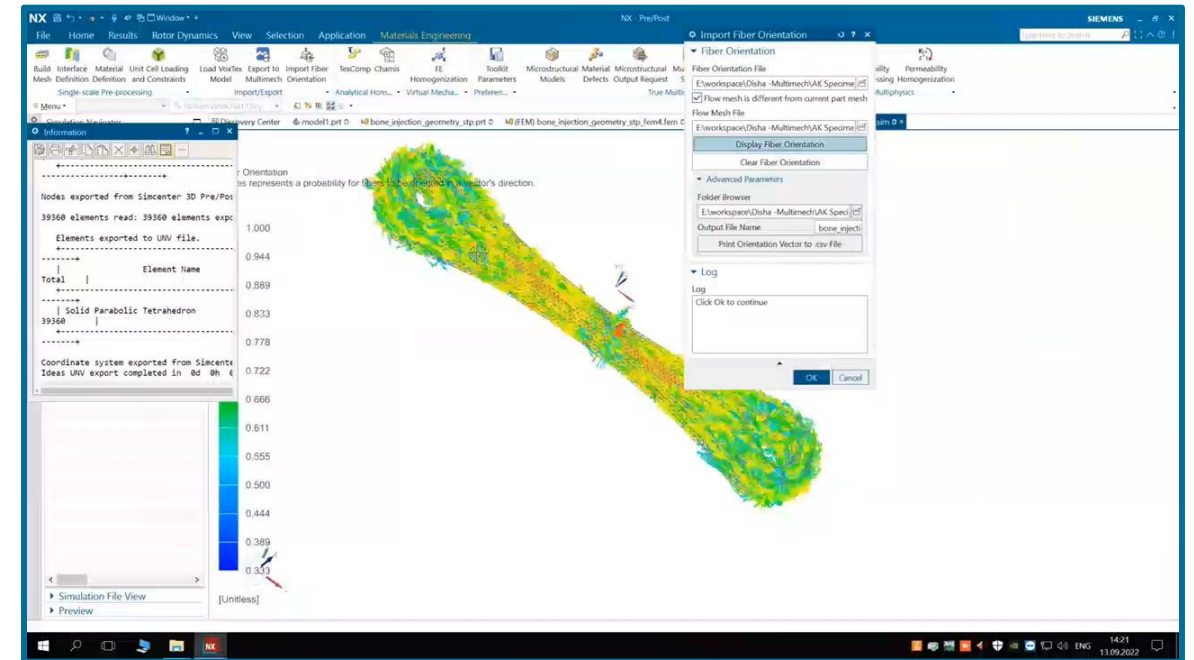
INTEGRATIVE SIMULATION

SFRP Injection Molding Workflow – *Simcenter 3D* integration

Simcenter 3D / NX Module

Step 3:

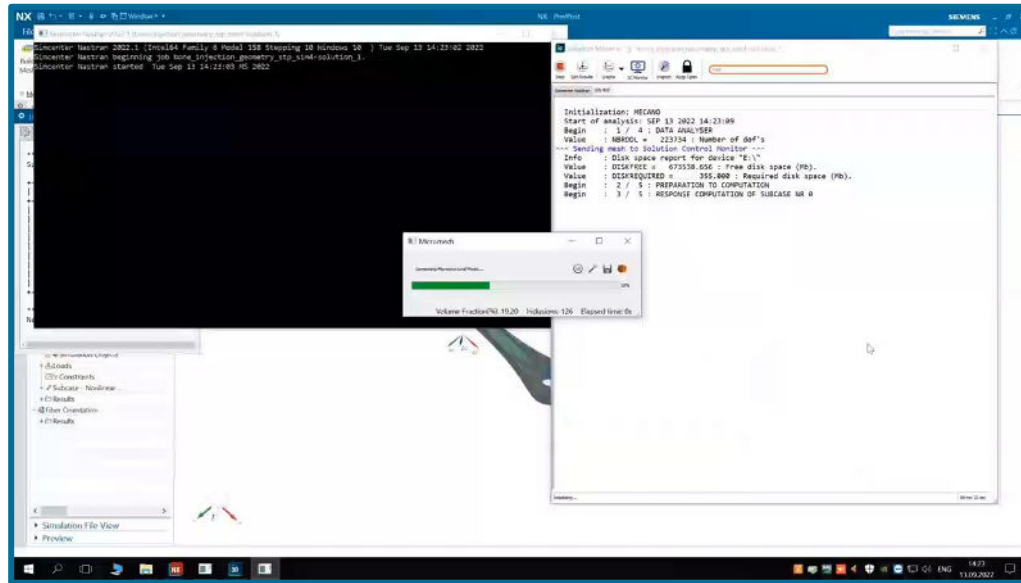
- Mapping fibre orientation from process simulations such as STAR CCM+, Moldex3D in .o2d format
- Links the process simulation results to the structural simulations



INTEGRATIVE SIMULATION

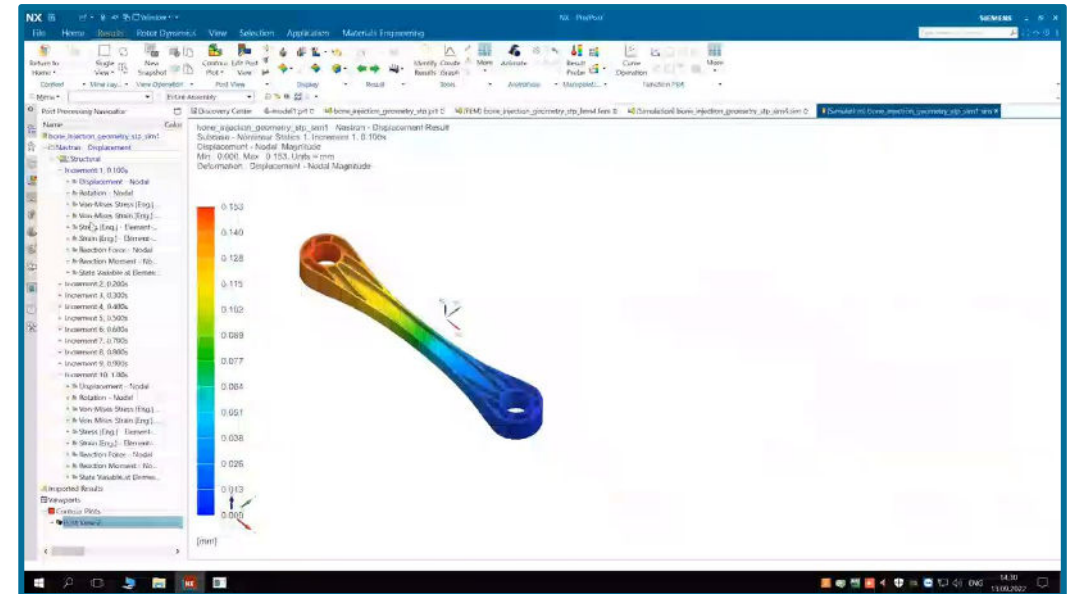
SFRP Injection Molding Workflow – *Simcenter 3D* integration

Simcenter 3D / NX Module



Step 4:

- Setting up the structural simulation



Step 5:

- Results

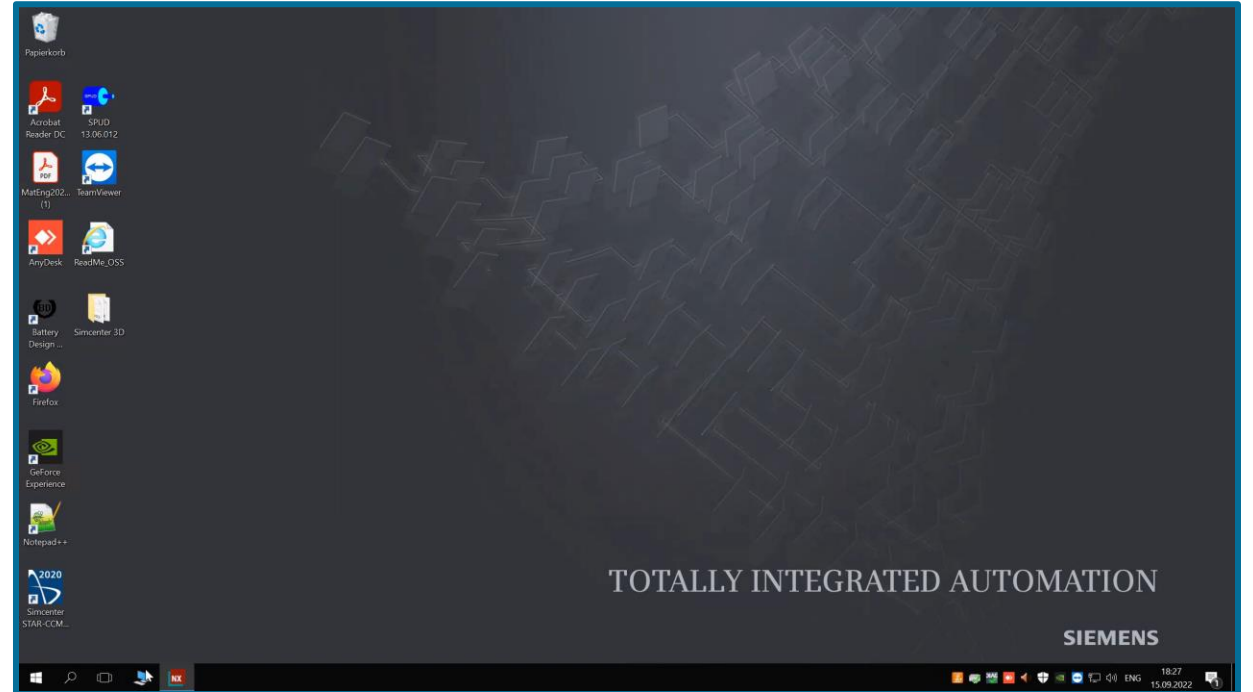
Calculating the component's structural integrity takes into account the materials properties, microstructure of the reinforcing materials, and processing parameters

INTEGRATIVE SIMULATION

SFRP Injection Molding Workflow – *Simcenter 3D integration*

Multimechanics Module - ViscoLab Tool

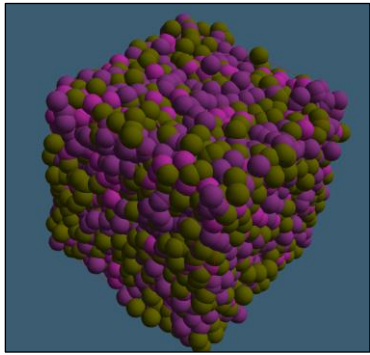
- The structure viscoelasticity(VE) data helps to predict the modulus of the material with respect to time and temperature.
- **ViscoLab** aids to shifts and fits the VE experimental data to numerical model, which depicts the behavior of material via numerical simulations.



INTEGRATIVE SIMULATION

SFRP Injection Molding Workflow – *Simcenter 3D* integration

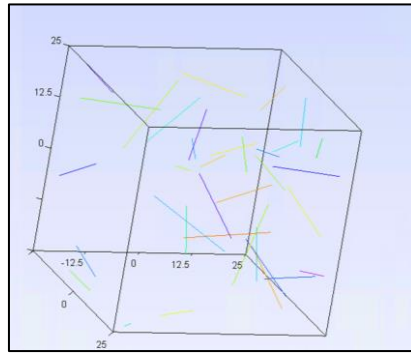
Outlook: Implementation of Culgi (Molecular Dynamics)



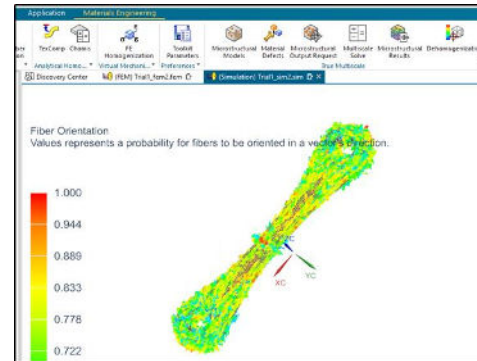
Molecular Dynamics

With Culgi

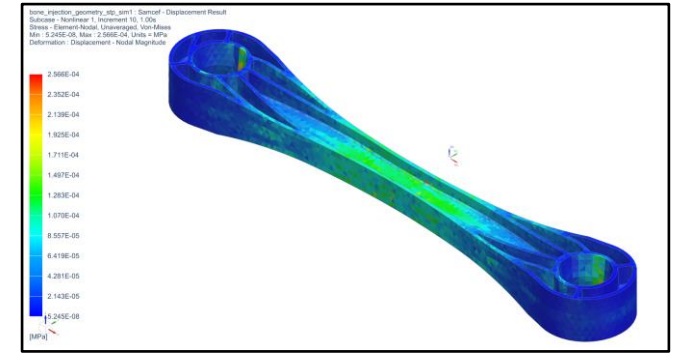
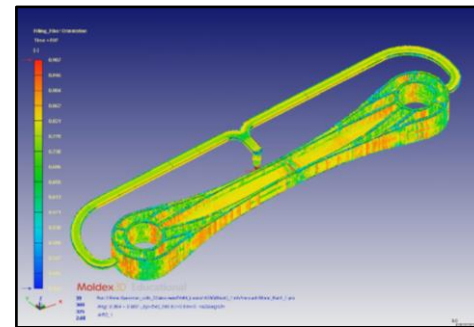
Installed recently in Sept 2022



Microstructure & Mesostructures



Process Simulation



Multiscale Structural Simulation

Zusammenfassung

SIEMENS

Datendurchgängigkeit nicht nur bei den realen Anlagen, sondern **auch bei den Digitalen Zwillingen**

Nur mit **Datendurchgängigkeit** lassen sich die Abläufe **gesamtheitlich optimieren**

Business Trips ins **Metaverse** werden genau selbstverständlich werden wie das Bildschirm Teilen bei Web-Konferenzen – dazu ist **Datendurchgängigkeit der Digitalen Zwillinge** erforderlich

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