Virtual commissioning in the factory

Florian Wegmann

AUTODESK. UNIVERSITY

Section Break

About the speaker

Florian Wegmann

Mr. Wegmann graduated in business administration and IT system administration, along with several years of experience in sales. He has been supporting machineering since 2015 with his expertise in technical sales and selected customer projects. Within machineering he manages key accounts and is responsible for extending the global dealer network. Previously Florian worked at XR Systems for four years.

About the Co-speaker

Daniel Lutz

Daniel Lutz is from the South of Germany, where he completed his mechanical engineering studies in 1992. He has held positions in the industry both as an engineer as well as the head of the engineering department head before moving to an Autodesk software reseller based in Stuttgart over 15 years ago. In 2011 he became the Tech Sales Specialist at Autodesk, a position that has allowed him to gather comprehensive experience in factory design, Autodesk Inventor mechanical design software, and the Autodesk Vault data management system.

Autodesk GmbH

Inventor Professional

Inventor Nastran

Inventor CAM

Inventor Nesting

Inventor Tolerance Analysis

Factory Design Utilities

One AutoCAD

Navisworks Manage

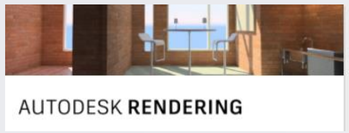
3ds Max

ReCap Pro

Vault Basic

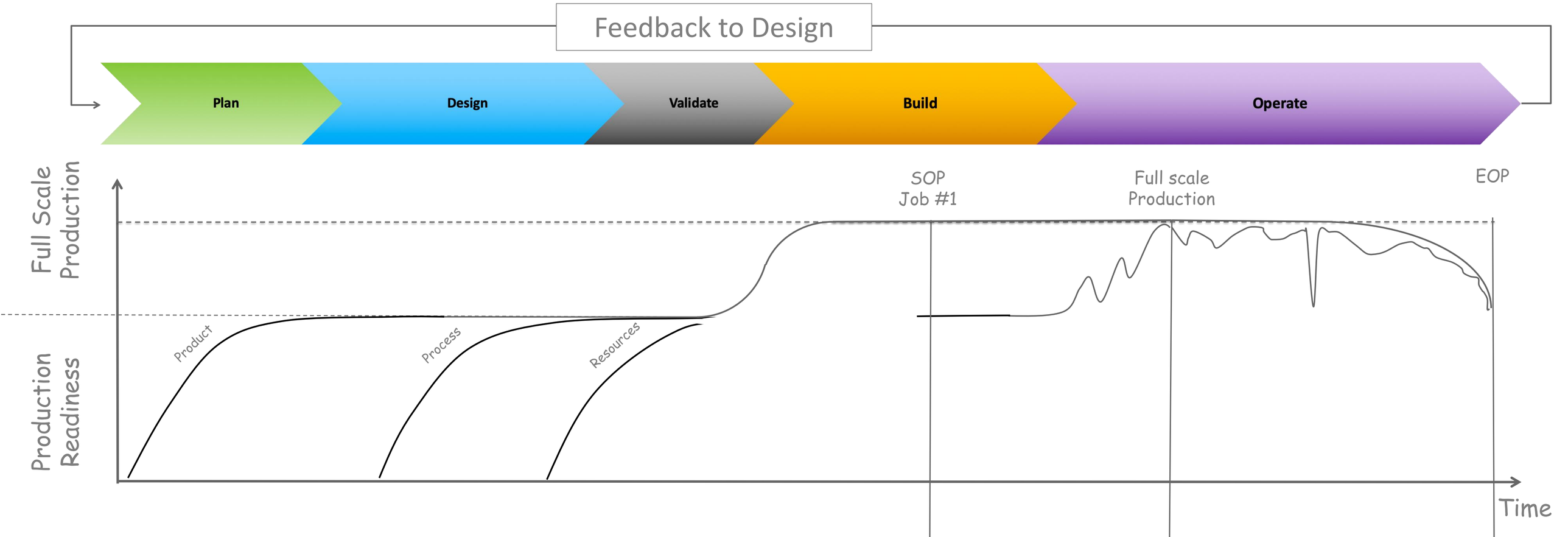
Fusion 360

ADSK Drive



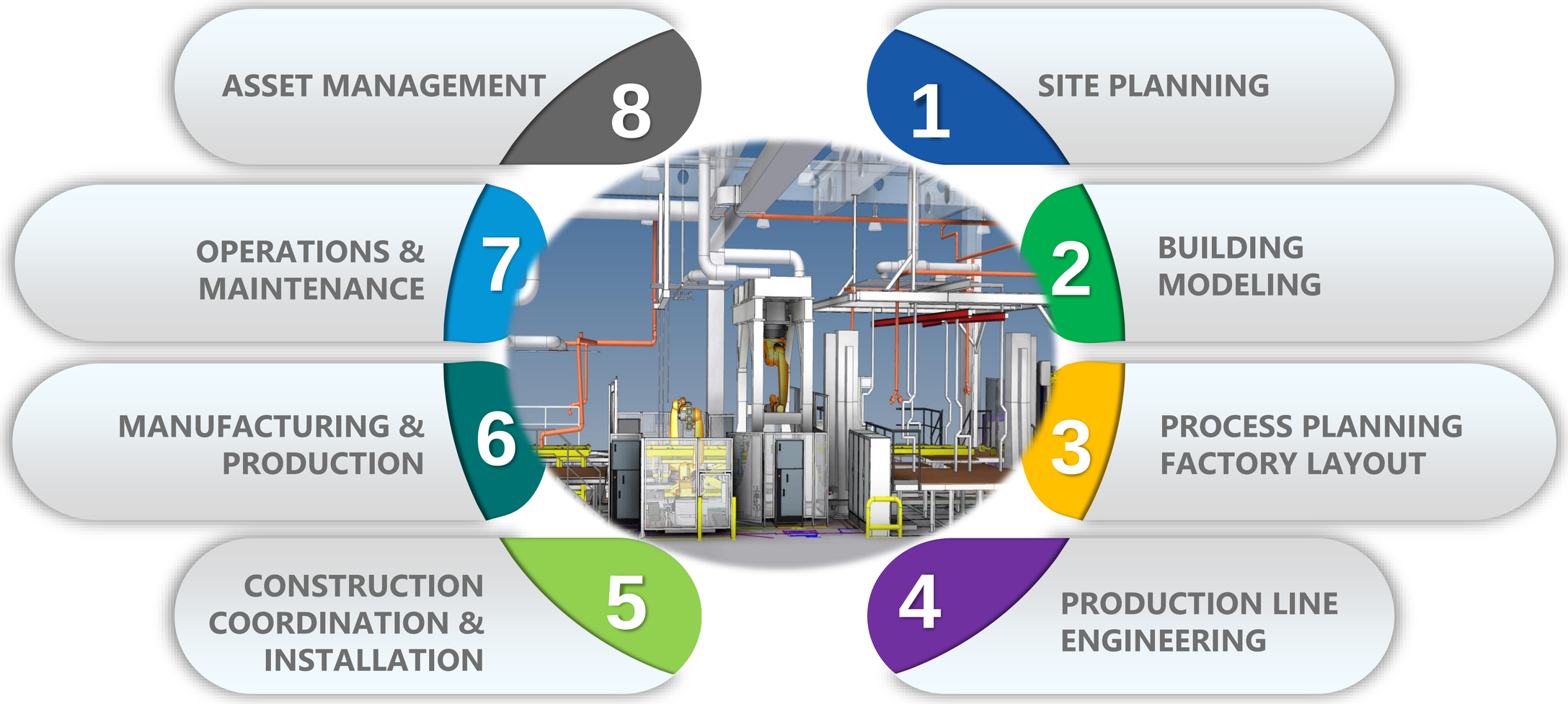
Strong Inventor centralized Workflows

Increasing Engineering & Manufacturing Excellence

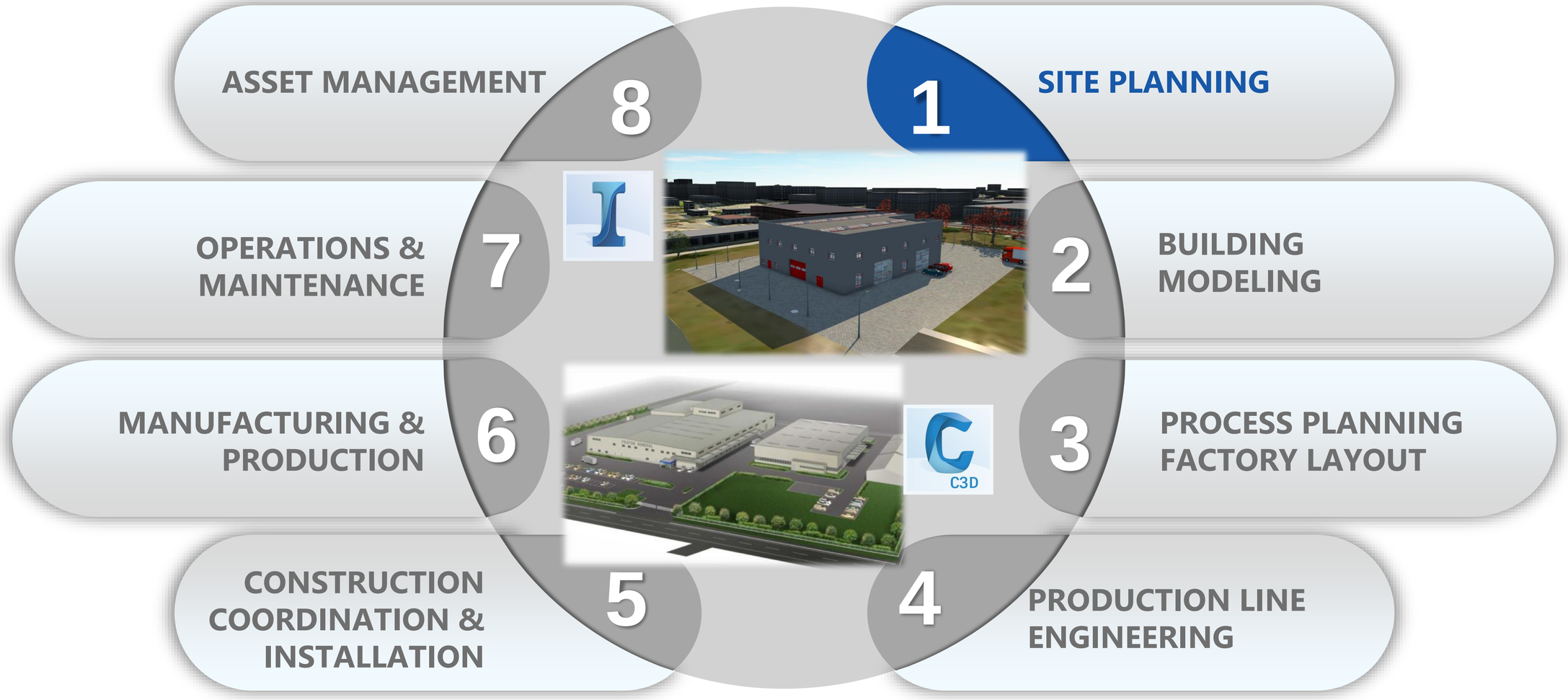


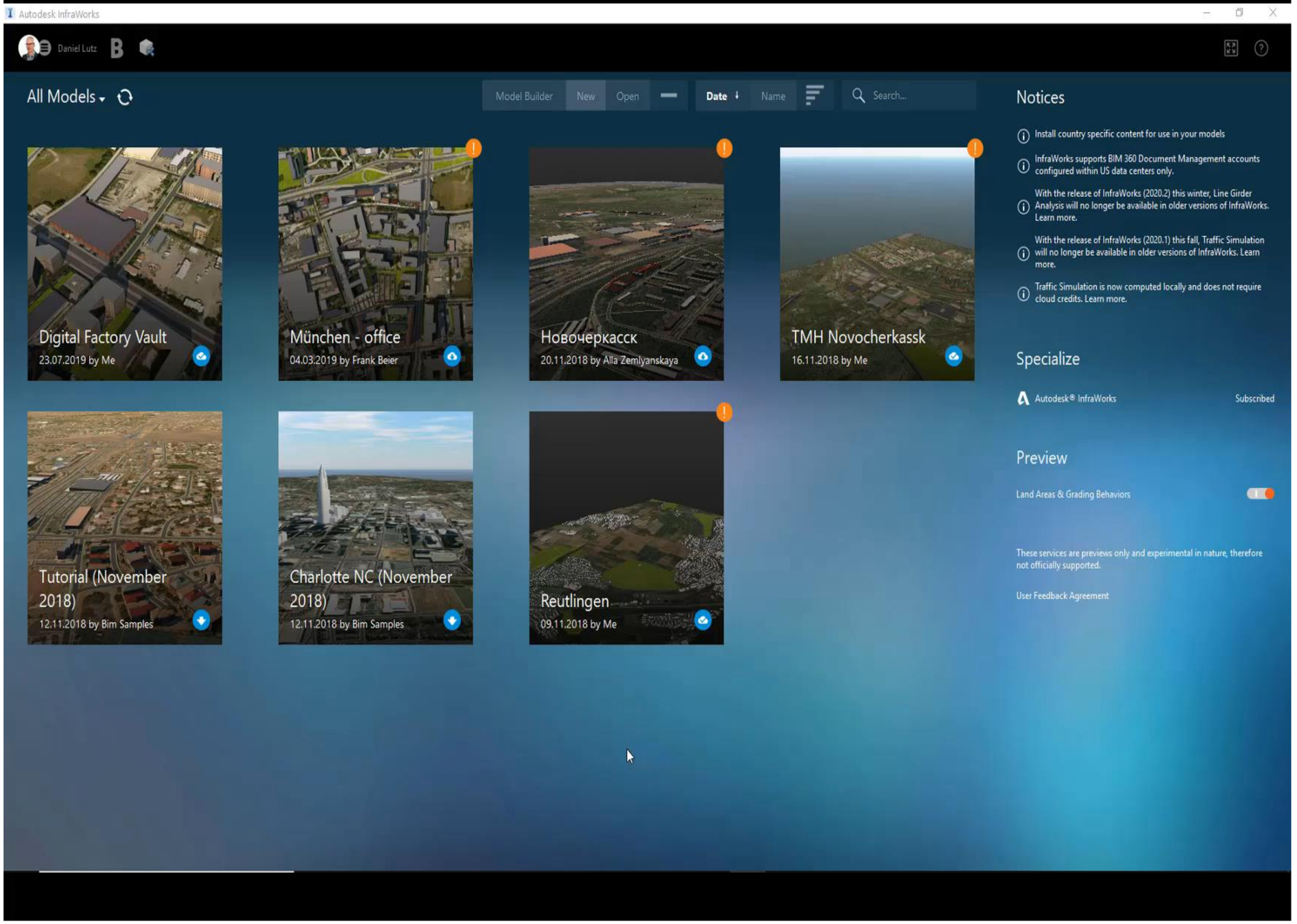
KPI			
	Reduce Time 2 Market, Cost 2 Market	Vertical Start-Up	Increase OEE
	Increase Quality	Time 2 Volume	(Availability, Performance, Quality)

Digital Planning and Modeling for Operational Efficiency

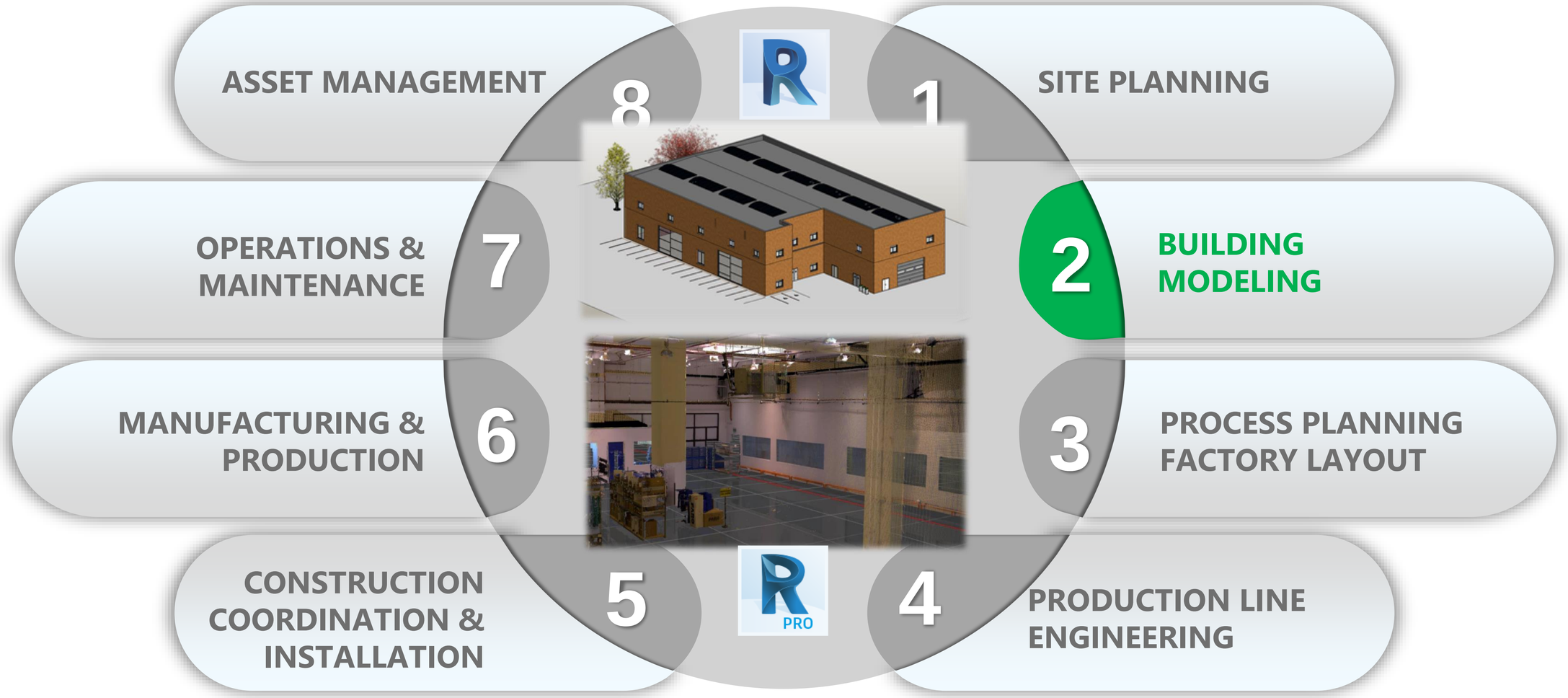


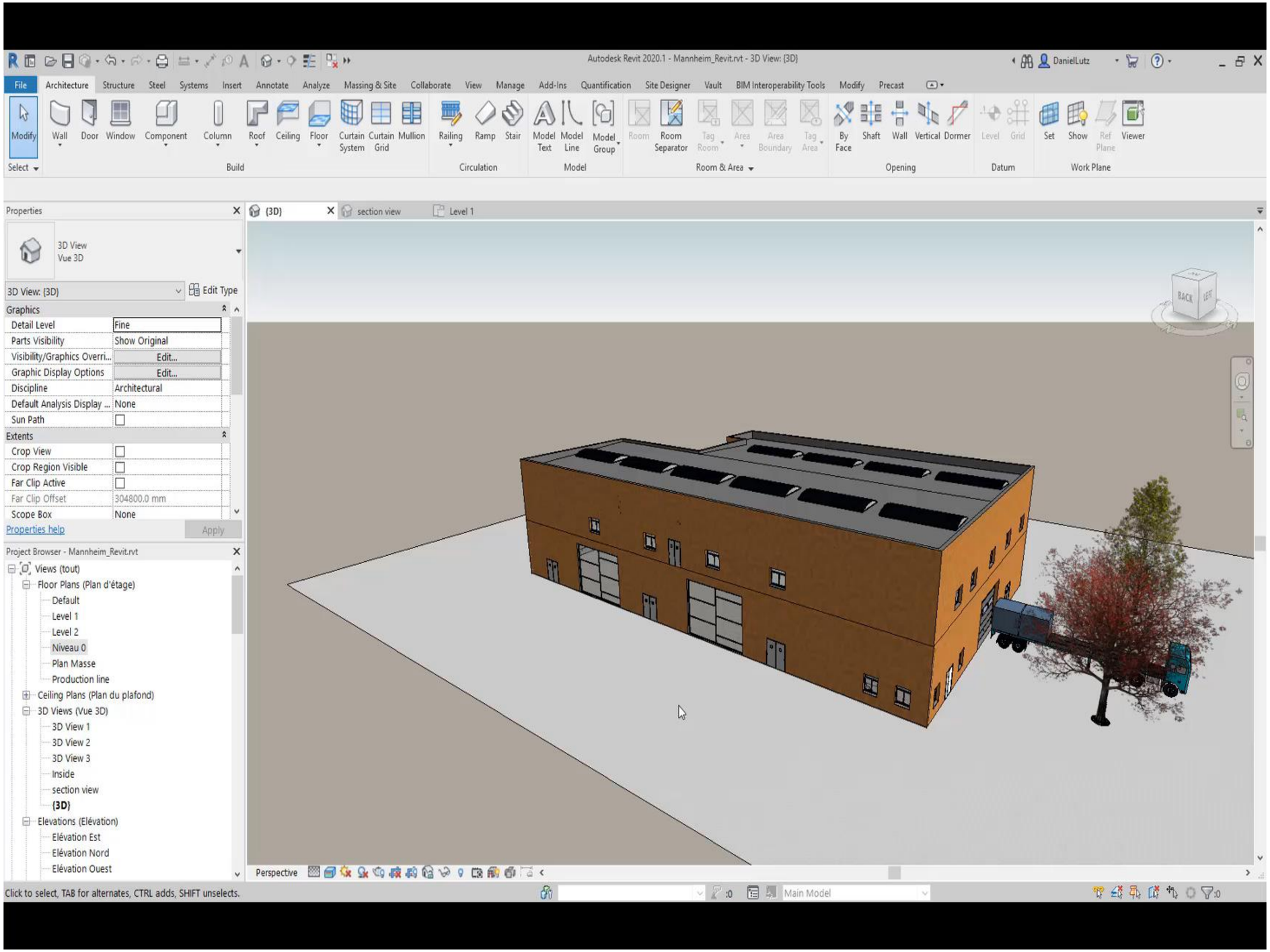
Optimizing site selection and position



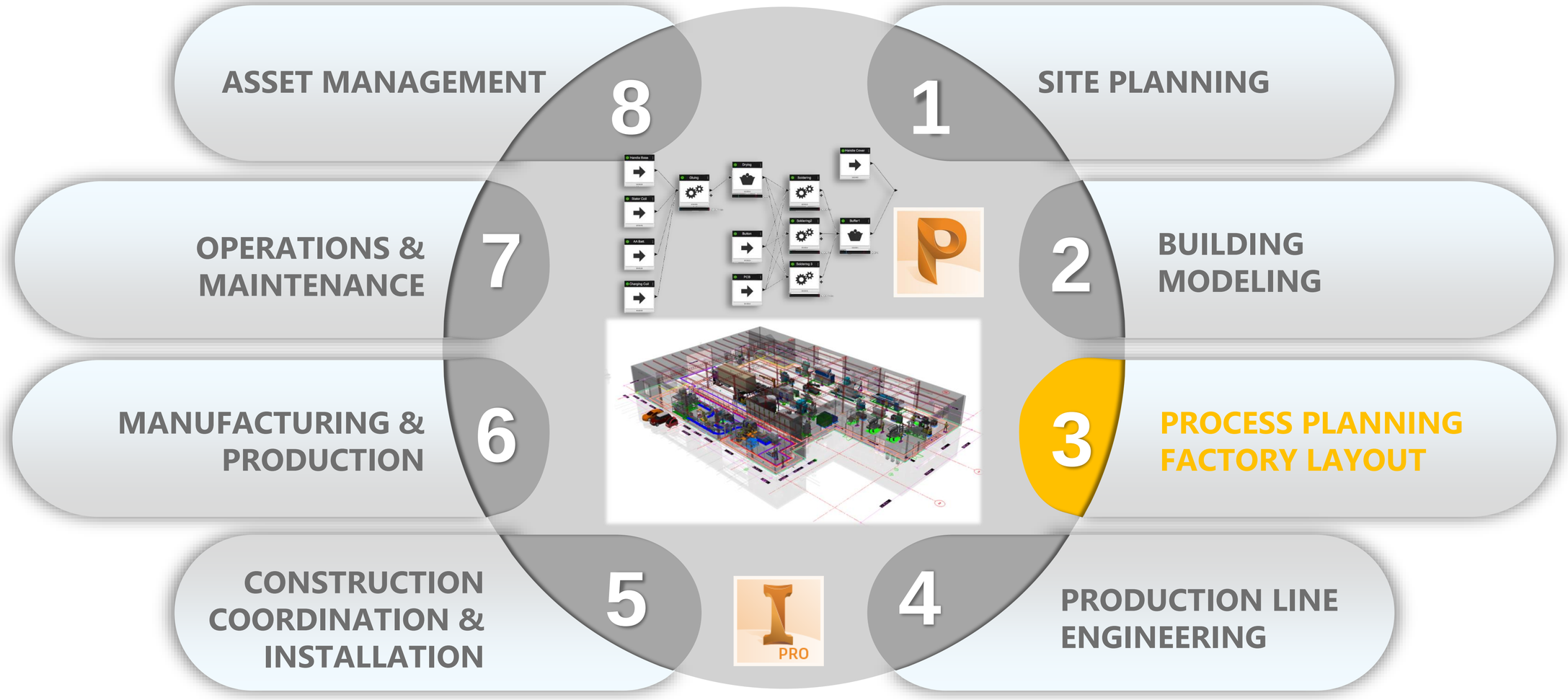

Autodesk InfraWorks
Daniel Lutz
All Models
Model Builder
New
Open
Date
Name
Search...
Digital Factory Vault
23.07.2019 by Me
München - office
04.03.2019 by Frank Beier
Новочеркасск
20.11.2018 by Alla Zemlyanskaya
TMH Novocherkassk
16.11.2018 by Me
Tutorial (November 2018)
12.11.2018 by Bim Samples
Charlotte NC (November 2018)
12.11.2018 by Bim Samples
Reutlingen
09.11.2018 by Me
Notices
Install country specific content for use in your models
InfraWorks supports BIM 360 Document Management accounts configured within US data centers only.
With the release of InfraWorks (2020.2) this winter, Line Girder Analysis will no longer be available in older versions of InfraWorks. Learn more.
With the release of InfraWorks (2020.1) this fall, Traffic Simulation will no longer be available in older versions of InfraWorks. Learn more.
Traffic Simulation is now computed locally and does not require cloud credits. Learn more.
Specialize
Autodesk® InfraWorks
Subscribed
Preview
Land Areas & Grading Behaviors
These services are previews only and experimental in nature, therefore not officially supported.
User Feedback Agreement

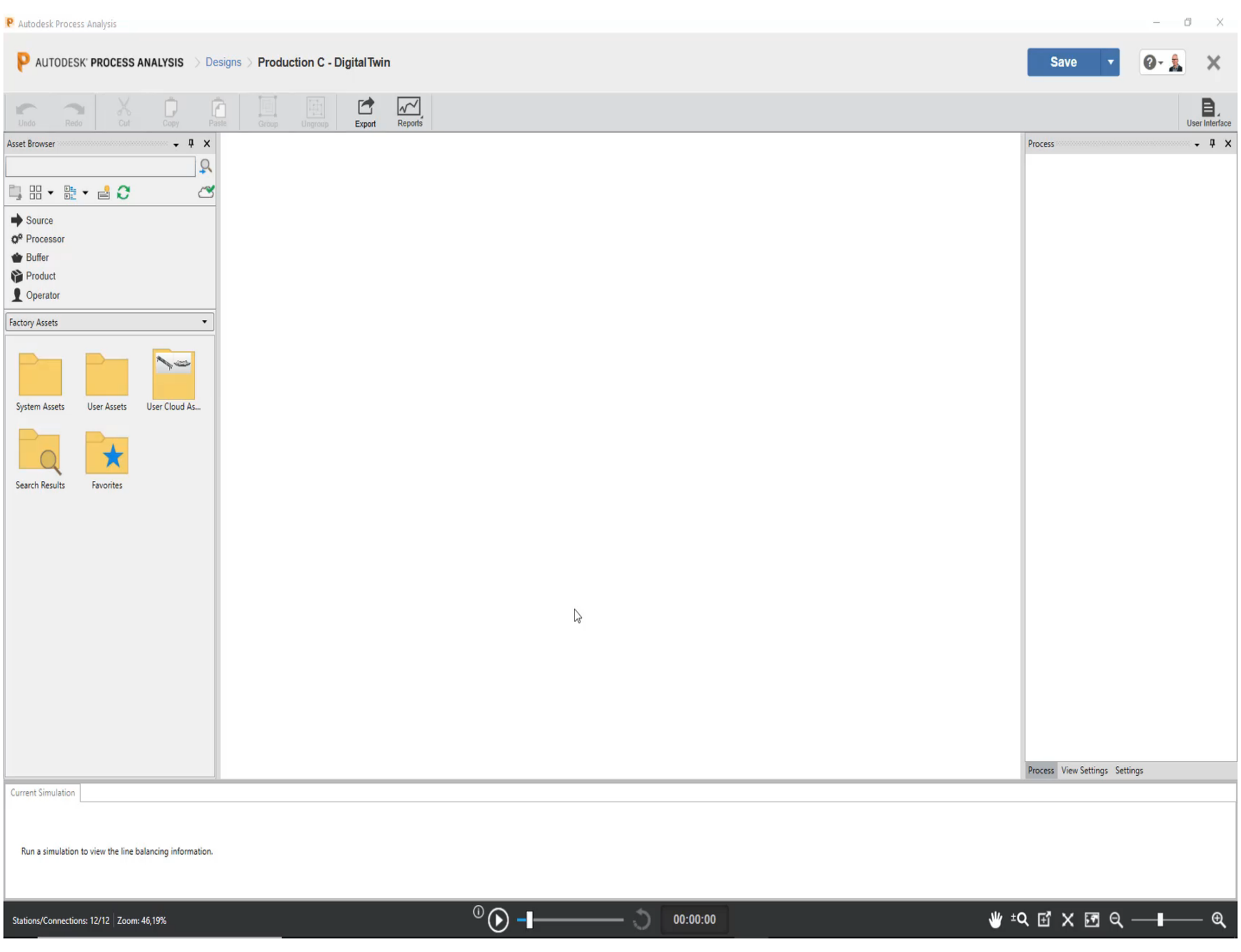
Model creation for new and existing facilities



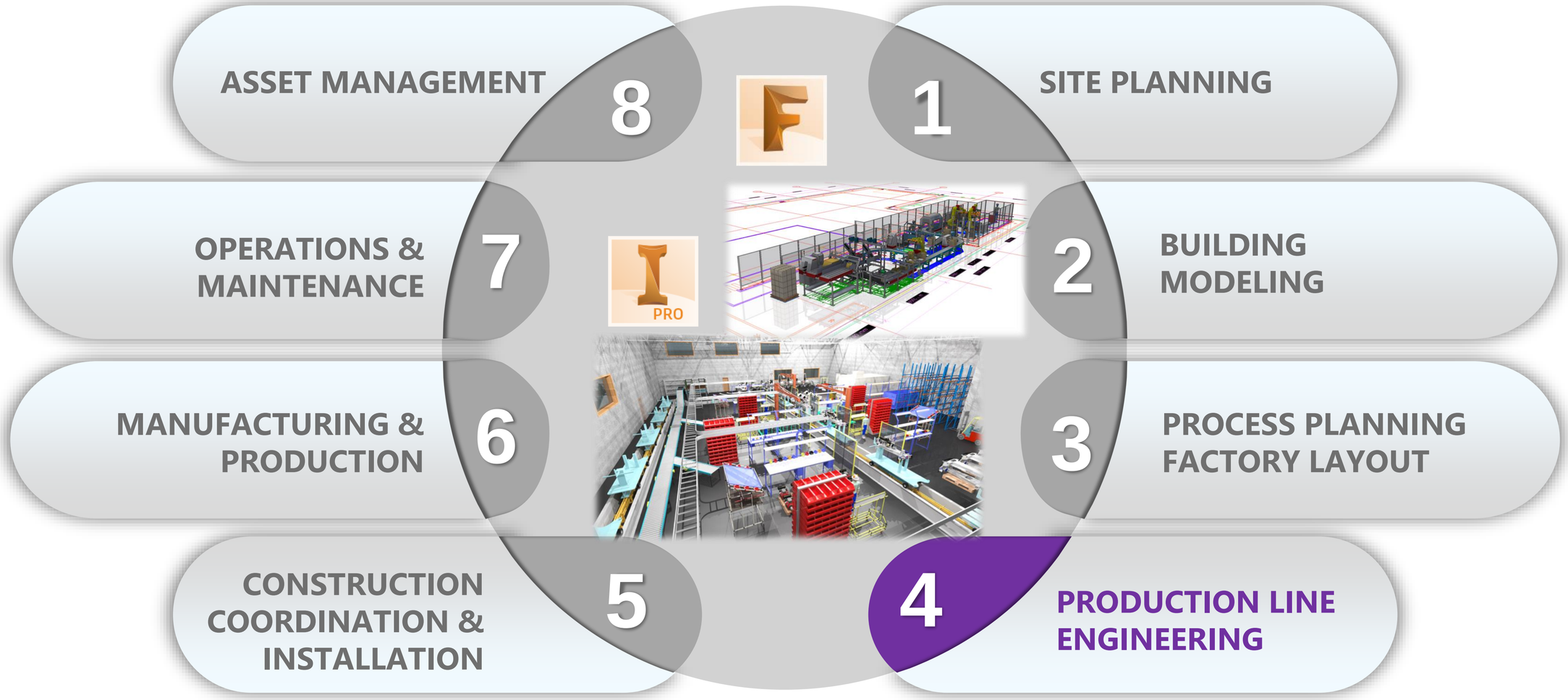

Autodesk Revit 2020.1 - Mannheim_Revit.rvt - 3D View: {3D}
DanielLutz
File
Architecture
Structure
Steel
Systems
Insert
Annotate
Analyze
Massing & Site
Collaborate
View
Manage
Add-Ins
Quantification
Site Designer
Vault
BIM Interoperability Tools
Modify
Precast
Modify
Select
Wall
Door
Window
Component
Column
Roof
Ceiling
Floor
Curtain System
Curtain Grid
Mullion
Build
Railing
Ramp
Stair
Circulation
Model Text
Model Line
Model Group
Model
Room
Room Separator
Tag Room
Area
Area Boundary
Tag Area
Room & Area
By Face
Shaft
Wall
Vertical
Dormer
Opening
Level
Grid
Datum
Set
Show
Ref Plane
Viewer
Work Plane
Properties
3D View
Vue 3D
3D View: {3D}
Edit Type
Graphics
Detail Level
Fine
Parts Visibility
Show Original
Visibility/Graphics Overri...
Edit...
Graphic Display Options
Edit...
Discipline
Architectural
Default Analysis Display ...
None
Sun Path
Extents
Crop View
Crop Region Visible
Far Clip Active
Far Clip Offset
304800.0 mm
Scope Box
None
Properties help
Apply
Project Browser - Mannheim_Revit.rvt
Views (tout)
Floor Plans (Plan d'étage)
Default
Level 1
Level 2
Niveau 0
Plan Masse
Production line
Ceiling Plans (Plan du plafond)
3D Views (Vue 3D)
3D View 1
3D View 2
3D View 3
Inside
section view
{3D}
Elevations (Elévation)
Elévation Est
Elévation Nord
Elévation Ouest
{3D}
section view
Level 1
BACK
LEFT
Perspective
Click to select, TAB for alternates, CTRL adds, SHIFT unselects.
Main Model

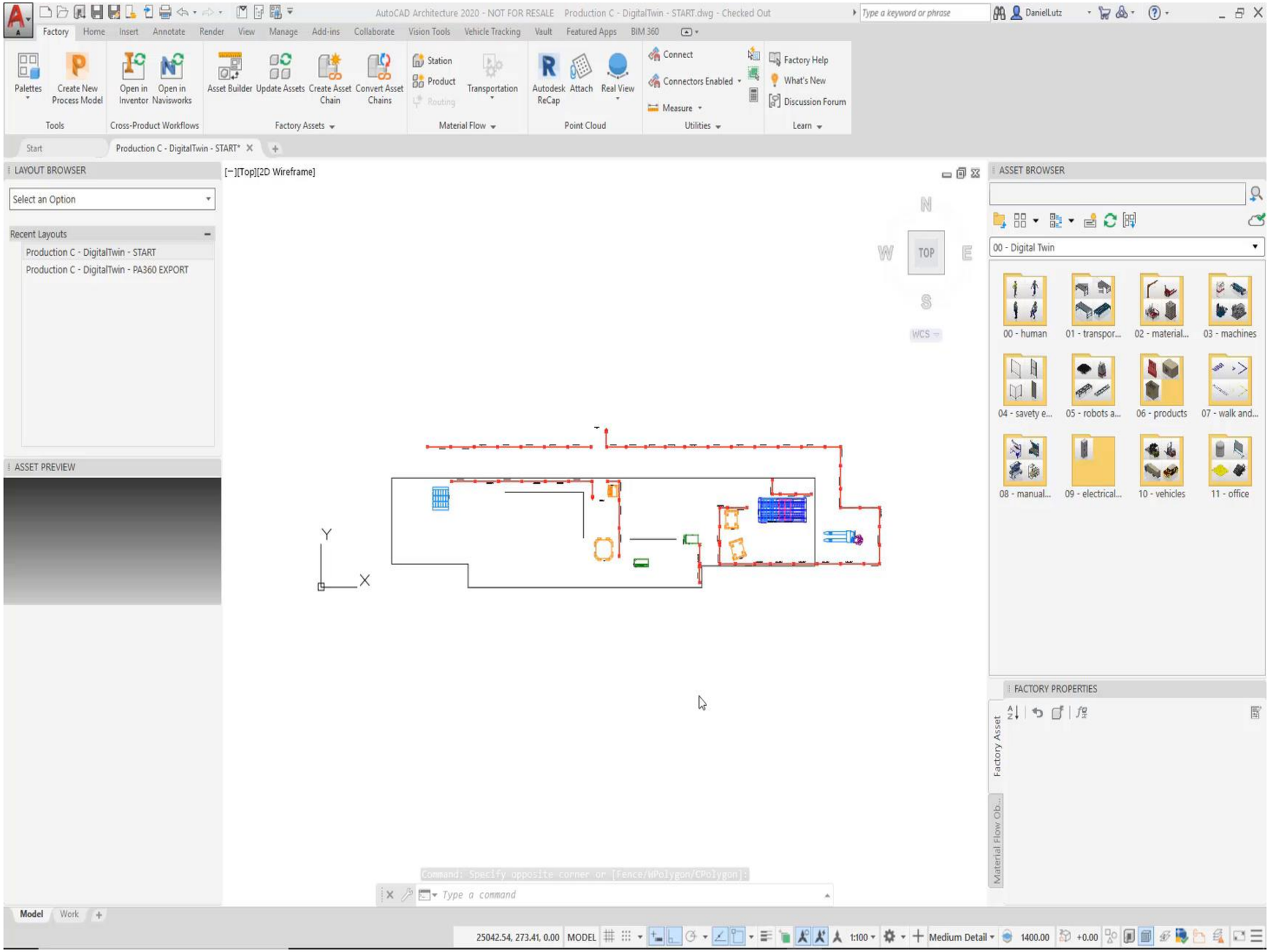
Process analysis to optimize production line layout



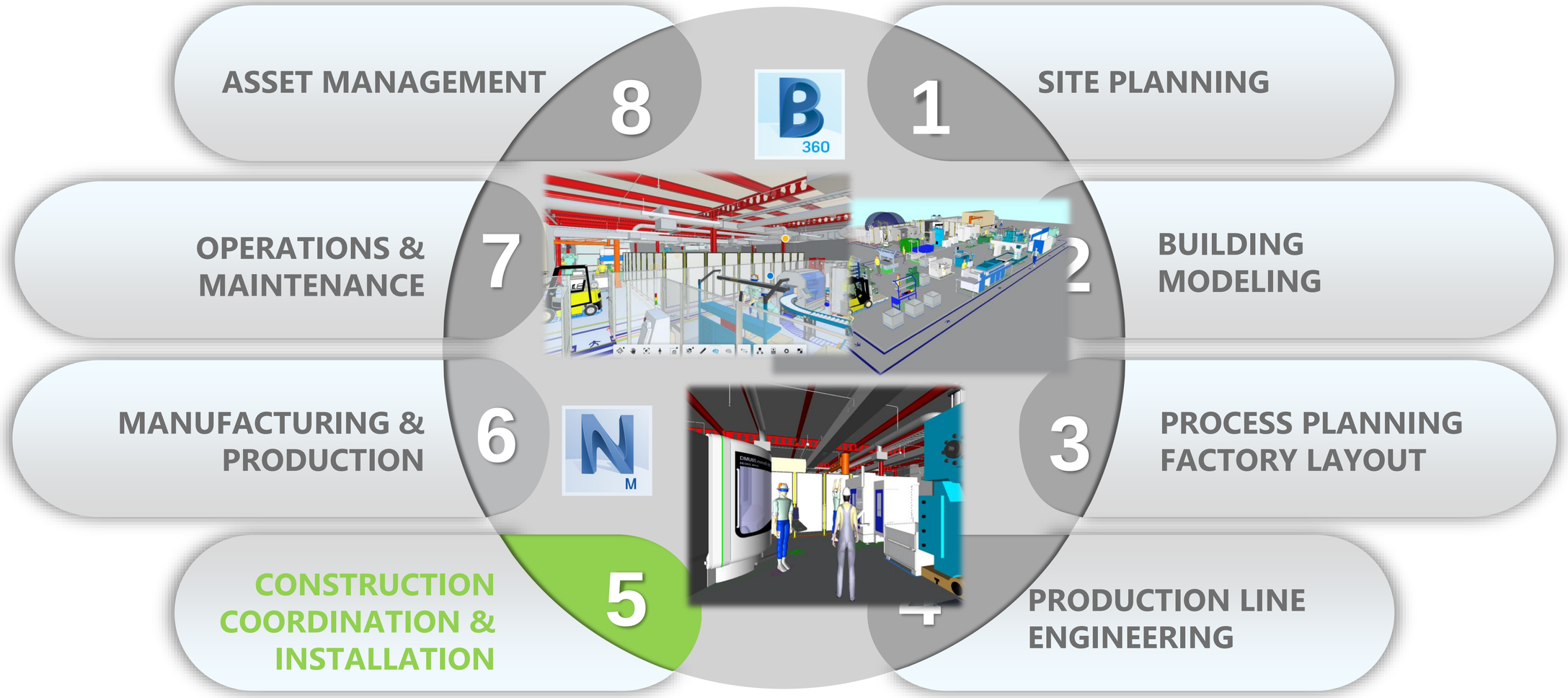

Autodesk Process Analysis
AUTODESK PROCESS ANALYSIS
Designs
Production C - DigitalTwin
Save
Undo
Redo
Cut
Copy
Paste
Group
Ungroup
Export
Reports
User Interface
Asset Browser
Source
Processor
Buffer
Product
Operator
Factory Assets
System Assets
User Assets
User Cloud As...
Search Results
Favorites
Process
Process
View Settings
Settings
Current Simulation
Run a simulation to view the line balancing information.
Stations/Connections: 12/12
Zoom: 46,19%
00:00:00

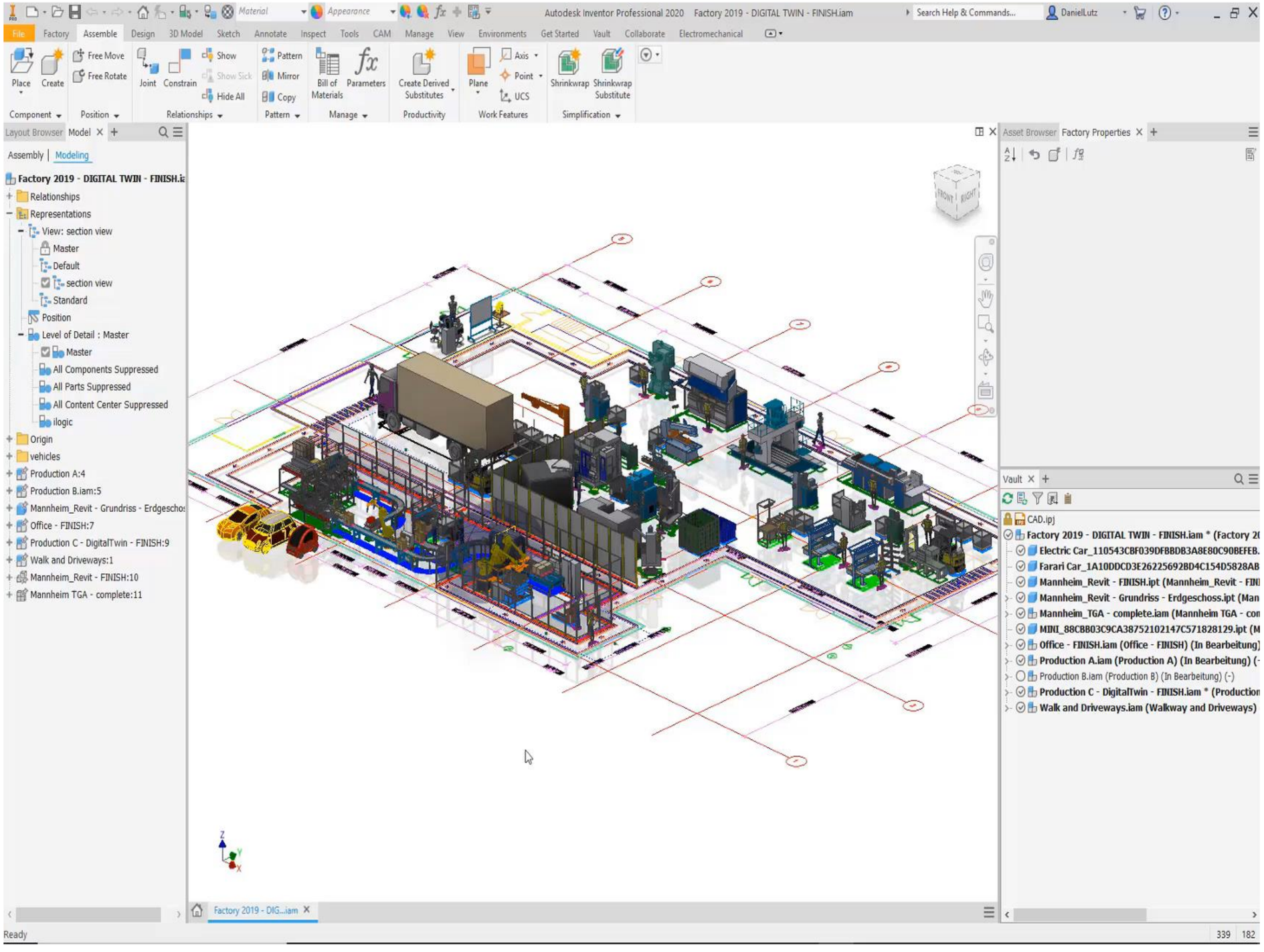
Detail design and engineering of the lines




AutoCAD Architecture 2020 - NOT FOR RESALE
Production C - DigitalTwin - START.dwg - Checked Out
Factory
Home
Insert
Annotate
Render
View
Manage
Add-ins
Collaborate
Vision Tools
Vehicle Tracking
Vault
Featured Apps
BIM 360
Palettes
Create New Process Model
Open in Inventor
Open in Navisworks
Asset Builder
Update Assets
Create Asset Chain
Convert Asset Chains
Station
Product
Routing
Transportation
Autodesk ReCap
Attach
Real View
Connect
Connectors Enabled
Measure
Factory Help
What's New
Discussion Forum
Tools
Cross-Product Workflows
Factory Assets
Material Flow
Point Cloud
Utilities
Learn
Start
Production C - DigitalTwin - START*
LAYOUT BROWSER
Select an Option
Recent Layouts
Production C - DigitalTwin - START
Production C - DigitalTwin - PA360 EXPORT
ASSET PREVIEW
[−][Top][2D Wireframe]
N
W
TOP
E
S
WCS
Y
X
ASSET BROWSER
00 - Digital Twin
00 - human
01 - transpor...
02 - material...
03 - machines
04 - savety e...
05 - robots a...
06 - products
07 - walk and...
08 - manual...
09 - electrical...
10 - vehicles
11 - office
FACTORY PROPERTIES
Factory Asset
Material Flow Ob...
Command: Specify opposite corner or [Fence/WPolygon/CPolygon]:
Type a command
Model
Work
25042.54, 273.41, 0.00
MODEL
1:100
Medium Detail
1400.00
+0.00

Avoid rework with multi discipline coordination




Autodesk Inventor Professional 2020
Factory 2019 - DIGITAL TWIN - FINISH.iam
Search Help & Commands...
DanielLutz
File
Factory
Assemble
Design
3D Model
Sketch
Annotate
Inspect
Tools
CAM
Manage
View
Environments
Get Started
Vault
Collaborate
Electromechanical
Place
Create
Free Move
Free Rotate
Joint
Constrain
Show
Show Sick
Hide All
Pattern
Mirror
Copy
Bill of Materials
Parameters
Create Derived Substitutes
Plane
Axis
Point
UCS
Shrinkwrap
Shrinkwrap Substitute
Component
Position
Relationships
Pattern
Manage
Productivity
Work Features
Simplification
Layout Browser
Model
Assembly
Modeling
Factory 2019 - DIGITAL TWIN - FINISH.ia
Relationships
Representations
View: section view
Master
Default
section view
Standard
Position
Level of Detail : Master
Master
All Components Suppressed
All Parts Suppressed
All Content Center Suppressed
ilogic
Origin
vehicles
Production A:4
Production B.iam:5
Mannheim_Revit - Grundriss - Erdgescho
Office - FINISH:7
Production C - DigitalTwin - FINISH:9
Walk and Driveways:1
Mannheim_Revit - FINISH:10
Mannheim TGA - complete:11
Asset Browser
Factory Properties
Vault
CAD.ipj
Factory 2019 - DIGITAL TWIN - FINISH.iam * (Factory 2
Electric Car_110543CBF039DFBBDB3A8E80C90BEFEB.
Farari Car_1A10DDCD3E26225692BD4C154D5828AB
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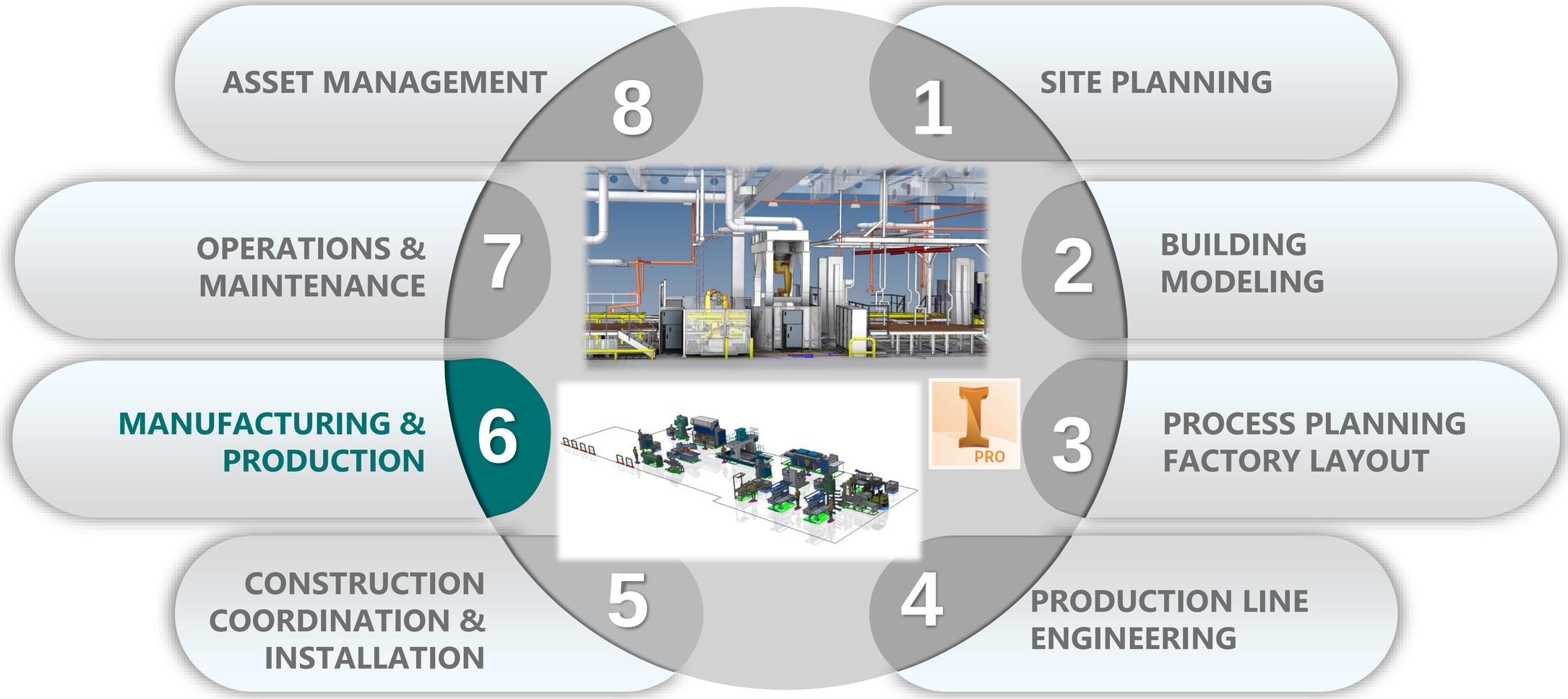
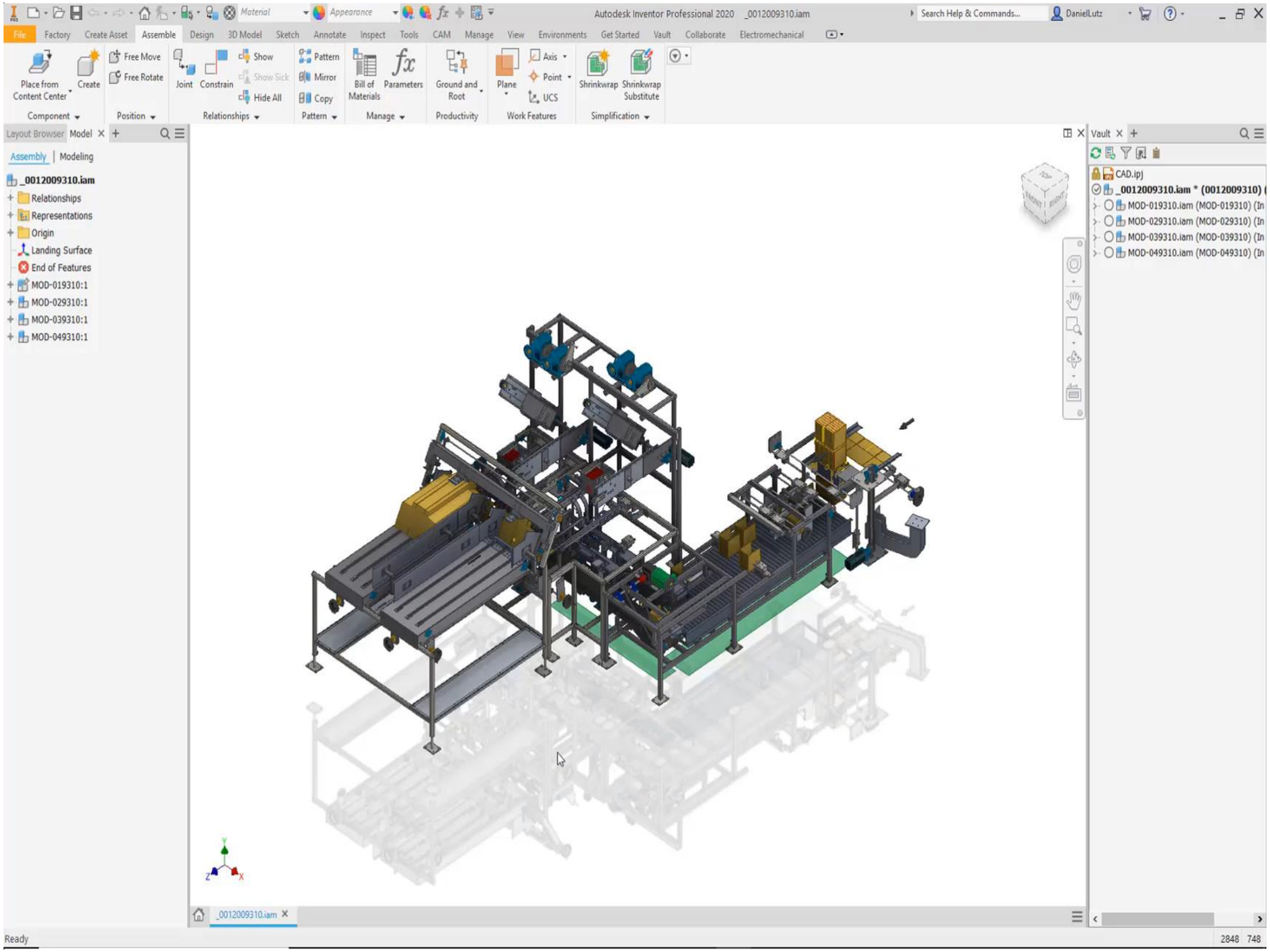
Production A.iam (Production A) (In Bearbeitung) (-
Production B.iam (Production B) (In Bearbeitung) (-)
Production C - DigitalTwin - FINISH.iam * (Production
Walk and Driveways.iam (Walkway and Driveways)
Factory 2019 - DIG...iam
Ready
339
182

Improve equipment performance




Autodesk Inventor Professional 2020 _0012009310.iam
Search Help & Commands...
DanielLutz
File Factory Create Asset Assemble Design 3D Model Sketch Annotate Inspect Tools CAM Manage View Environments Get Started Vault Collaborate Electromechanical
Place from Content Center
Create
Free Move
Free Rotate
Joint
Constrain
Show
Show Sick
Hide All
Pattern
Mirror
Copy
Bill of Materials
Parameters
Ground and Root
Plane
Axis
Point
UCS
Shrinkwrap
Shrinkwrap Substitute
Component
Position
Relationships
Pattern
Manage
Productivity
Work Features
Simplification
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Modeling
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Relationships
Representations
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Landing Surface
End of Features
MOD-019310:1
MOD-029310:1
MOD-039310:1
MOD-049310:1
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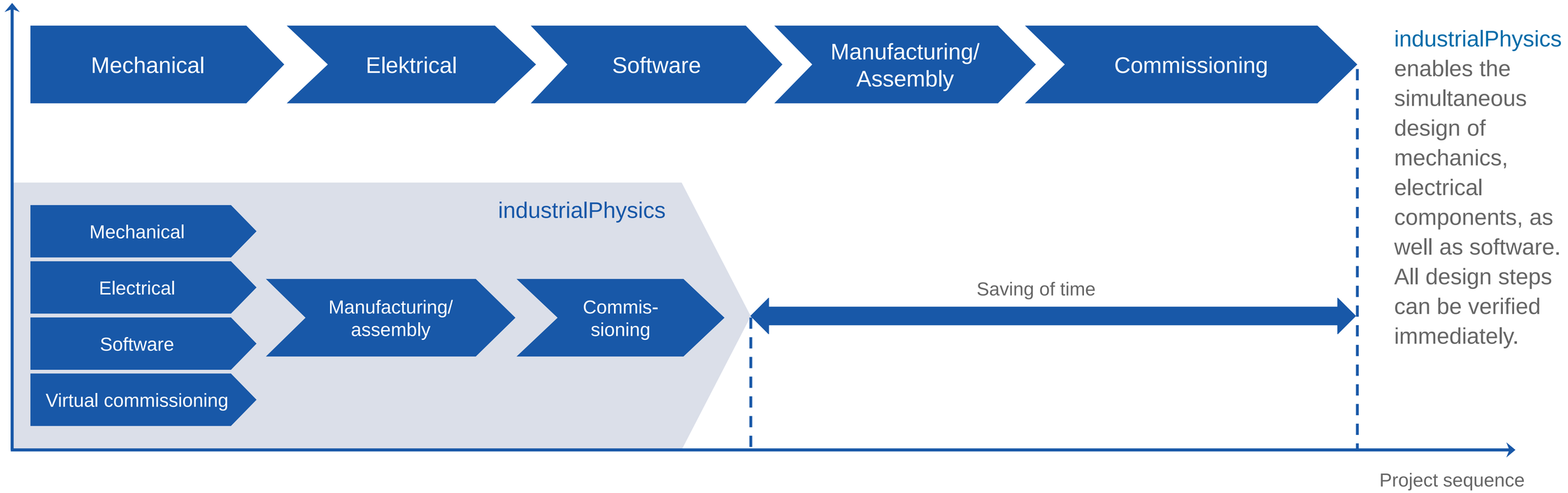
machineering GmbH & Co. KG

Benefits from working with industrialPhysics

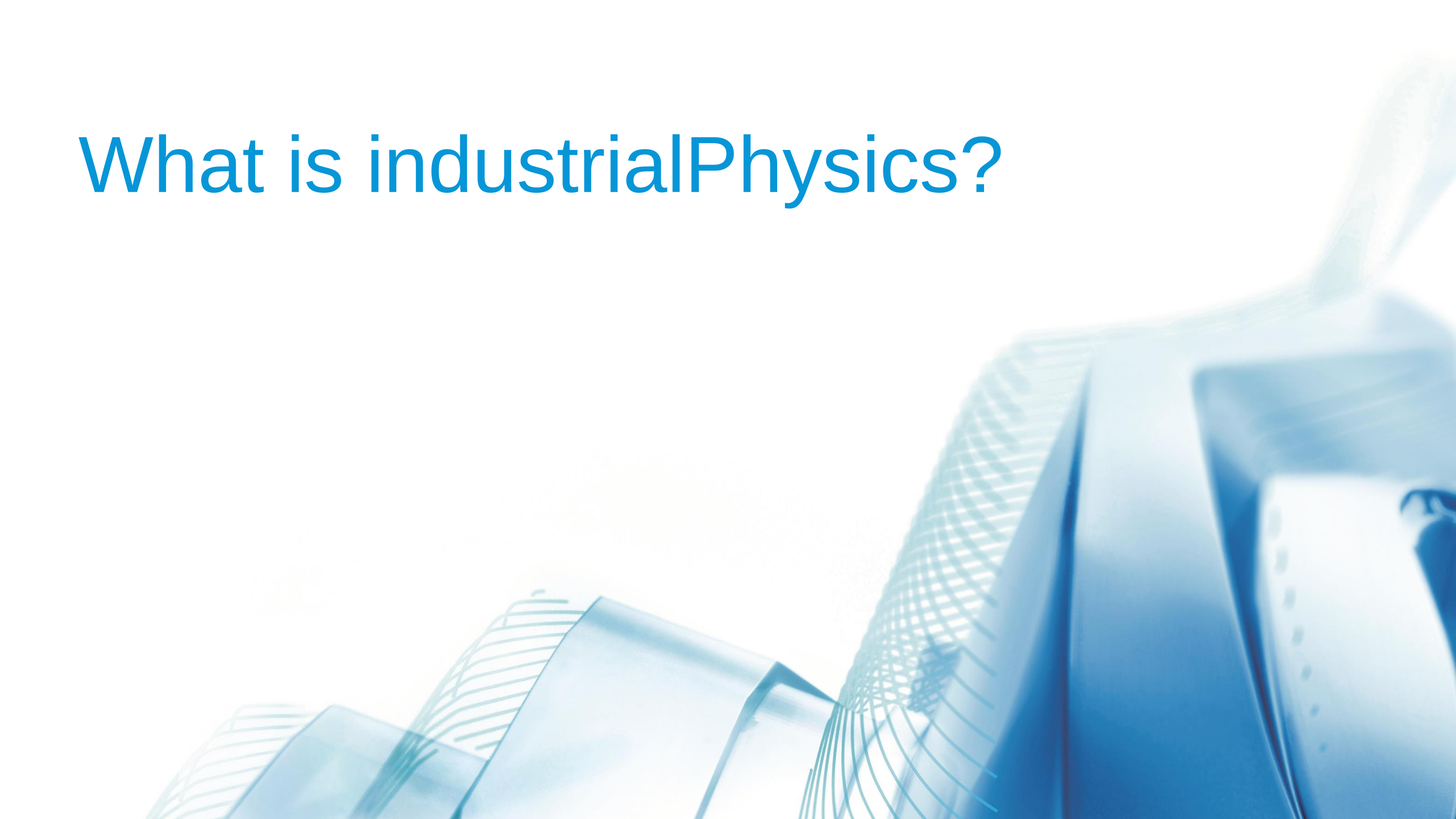


industrialPhysics enables the simultaneous design of mechanics, electrical components, as well as software. All design steps can be verified immediately.

Company

- 2009: Spin-off company of the Institute for Machine Tools and Economics in Munich (iwb)
- 2019: - 11 global sales partners
  - more than 400 licenses worldwide
  - specialist for virtual commissioning
  - customers: Bosch, Continental, IMA, Krones, P&G, TetraPak, Trumpf, Weber

What is industrialPhysics?



About industrialPhysics

- Extensive testing and simulation platform for mechatronic systems with complex material flow
- High-precision and real-time capable physics-engine
- Realistic visualization of production processes
- Innovative MCAD engineering
- Innovative HIL engineering

Benefits from working with industrialPhysics

1

Rigid-body physics
Parametrization of shape, mass / inertia, friction etc.

2

Sensors
Implementation of scanners and sensors

Physics engine

3

Kinematics
Illustration of robots and special kinematics

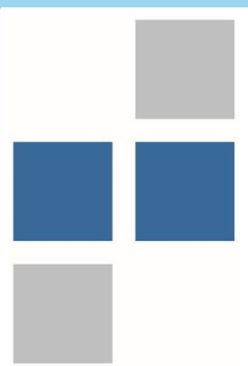
4

Actuators
Conveyor and axis drives

Interfaces for an all-in-one system

MCAD
PTC Creo Parametric,
PTC Creo Elements, SolidWorks,
Autodesk Inventor, SolidEdge

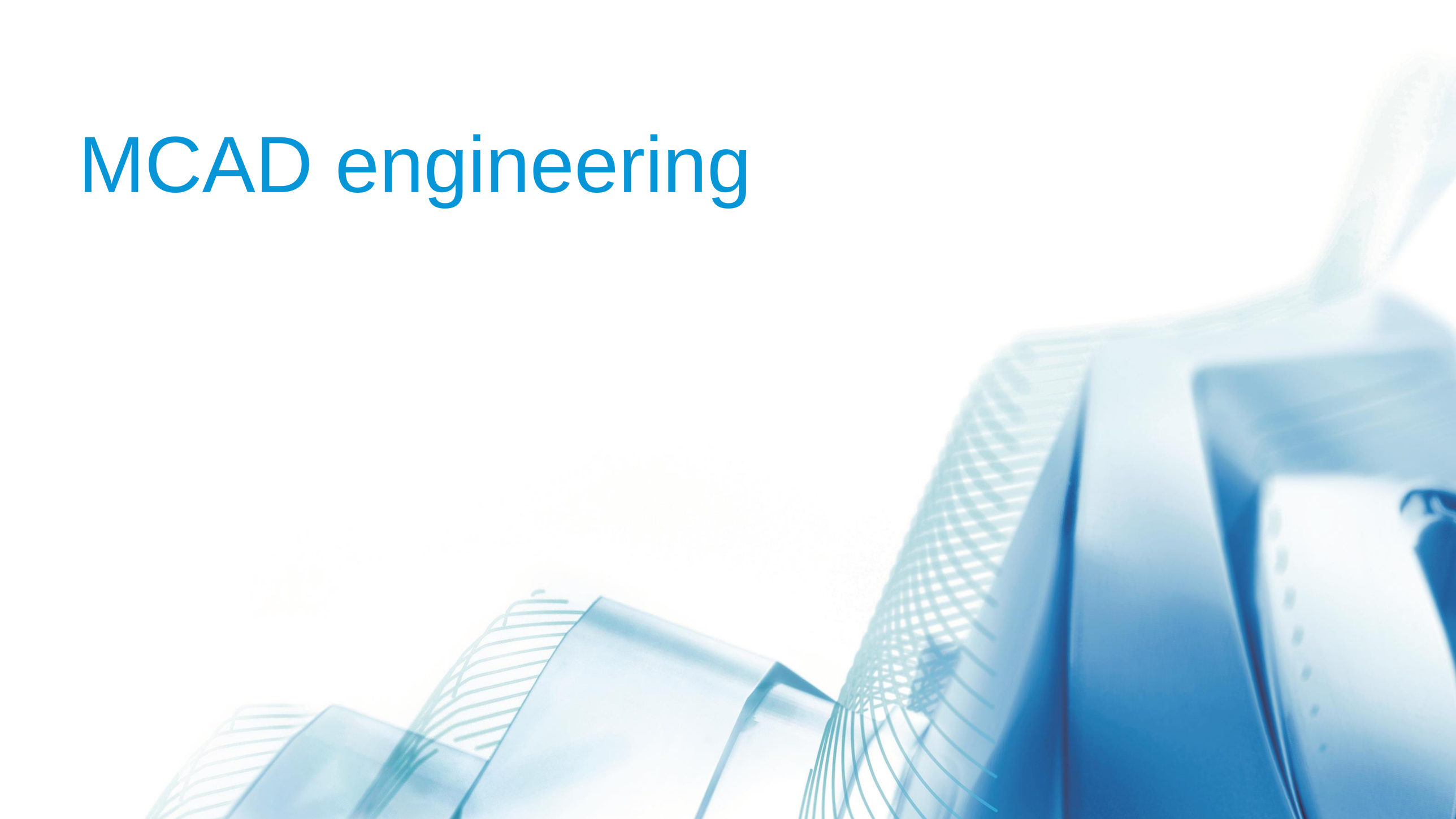
ECAD
Eplan P8, WSCAD,
Zuken E³



Robotik
Kuka, Fanuc, Staeubli, Yaskawa etc.

SPS
ABB, Bachmann, Beckhoff, B&R, Bosch Rexroth, CodeSys, Rockwell, Schneider Electric, Siemens

MCAD engineering



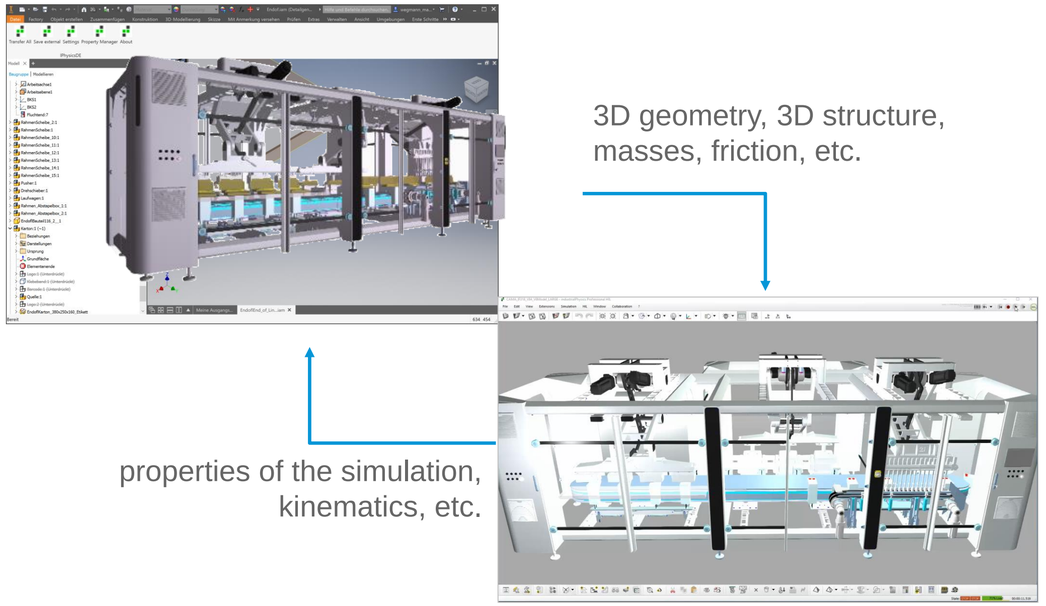
Innovative
MCAD engineering

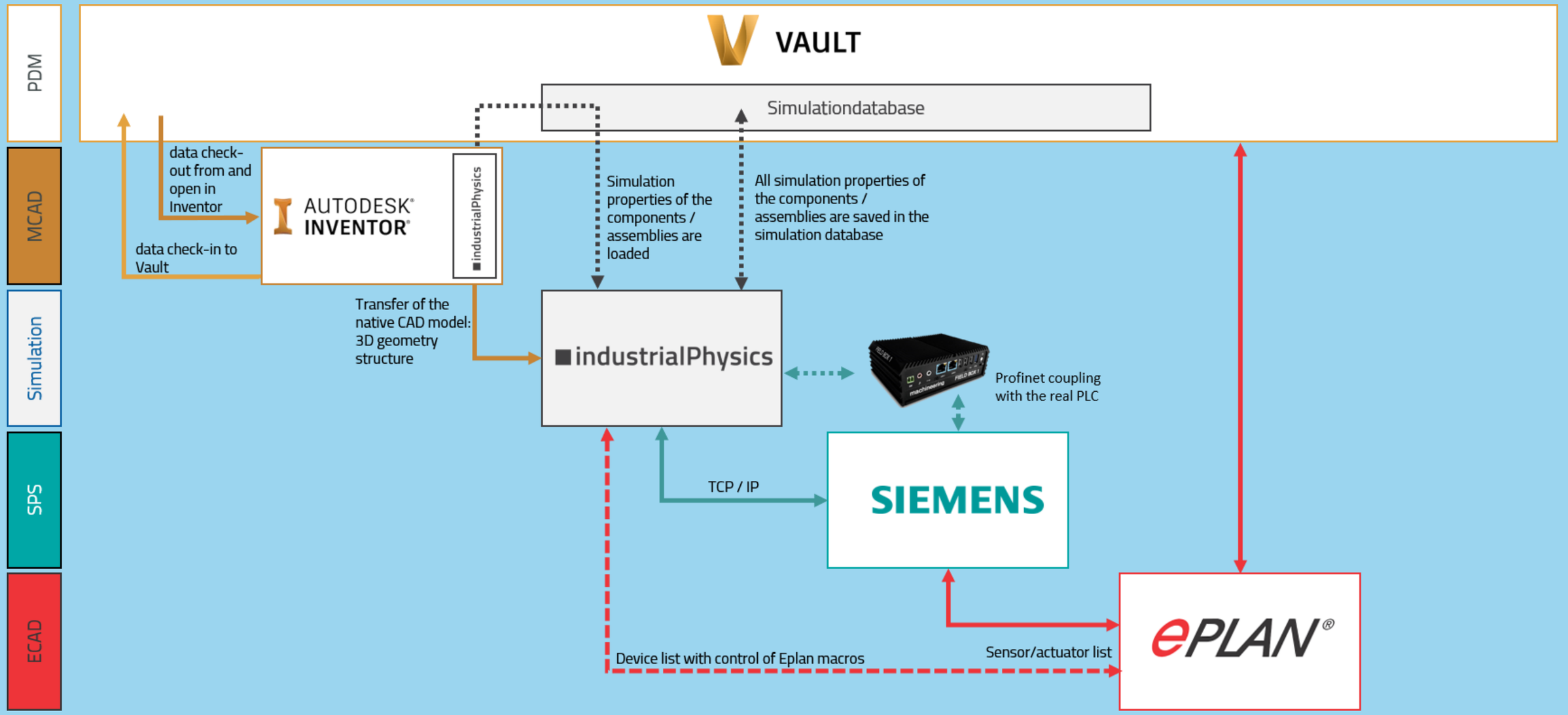
- Direct integration into MCAD-Systems
- Bidirectional interface:
  - Use of original CAD models
  - Delta synchronization
  - Easy transformation of CAD models into simulation models

✓ Immediate construction review

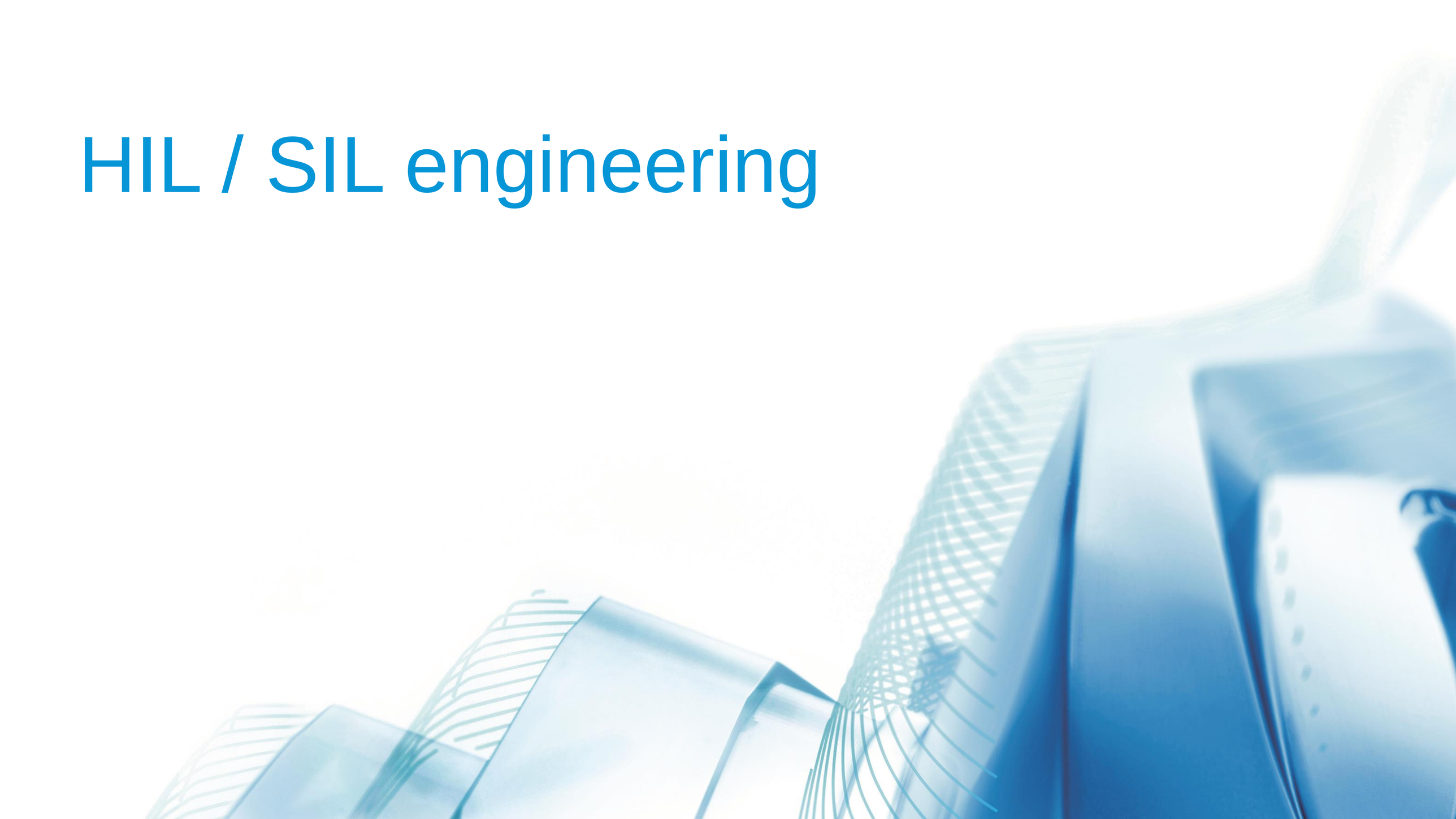
✓ Cost savings: no additional simulation hardware required

✓ Possible integration in PDM systems




PDM
MCAD
Simulation
SPS
ECAD
VAULT
Simulationdatabase
data check-out from and open in Inventor
data check-in to Vault
AUTODESK INVENTOR
industrialPhysics
Simulation properties of the components / assemblies are loaded
All simulation properties of the components / assemblies are saved in the simulation database
Transfer of the native CAD model: 3D geometry structure
industrialPhysics
Profinet coupling with the real PLC
TCP / IP
SIEMENS
ePLAN
Device list with control of Eplan macros
Sensor/actuator list

HIL / SIL engineering



Innovative
HIL / SIL engineering

Supported PLC systems:

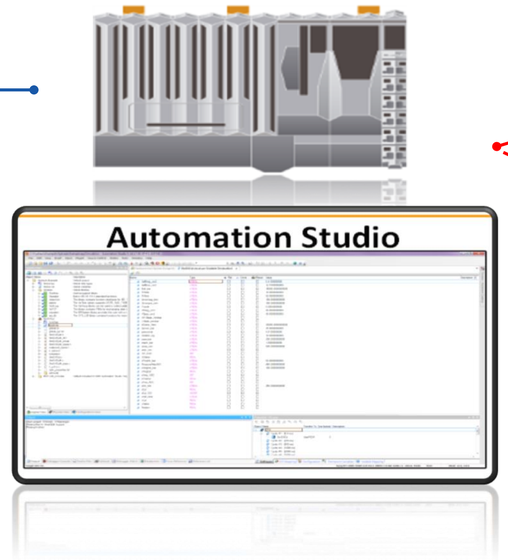
- ABB
- B&R
- Bachmann
- Beckhoff
- Bosch Rexroth
- Siemens
- Schneider Electric

Supported field bus protocols:

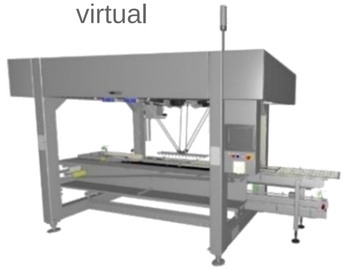
- Profibus
- Profinet
- Profisafe
- TCP / IP
- ADS
- EtherCAT
- Ethernet / IP
- OPC / UA

- ✓ Programming in the PLC‘s native IDE
- ✓ Easy mapping through ControlTags
- ✓ Direct verification of the PLC code with the simulation

Principle



virtual



real

FieldBox1

- Multi device emulator
- PROFINET / Ethernet / IP / EtherCAT
- Up to 3 networks per bus system

Principle

TCP / IP

PROFINET

Ethernet / IP

EtherCAT

Fieldbus

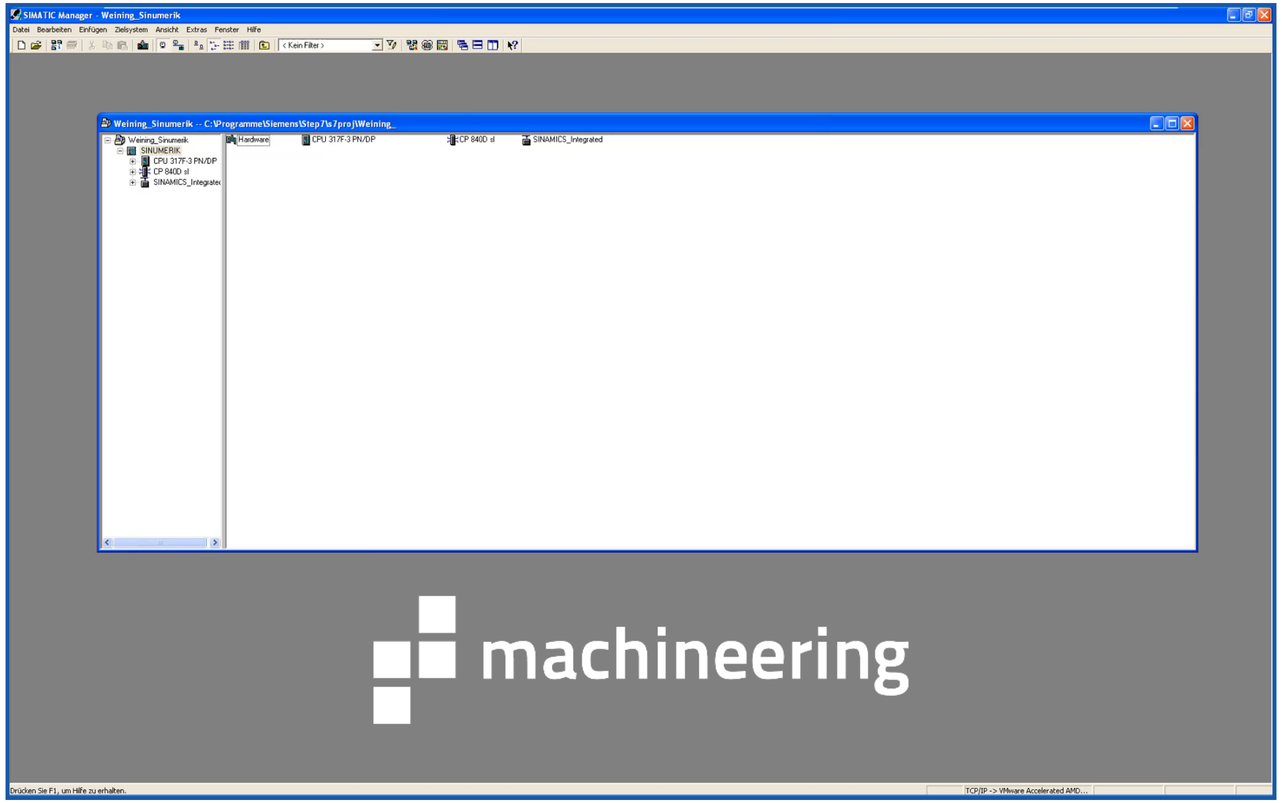
SIEMENS

Rockwell Automation

BECKHOFF

SPS

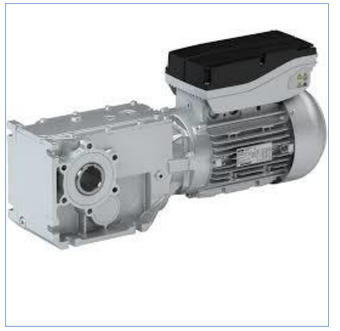
FieldBox1: Example Siemens Sinumerik

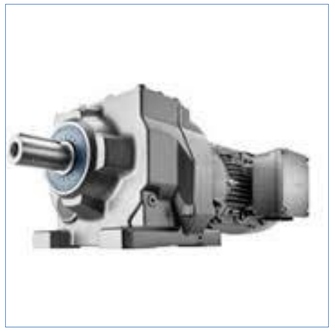


Drives / Sensors

Drives / Sensors

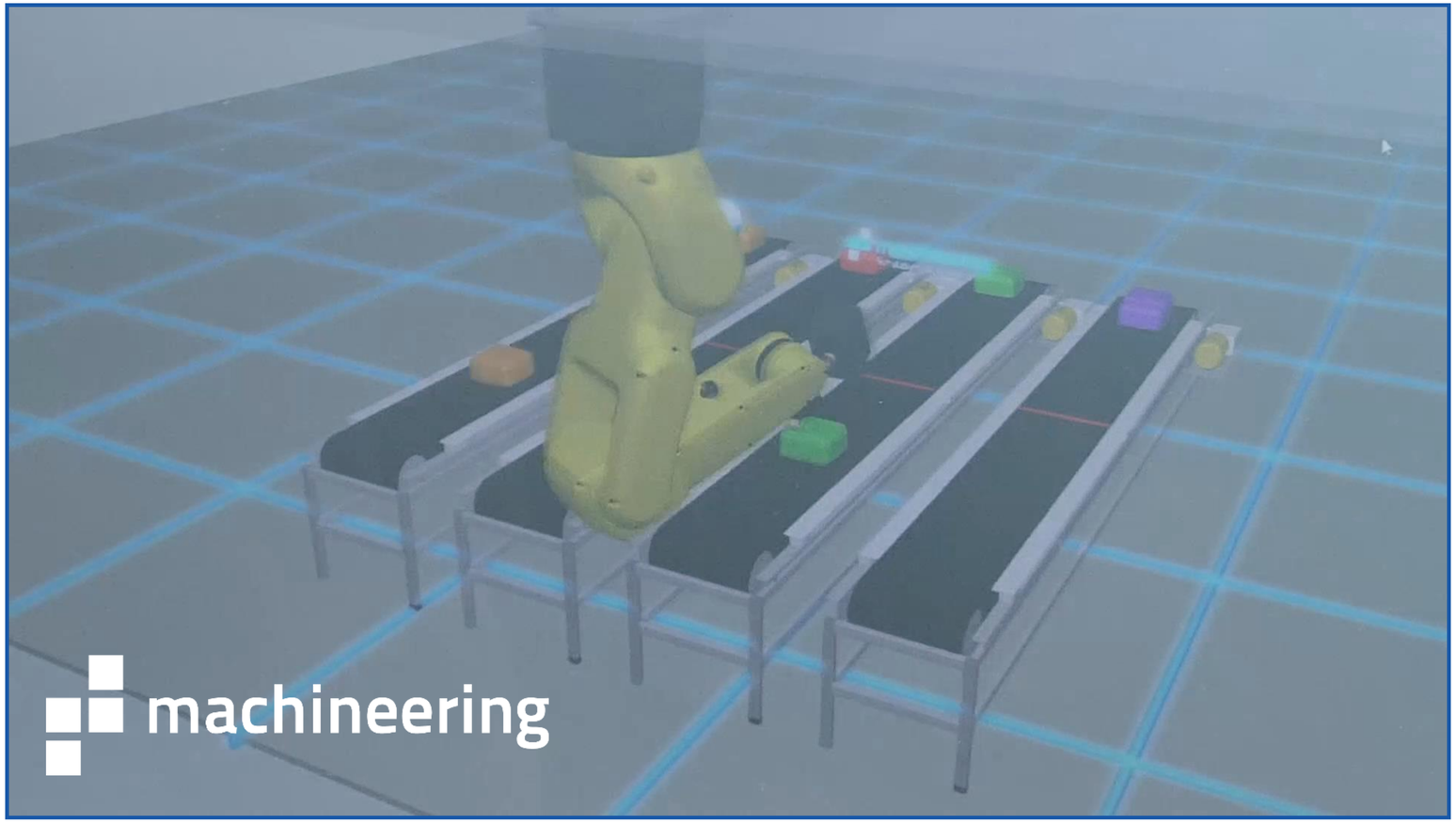
- Emulated drives on the control
- Drives library
- Sensors library





Example SPS IPC Drives

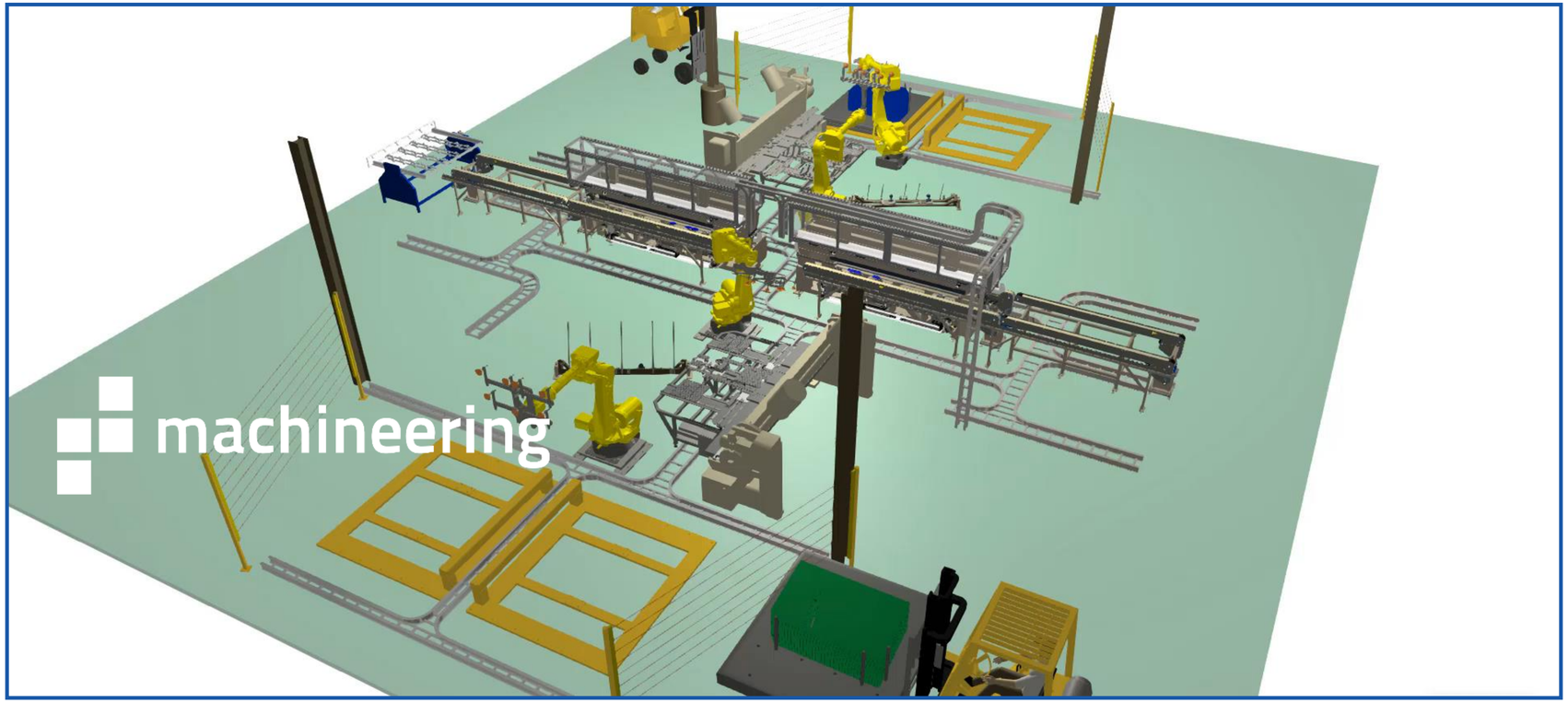


Robotics

Robotics with industrialPhysics

- 3D robot objects + reverse kinematics
- Connection to real robot controls e.g. Fanuc, KUKA, Mitsubishi, Staeubli
- Virtual commissioning of complete robotic systems

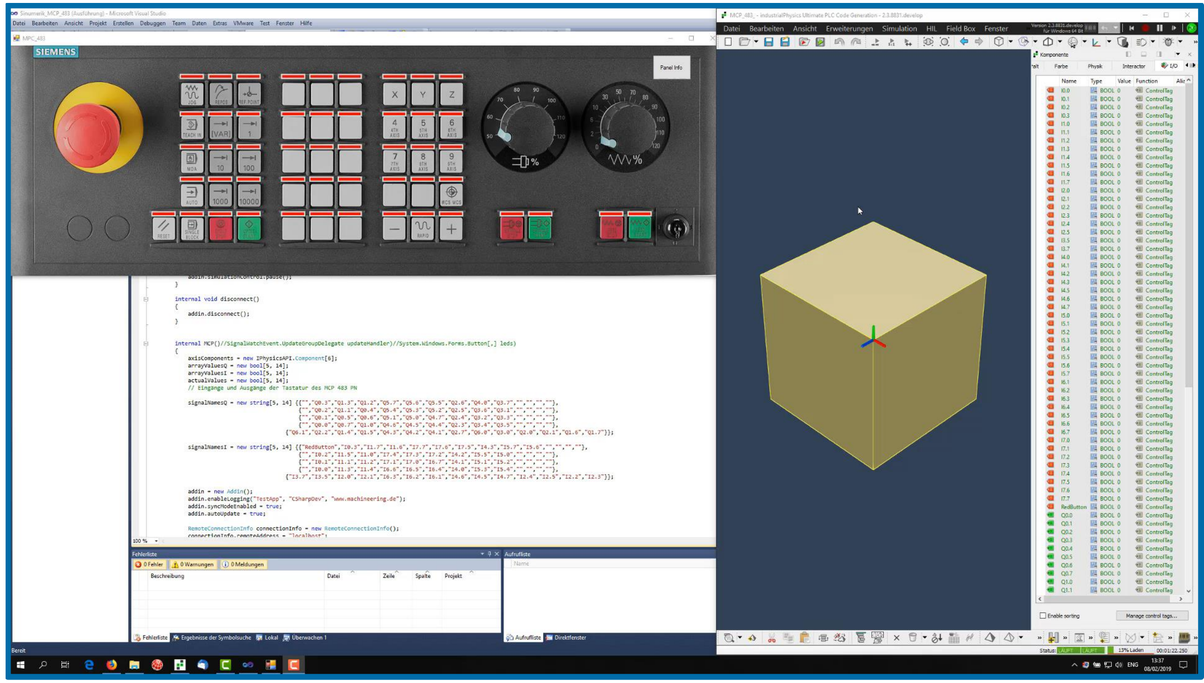
Commissioning example of a complex robotic system in the automotive industry



Extensibility

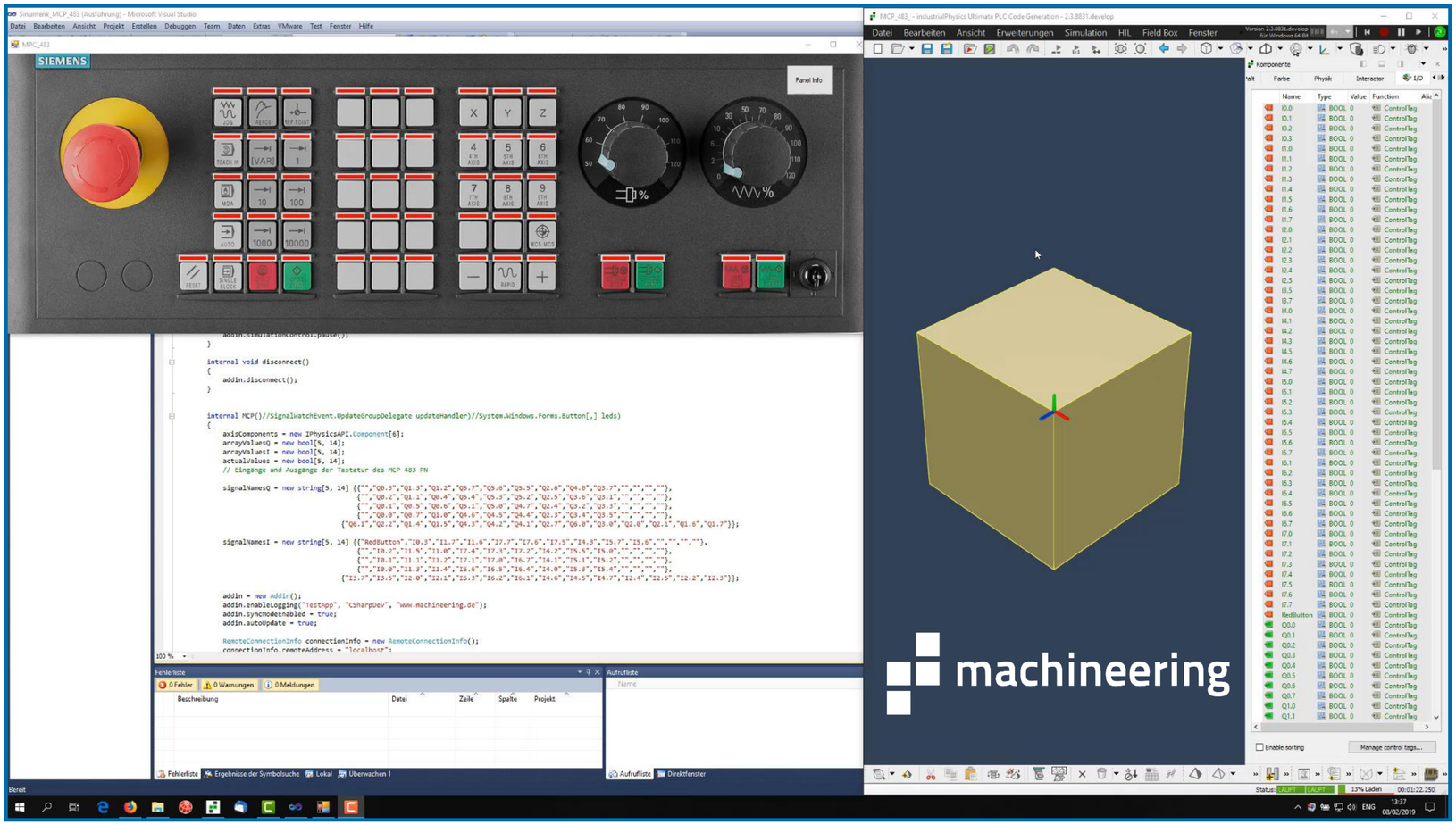
Plug-in technology

- Special bus drivers
- Server technology
- Data base interfaces
- MES systems
- Third-party simulation models
- HMIs
- AGV controllers



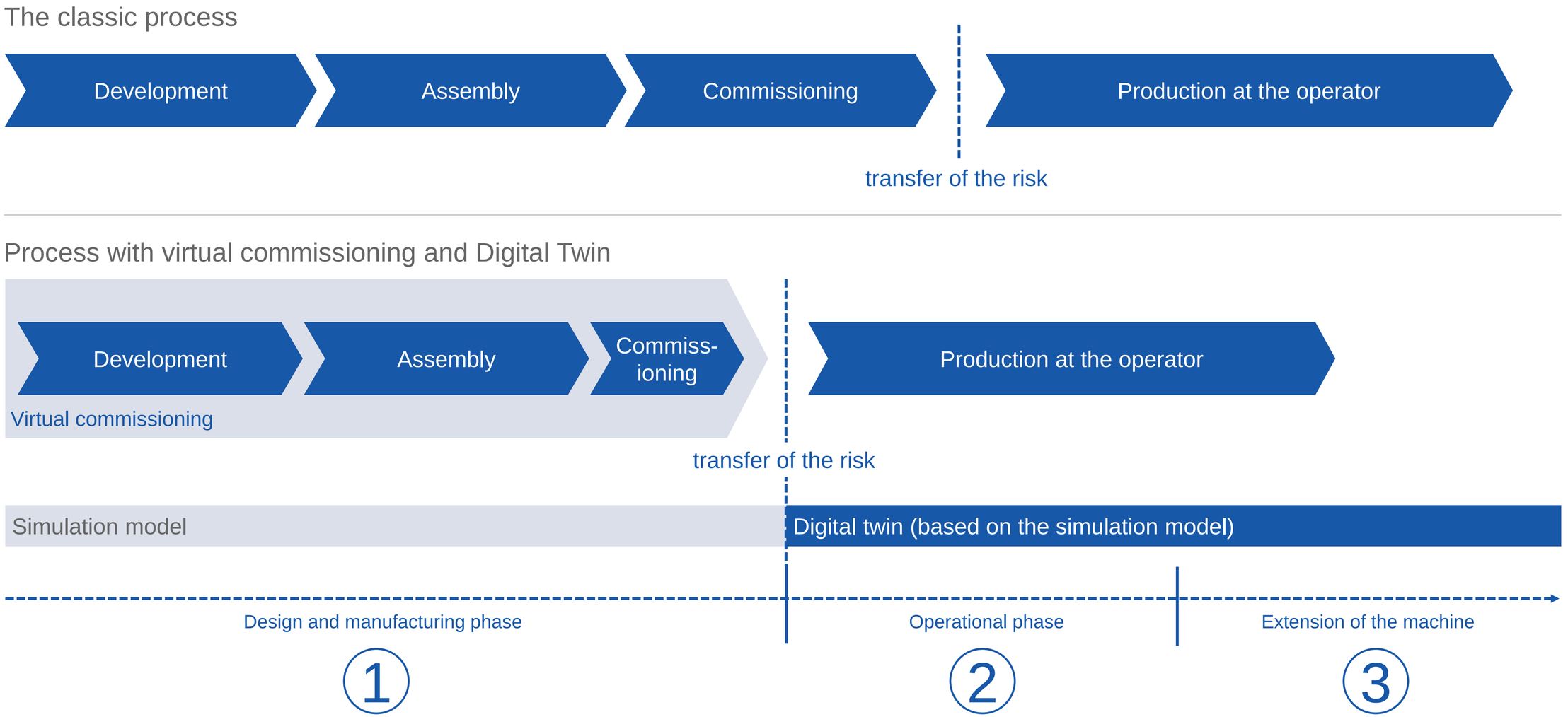
- C API
- C++ API
- C# API
- OPC/UA

Example of a user-defined HMI



Digital Twin

Derivation of the Digital Twin from the simulation model



Using your simulation model as Digital Twin

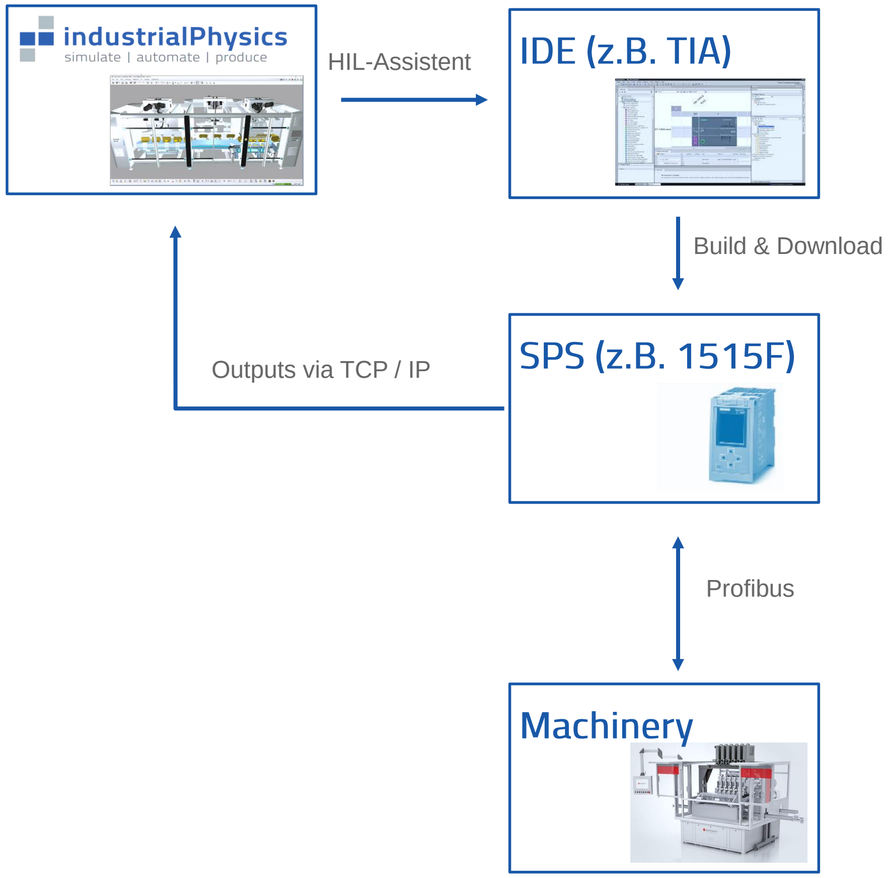
Switching between machine and simulation mode allows for:

- use case 1: Digital Twin
- PLC Inputs connected to real Hardware
- Writing of real machine‘s I / Os into simulation

  Result: Real-time, in-depth remote representation of the machine‘s state

- use case 2: Virtual commissioning of new product
- Review of possible alterations to the machine using the simulation model

  Result: Fundamental minimization of risk



Visualization
VR, AR, APP, Web

APP

- AR projection
- Iphone / IPAD APP
- Android APP

VR / AR

- VR systems: Oculus Rift, HTC Vive
- AR systems: Microsoft HoloLens
- VR rooms

Krones AG – Hololens at „drinktec 2017“

https://www.youtube.com/watch?v=Lda2Ur7yue4

“At the drinktec 2017, visitors had the chance to take a look inside the Bottling on Demand concept study. The video gives an insight into the Augmented Reality project”.

Potentials

Benefits for the management

REDUCTION

of commissioning time

REDUCTION

of overall

development time

INCREASE

in software quality

REDUCTION

of cost

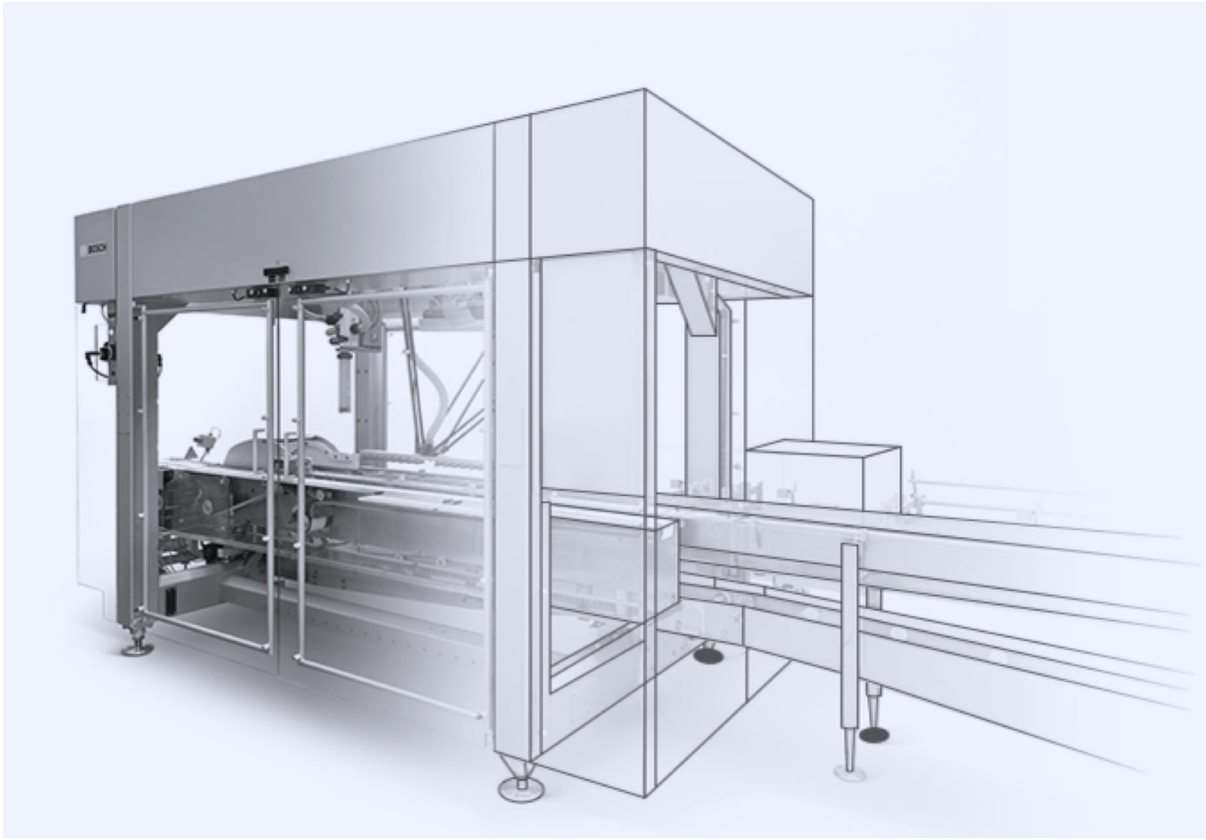
Engineering benefits

Benefits for the engineer

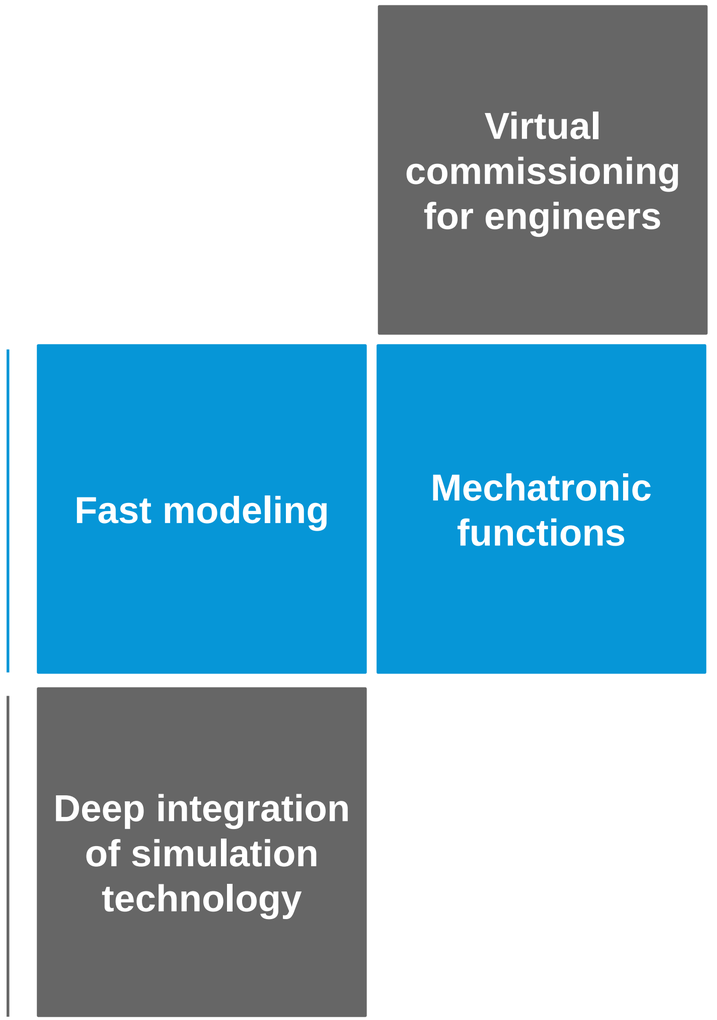
- Reduction of risk for complex plants/projects
- Comparison of planning scenarios
- Assessment of plant output and overall effectiveness
- Visualization of the production processes

Benefits on machine level

- Considerable simplification of the commissioning
- Transparent change management
- Optimization of the machine sequence plan
- Detection of obsolete functions (redundancies)
- Formation of focused function blocks (modularization)



Advantages vs other tools



- Direct MCAD integration
- Sequence control

- Simple implementation of conveyors and handling systems
- Implicit modeling based on rigid-body physics

- Various basic functions for drives and sensors
- ModelScript for PLC logic and electronic protocols
- Mechanical behaviour of the machine in 3D physics

- Parallel processing of 3D physics, drives and logic simulation as well as virtual PLCs and PLC drivers
- One comprehensive data model
- Visualization of large systems

Our customers

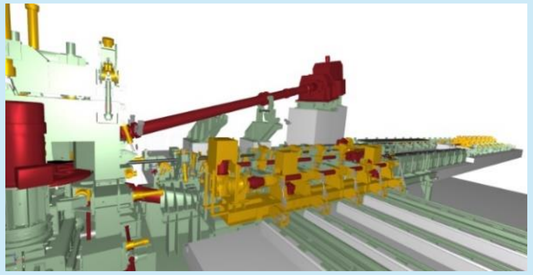
industrialPhysics at the steel industry

1 **Goals**

- Safeguard the plant with virtual commissioning
- Fast production ramp-up by intensive training of operators
- Improvements for sales of large and complex production systems

2

3



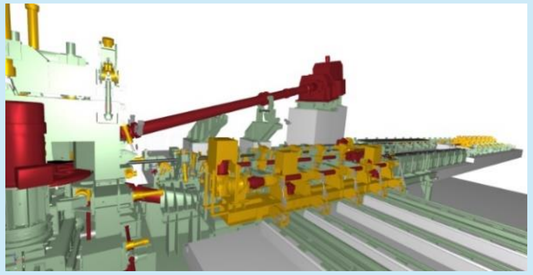
industrialPhysics at the steel industry

1

2 Project steps

- Generating a simulation model based on real CAD data
- Connection of PLCs to the simulation model
- Programming the PLC code and testing with the virtual model
- Derivation of tested control code directly to the real plant

3



industrialPhysics at the steel industry

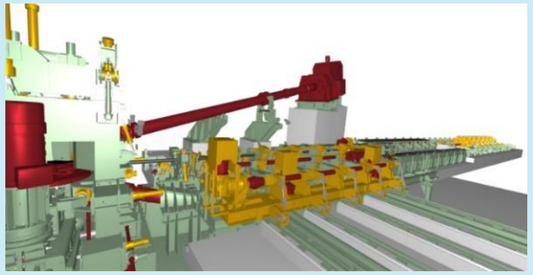
1

2

3 Savings

- Before:
  Loss of 20.000 € / hour during standstill of the plant

- After:
  40% less standstill time by safeguarding the mechanical, electronic and electrical parts with virtual commissioning



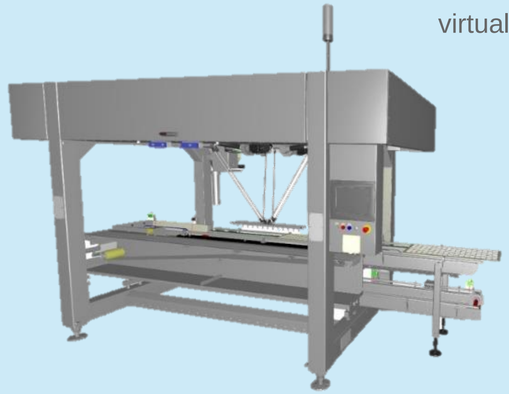
industrialPhysics at the packaging industry

1 Goals

- 100% software tests on virtual machines, material flow, and product simulation
- Predictable project milestones
- Reduction of abroad and travel times (commissioning cost) and increase of the OEE for the customer
- Improvement of the communication and know-how exchange between mechanical design and software development
- Reduction of the commissioning time at the real machine

2

3



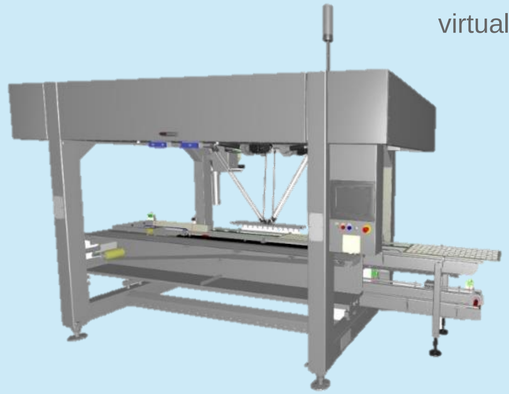
industrialPhysics at the packaging industry

1

2 **Project steps**

- Generating a simulation model based on real CAD data
- Simulation of the software concept without PLC
- Definition of I / O parameter between PLC, simulation and virtual axes
- Connection of simulation, PLCs and HMI and testing of software

3



industrialPhysics at the packaging industry

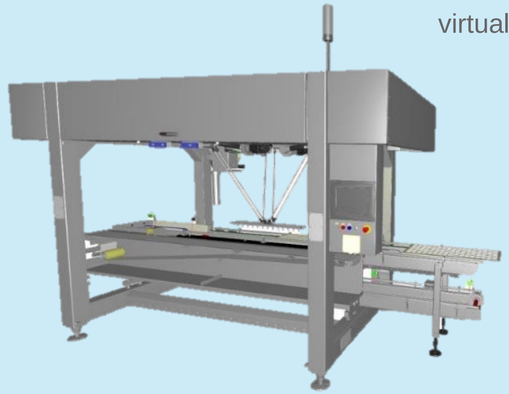
1

2

3 Savings

- Before:
  loss of 10.000 € / day as penalty for delivery delay

- After:
  Customer‘s deadline for commission can be met



virtual

real

Recognised by renowned companies

"With industrialPhysics from machineering we have been able to make projects possible that for reasons of time weren't feasible with classic approaches. Best of all: it was possible to present a functioning controller including HMI to the customer on the simulation while the real plant was still under construction in the hall. That way he was able to familiarize himself with the user interface and realize his individual wishes."

Head of electrical design

"Your simulation is just loads of fun. Thanks to the bidirectional interface, our iteration cycles are so short that it knocks me off my feet every time. Thank you for this development.“

Simulation expert

"You see, the workshop has already paid for itself. Did you know that we need another degree of freedom here?“

Manager of the Head of Design

“We have even built a house for the simulation: our interdisciplinary teams work in project teams directly with CAD and simulation at the same workstation. The quality of our machines and the speed of reaction of our team has brought us rapid growth.“

Manager, Technology

"Simulation is indispensable today…we believe that machineering will become the market leader. In our opinion there is great potential in the direct connection to our CAD system and the coupling to all common control systems.“

Manager, Control Technology

"We were impressed by the ease of use of the machineering tool right from the start. We were able to imagine the broad range of applications for our plant simulation and even ship the application as a product to our customers."

Manager, Virtual Commissioning Lab

References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BOSCH
Invented for life
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cama GROUP
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MEHR AUS HOLZ.
WestRock
Fraunhofer
Gebo Cermex
SIG
SPRINGER
DIVIDELLA
KÖRBER SOLUTIONS
KRONES
LIPPERT
aumann
OPTIMA
P&G
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AC
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GERMANY
framag
engineering for the best
FOCKE & CO
Schneider Electric
SEIDENADER
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SEMA
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somic
VERPACKUNGSMASCHINEN
Winkler + Dünnebier
Tetra Pak®
PROTECTS WHAT'S GOOD
Thimonnier
TRUMPF
TVI
MEAT PORTIONING
Vollert
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weber®
The High Tech Company
it's possible!
evopro
ZAHORANSKY
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LINZ CENTER OF MECHATRONICS GMBH

Products

Standard software for individual requirements

	ULTIMATE	PROF. HIL	PROF. HIL CLASSIC	MECHATRONIC DESIGN	ADVANCED
PHYSICS SIMULATION	✓	✓	✓	✓	✓
VR + AR VISUALIZATION	✓	✓	✓	✓	✓
ADVANCED PROGRAMMING	✓	✓	✓	✓	✓
MCAD-INTEGRATION	✓	✓		✓	
SPS-CONNECTION	✓	✓	✓		
ROBOTIK (GREY: OPTIONAL)	✓	✓	✓	✓	✓
FELDBUS, REAL-TIME CAPABILITY	✓				

Thank you for your attention!