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Simulation for Automation & Virtual Commissioning

siemens.com/virtual-commissioning

“…digital twins are slowly entering mainstream use”

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“The results — especially when compared with past surveys — show that **digital twins are slowly entering mainstream use**,” said Benoit Lheureux, research vice president at Gartner.

Gartner, Survey on Digital Twins, 2019

In context of digitalization the competitive advantage of OEMs will shift from „Competence in steel and iron to competence in software and data analysis.“ Digital twins – the virtual copy of the value chain on three level product, production and performance – will become more and more important or even a must-have in numerous areas of OEM industry.

IG Metall, Digital Transformation in OEM industry, 2018

„13% of organizations implementing IoT projects already use digital twins, while 62% are either in the process of establishing digital twin use or plan to do so…“

Gartner, Survey on Digital Twins, 2019

Simulation & virtual commissioning
Different challenges through the lifecycle

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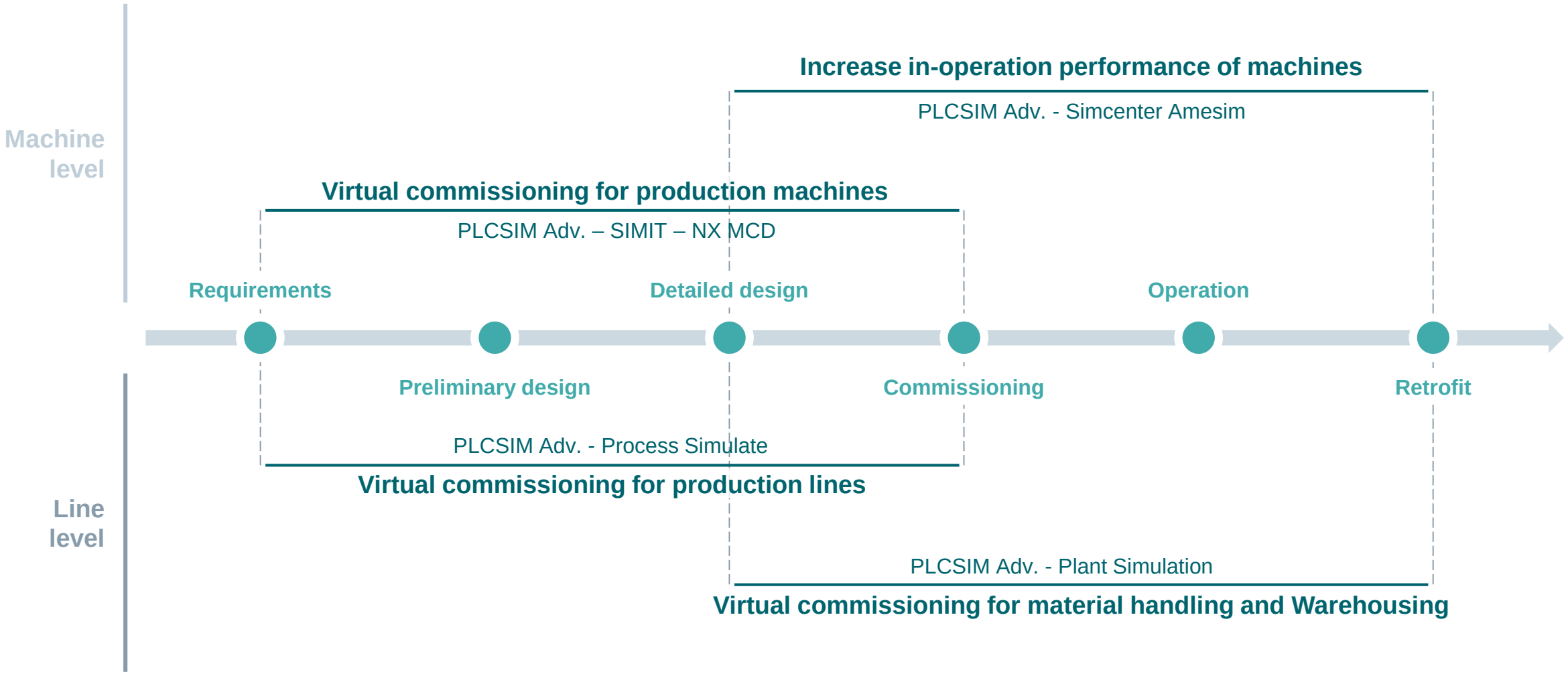

Simulation & virtual commissioning leads to faster time-to-market, reduced error costs and risks

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Pain point of machine & line builder		Advantages of simulation & virtual commissioning
Speed	Increasing complexity leads to longer time from the product idea to the industrial production.	• Reduced time-to-market thanks to parallelization of mechanical and automation engineering
Cost	Damages to the machine during commissioning are expensive, as well as improving the design after prototyping (time- and moneywise)	• Test earlier and avoid mistakes during engineering phases
Risk	Starting a new production machine or line includes uncertainties concerning the schedule and the performances.	• Secure design, reduce risk and time from the concept to real commissioning
Flexibility	Access to real machine for retrofit and optimization is limited as machine downtimes have to be avoided	• Validate changes on the production machine or line during operation

The virtual environment is dependent upon the respective issue under investigation

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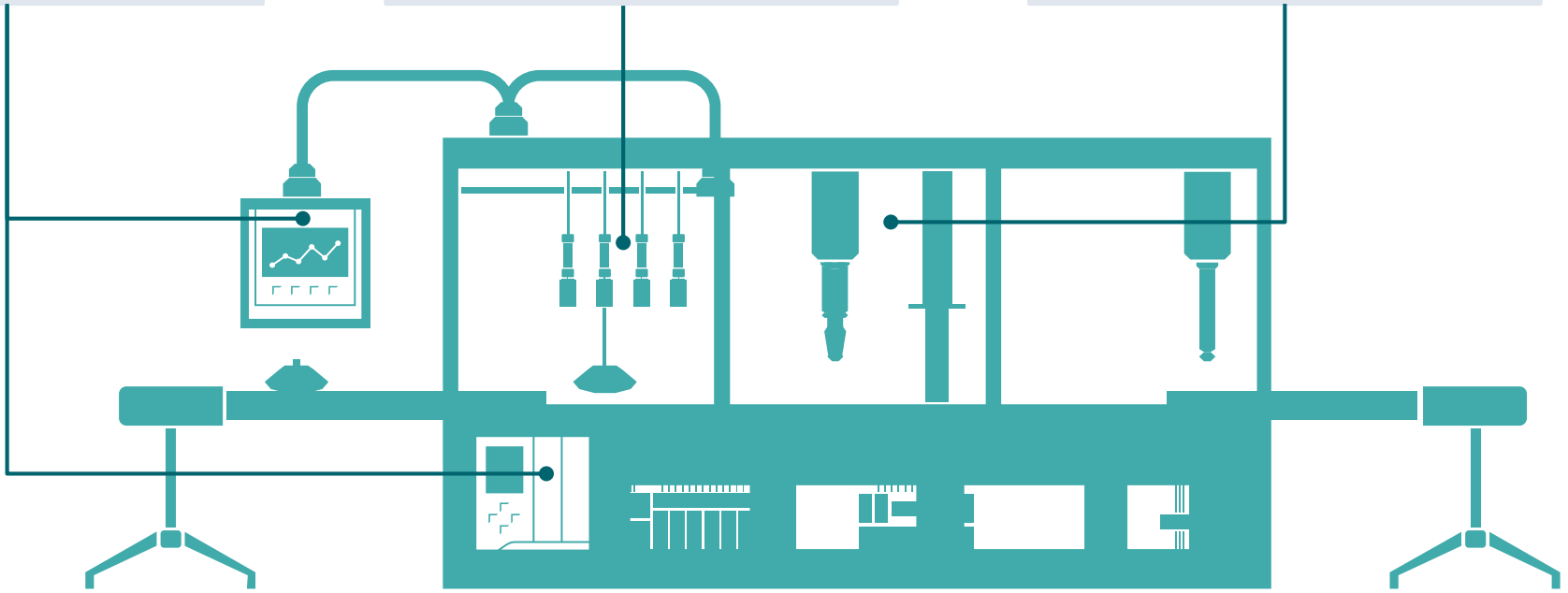
Logic of PLC and HMI control components

Interaction between mechanical and automation system

Interaction of multiple components in a cell, plant or line



The Siemens portfolio offers solution scenarios for virtual commissioning for all analysis stages

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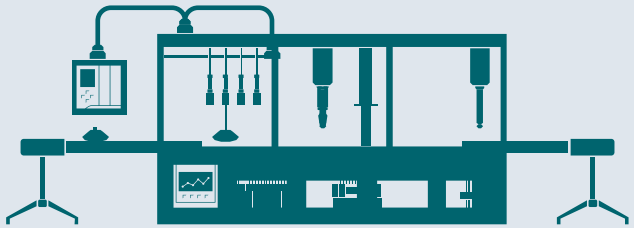
Digitization readiness

Complexity and planning reliability

Validation of control logic, as well as visualization

Validation & optimization of automation logic and component behavior of a machine

Validation & optimization of interaction between various components within a line, plant or cell



Workflow level

Controllers and HMI

Production machines

Production cells, lines or factory

The Siemens portfolio covers application scenarios for virtual commissioning for all analysis stages

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Digitization readiness

Complexity and planning reliability

Validation of control logic, as well as visualization

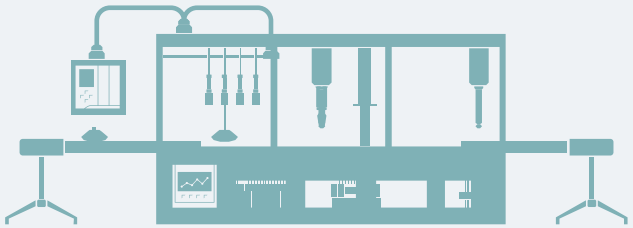
Approx. 95% of all TIA Portal programmers

Validation of automation logic and component behavior of a machine

- Basic solution for S7-1500 applications (Software- in-the-loop)
- Advanced solution for broad market (Hardware-in-the-loop & software-in-the-loop)

Validation of interaction between various components within a line, plant or cell

Line builder, end user, SI



Workflow level

VC for controllers and HMI

VC for machine builders

VC for production cells, line or factory

The virtual machine model is a combination of different simulation models

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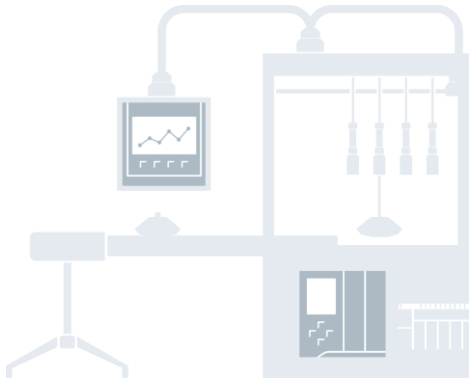
Virtual machine model



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Automation model

Logic of the PLC program and visualization

PLCSIM Advanced

+

Electrical model and behavior pattern

Active components (e.g. drives, valves) and behavior of peripherals

SIMIT

+

Physical and kinematic model

Mechanical components

NX MCD

Siemens offers

- Scalable VC solutions depending on the customers targets and skills
- One integrated software landscape
- Implemented interfaces to PLCSIM Advanced for simulation software for physical/kinematic model (in NX Mechatronics Concept Designer) and behavior model (in SIMIT)
- Pre-Sales and consulting support

PLCSIM vs PLCSIM Advanced
Functional Differences

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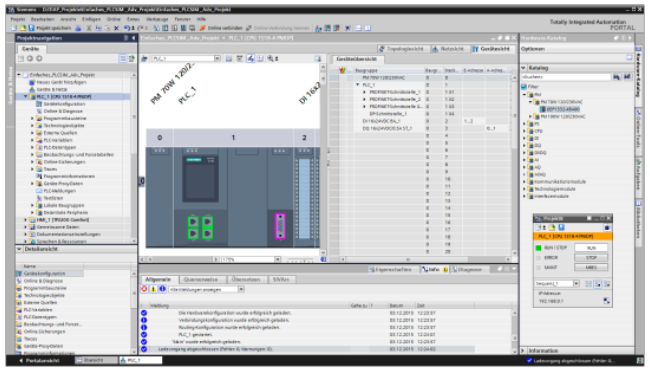
PLCSIM



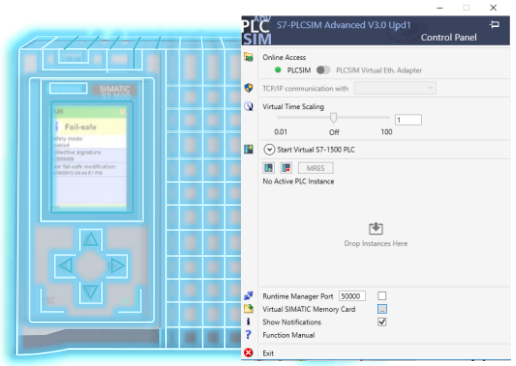
Controller simulation integrated in STEP 7 with TIA Portal

Application use case:

- Function test and validation of the STEP 7 program

PLCSIM		PLCSIM Advanced
✓ / ✓	S7-1200 (F)/ S7-1500 (F/T)	✗ / ✓
✗	API	✓
up to 2	Multiple instances	up to 16
✗	Distributed instances	✓
✗	OPC UA	✓
✗	Web server	✓
✓	Process diagnostics	✓
(✓)	Traces	✓
(✓)	Motion	✓
via softbus	S7 communication	✓
via softbus	Open User communication	✓
(✓)	know how protected blocks	✓
✗	Virtual time	✓
✗	Connection of real PLCs/HMIs	✓
✗	DNS use	✓
✗	Virtual memory card	✓

PLCSIM Advanced



Virtual S7-1500 Controller

Application case:

- Function test of the STEP 7 program - also in the context of a plant / machine
- Operator training
- Virtual Commissioning / Factory Acceptance Test (FAT)

Simulation at every level

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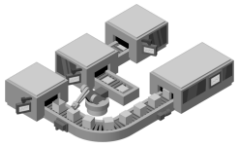
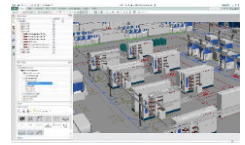
Production line

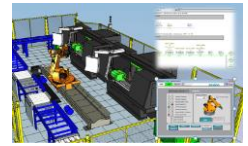


Tecnomatix Plant Simulation



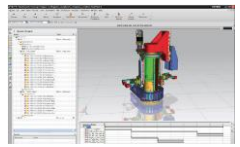
Robotic cell

Tecnomatix Process Simulate

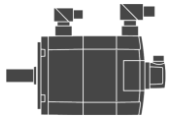


Production machine

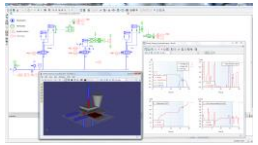
NX Mechatronic Concept Designer



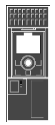
Component physics



Simcenter Amesim



Component communication



SIMIT

Automation

PLCSIM Advanced and WinCC

Automation validation and basic virtual commissioning

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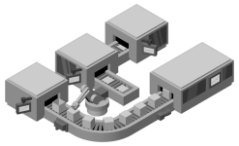
Production line

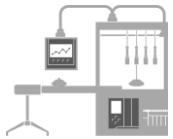


Tecnomatix Plant Simulation

Robotic cell

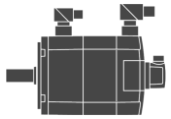
Tecnomatix Process Simulate

Production machine



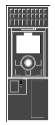
NX Mechatronic Concept Designer

Component physics



Simcenter Amesim

Component communication



SIMIT

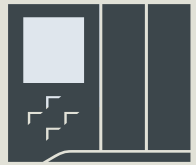
Automation

PLCSIM Advanced and WinCC

Automation validation and simple virtual commissioning
Validate the automation program

- How can I validate my automation program?
- What is the time response of the system?
- Did I configure my communication right?
- How does my automation code react in case of failure?
- Is my safety working?

Replacement of hardware test setup



With **SIMATIC S7- PLCSIM Advanced** & **WinCC**

- using comprehensive simulation of controller functionality
- testing via TIA Portal tools. e.g. watchtables, simulated HMI / HMI runtime etc.

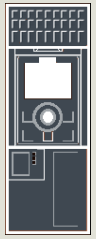
Automatic program code validation

With **SIMATIC S7- PLCSIM Advanced**, **WinCC** & test application

- using data exchange over API for automatic testing of function blocks
- testing via customer specific test application
- General test application „S7UnitTest“ for basic automated tests is provided via SIOS:

https://support.industry.siemens.com/cs/ww/de/view/109746405

Simulation of electrical components



With **SIMIT**

- testing logical response of electrical components
- using predefined catalogs including drive communication

Virtual commissioning for production machines

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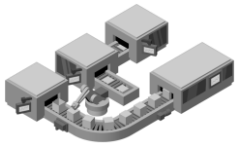
Ingenuity for life

Production line

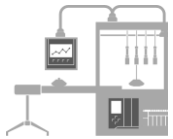


Tecnomatix Plant Simulation

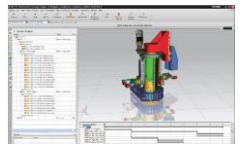
Robotic cell

Tecnomatix Process Simulate

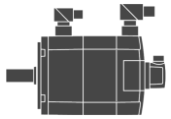
Production machine



NX Mechatronic Concept Designer

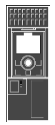


Component physics



Simcenter Amesim

Component communication



SIMIT

Automation

PLCSIM Advanced and WinCC

Virtual commissioning for production machines
Validate Machine Design and Kinematic – Optimize Engineering

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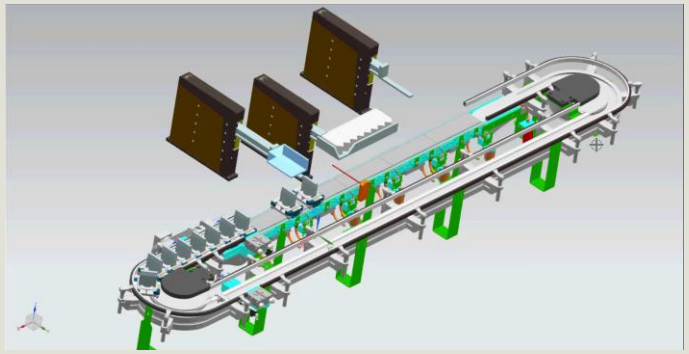
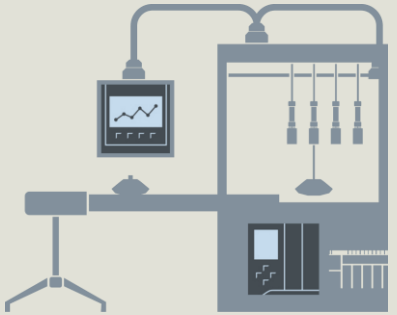
- How does the machine work ? What is the sequence of operations ?
- Is there a risk of collisions ?
- Where should I place a sensor ?
- How should my cam profile look ?
- What happens if I change the mechanical design of the machine ?

Simulation of production machines

With **NX Mechatronic Concept Designer**

- Define and validate the mechatronic concept of the machine directly with the CAD model in the early phases of development
- Enable collaboration by sharing data between mechanical, electrical and automation departments
- Define mechatronic model including kinematic, sensors, actuators, logic and signals
- Reuse standardized mechatronic components for a faster machine design
- Optimize machine design before the first prototype (sequence, traveling path, speed of motors, position of sensors…)
- Connect directly with PLC Hardware or PLC Simulation (PLCSIM Adv.)





Increase In Operation Performance for Production Machines and Machine Tools

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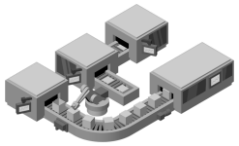
Ingenuity for life

Production line

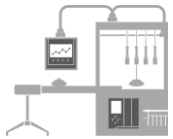


Tecnomatix Plant Simulation

Robotic cell

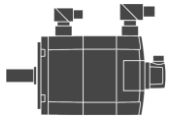
Tecnomatix Process Simulate

Production machine

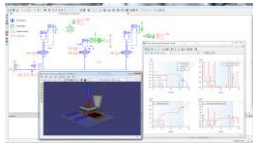


NX Mechatronic Concept Designer

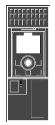
Component physics



Simcenter Amesim



Component communication



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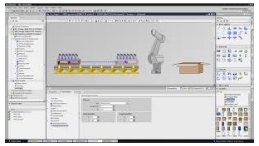
Automation

PLCSIM Advanced and WinCC



Increase In Operation Performance for Production Machines and Machine Tools - Optimize the machine, cell or plant

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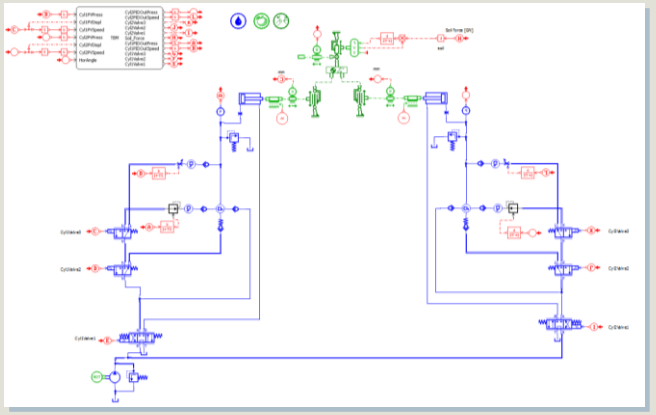
- Is the electric motor powerful enough?
- What is the time response of the system?
- What maximum pressure can be reached?
- Is there any risk of vibration?
- How can I optimize the control parameters of my automation?

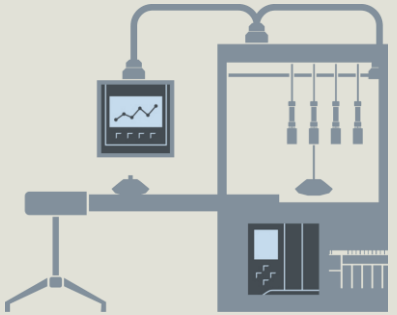
Simulation of components and machine physics

With **Simcenter Amesim**

- Optimization before machine building and during operation
- Size actuators according to performance and consumption targets
- Connect directly with PLC Hardware or PLC Simulation (PLCSIM Adv.)

- In operation simulation for additional information on the current state of the machine and additional safety loops (virtual sensors)
- In operation optimization using the simulation of future machine states
- Validate performances during retrofit phases





Virtual commissioning for production lines

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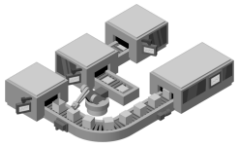
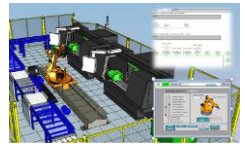
Production line



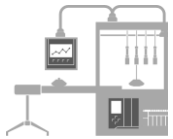
Tecnomatix Plant Simulation

Robotic cell

Tecnomatix Process Simulate

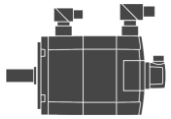


Production machine

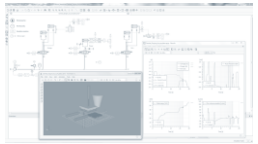


NX Mechatronic Concept Designer

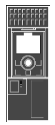
Component physics



Simcenter Amesim



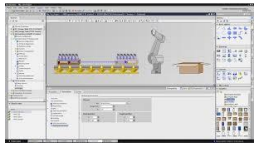
Component communication



SIMIT

Automation

PLCSIM Advanced and WinCC



Virtual commissioning for production lines
Validate Robotic - Optimize Engineering

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- Is the layout of my production cell valid ?
- Can my robot tool reach all the right positions without collisions ?
- What is the cycle time of my production cell ?
- What if a component is failing or a robot stopping ?
- How can I validate my robot code with my automation including safety ?

Simulation of robotic cells

With **Tecnomatix Process Simulate**

- Design production cell layout and validate mechanical sequences
- Create robot trajectories, check collisions and reachability
- Develop and validate complete robot programs using robot controllers
- Verify PLC code together with robot programs and HMI
- Test Safety Interlocks
- Perform System Diagnostic testing
- Validate prior to cell construction

Increase In Operation Performance for Production Lines

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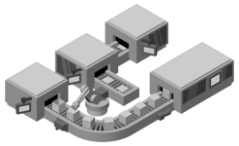
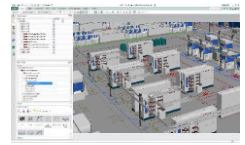
Ingenuity for life

Production line



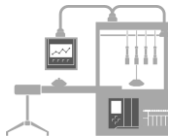
Tecnomatix Plant Simulation



Robotic cell

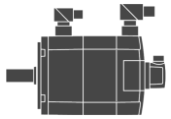
Tecnomatix Process Simulate

Production machine

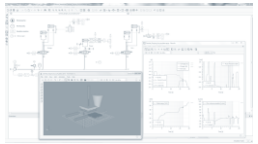


NX Mechatronic Concept Designer

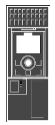
Component physics



Simcenter Amesim



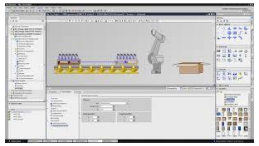
Component communication



SIMIT

Automation

PLCSIM Advanced and WinCC



Increase In Operation Performance for Production Lines - Optimize Material Flow and Line Performances

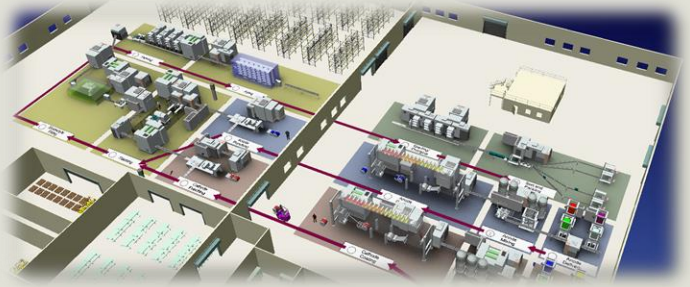
SIEMENS
Ingenuity for life

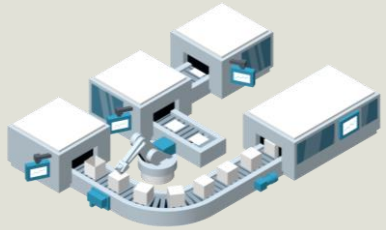
- What is the throughput time of my production line ?
- How much stock do I need and my buffer size ?
- How to optimize the work in progress ?
- What are the best control parameters & strategies ?
- How can I plan the maintenance of different parts of my plant ?

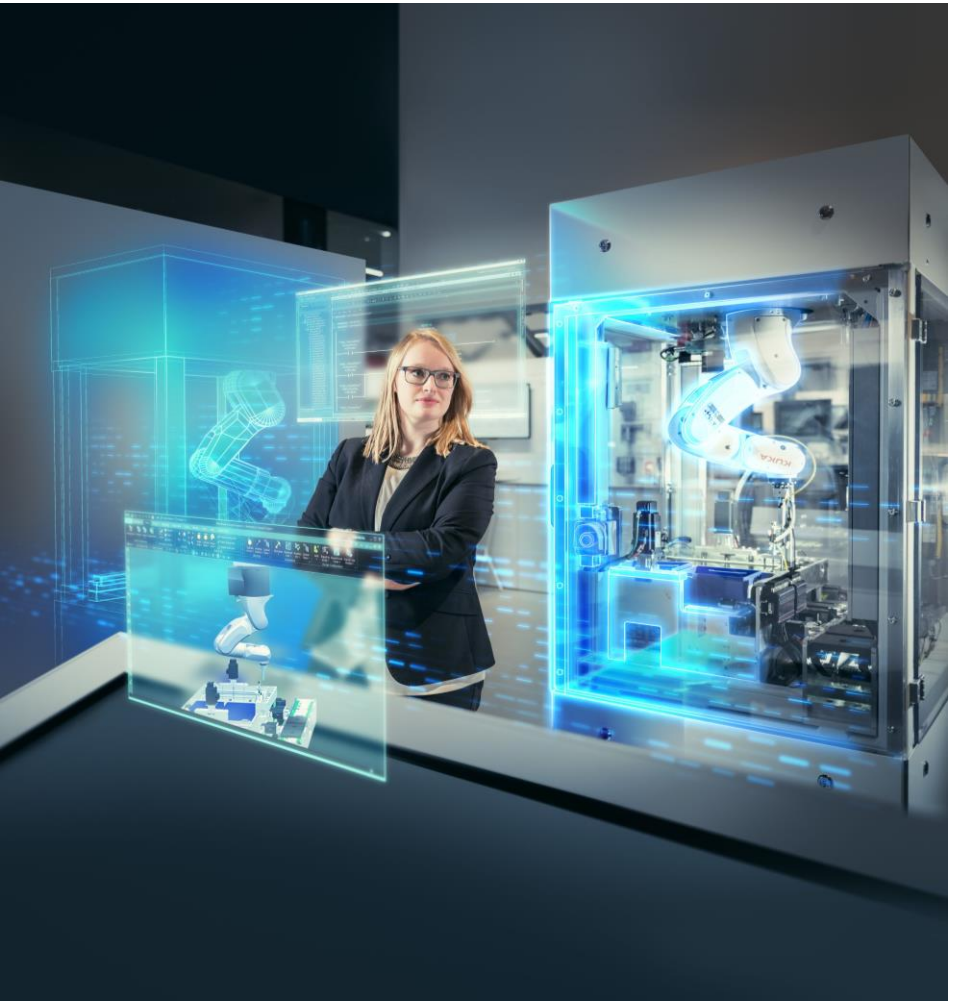
Simulation of production lines

With **Tecnomatix Plant Simulation**

- Validation prior to conveying or AGVs system construction
- Validate material flow and control logic
- Optimize PLC parameters, control strategy and HMI
- Verify conveying unit and head unit level
- Perform system diagnostic testing
- Perform “what-if” scenarios (Failure Modes or Maintenance Modes)
- Operator training







Robert Westlake

Siemens – Application Engineer

robert.westlake@siemens.com

siemens.com