Virtual Commissioning and the Digital Twin for Machine Builders
Colm Gavin – Siemens Digitalization Specialist
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Before we start… A Penny for Your Thoughts

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You have essential requirements

New business models

Speed
Flexibility
Quality
Efficiency
Virtual Commissioning enables parallel work and thus a shorter time to market.
Simulation allows errors to be identified early in the product life cycle

**Six Sigma/Quality Rule**

**Rule of tens**

"The rule of tens says that error-related costs for an unidentified error increase by a factor of 10 from one value-added level to the next. The earlier an error is identified and corrected, the cheaper this is for the organization. (…)"

<table>
<thead>
<tr>
<th>Cost per error</th>
<th>Planning</th>
<th>Development</th>
<th>Startup</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>$1</td>
<td>$10</td>
<td>$100</td>
<td>$1000</td>
<td></td>
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**Conclusion**

The quality of the engineering project must be increased as early as possible in the product life cycle!

1) This assumes that the error would otherwise not be detected until operation

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Virtual Commissioning - lowers the risks for real commissioning

Without Virtual Commissioning
Unexpected problems increase:

- Time requirements
- Personnel requirements
- Materials requirements

And when international projects are involved ... = Incalculable costs

With Virtual Commissioning
Problem scenarios are known from Virtual Commissioning

Best case: Cause of error eliminated
- Sequence of operations verified
- Personnel are trained before machine is built
- Use digital twin for promotional purposes

Calculable costs =
Simulation at every level

Real World

Virtual World

Machine Cell Plant

Virtual Machine Cell Plant

Sensors & Actuators

Virtual Sensors & Actuators

Controller

Virtual Controller

HMI

Virtual HMI
Simulation at every level
You have specific challenges

- Production line
- Robotic cell
- Production machine
- Component physics
- Component & Periphery
- Automation

Tecnomatix Plant Simulation
Tecnomatix Process Simulate
NX Mechatronic Concept Designer
Simcenter Amesim
SIMIT
PLCSIM Advanced & WinCC
With PLCSIM or PLCSIM Advanced, customers can check their control program in a virtual way.

Validation of control logic and visualization:
- PLCSIM
- PLCSIM Advanced
- HMI simulation

Validation of interaction between controller and mechatronics of a machine:
- PLCSIM Advanced
- NX MCD
- SIMIT (for synchronous motion)

Validation of interaction of various components in a cell, line or plant:
- PLCSIM Advanced
- Simulation software, such as TECNOMATIX Process Simulate and TECNOMATIX Plant Simulation

Workflow Level:
- PLC/HMI simulation
- Machine simulation
- Cell/Line/Plant simulation
SIMATIC PLCSIM Advanced is the virtual controller of SIMATIC S7-1500

Benefit: Comprehensive simulation of controller functionality

A virtual controller
… for extensive function simulation including communication, know-how protected blocks, Safety and web server

Includes a documented public interface
… for exchange of data (I/Os, bit memory, DBs, timers) with customized co-simulation or test software

Support of multiple and distributed instances
… for simulation of multiple controllers on a PC/in the network

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The right co-simulation is determined by the application

Benefits of PLCSim Advanced:

- With the Application Programming Interface (API) in PLCSim Advanced, this allows for a software in the loop, high speed, synchronous communication of the I/O from the virtual PLC to the modelling software (under 5ms)
- There are NO changes to the PLC code required when switching from the virtual PLC to the real PLC at a later time.
- PLCSim Advanced also allows you to test the safety logic
Integration of PLM and TIA: Merging mechanical and automation engineering

Mechanical model

Software in-the-loop

Automation

3D Model (e.g. from SolidWorks, AutoCAD, CATIA, NX, etc.)

PLCSIM Advanced

Totally Integrated Automation Portal
NX Mechatronic Concept Designer

How will the machine work?

- Machine sequence
- Cam plates
- Cinematic description
- Control signals
- 3D basic geometry
- Sensor-actuator lists
- Reference designation
- Force/load profiles
Kinematic validation
Virtual commissioning with Mechatronic Concept Designer

Features
• Define mechatronic model including kinematic, sensors, actuators, logic and signals
• Connect directly with PLC Hardware or PLC Simulation (PLCSIM Adv.)
• Share data between mechanical, electrical and automation departments

Benefits
• Reuse standardized mechatronic components for a faster machine design
• Define and validate the mechatronic concept of the machine directly with the CAD model in the early phases of development
• Optimize machine design before the first prototype is even built (sequence of operations, CAM profiles, speed of motors, position of sensors, correct gear ratios, operator training)
Digital Twin

- Concept design with NX MCD of a filling machine for syringes
- Further reuse of the digital twin for NX CAD up to virtual commissioning

Benefit

- Faster development through early concept verification
- Increased flexibility and productivity
- Lower the engineering effort by 30%

“Our driver for Digitalization is our conviction that it will bring added value to the customer”

Dr. Hagen Gehringer
CEO
Bausch + Ströbel, Ilshofen

Bausch + Ströbel – the digital twin allowed for faster realization of customer demands, and reduced engineering effort by 30%
SN Maschinenbau – using a digital twin cut commissioning time by 50%

Digital Twin
• Concept design with NX MCD of a form, fill and seal machine
• Developed a digital twin that illustrates each individual part in dynamic operation

Benefit
• Saved one week spent at customer site, reducing actual commissioning time by 50%
• Increased flexibility and productivity
• Allowed for earlier operator training at end customer
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