Digitalization in Machine Engineering

Siemens MCD and Cadenas smart catalog components
Siemens MCD and Cadenas smart catalog components

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- Overview: Interdisciplinary engineering of machinery and equipment with the Mechatronics Concept Designer

- Early mechatronic simulation in the design and development with support from CADENAS SmartParts

- Reuse of simulation objects and "smart" catalog parts

- Virtual commissioning with the Mechatronics Concept Designer
Complexity, globalization, customization and Compliance - Decisive factors for change in industrial machines

Complexity is the new standard in industrial engineering

New providers with low cost structures generate global competition

Customization is the New Formula for Success in the Global Pharmaceutical Packaging Market

The demand of the end users for customized products

The pressure by law affects many aspects of industrial engineering
### Increased pressure to innovate to component suppliers while maintaining profitability and satisfy delivery expectations

#### Complexity
- Change of Configure-to-Order (CTO) for Engineer-to-Order (ETO) increases complexity
- All software in the machine increases product complexity
- A higher number of product types makes the reuse of knowledge difficult

#### Globalization
- Global design, local manufacturing: Customers have individual demands on the configuration
- Increasing process complexity
- To maintain the competitive edge, products must be innovative

#### Customer specific obligations
- Demand for adaptation of standard deals
- Fewer opportunities for reuse of previous constructions
- Better management of customer requirements

#### Legal regulations
- Higher complexity of structures to ensure compliance
- Not for sale to markets without compliance; Risk of legal action
The situation in industrial engineering

TREND:

Complexity is the new standard in industrial engineering

Industry 4.0: The German government has provided € 200 million to support industry associations, research institutes and companies in the development of an implementation strategy for industry 4.0.
The Evolution of Industry 4.0 in production

First Industrial Revolution
based on the introduction of mechanical production equipment driven by water and steam power

Second Industrial Revolution
based on mass production achieved by division of labor concept and the use of electrical energy

Third Industrial Revolution
based on the use of electronics and IT to further automate production

Fourth Industrial Revolution
based on the use of cyber-physical systems

Source: DFKI (2011)
The influence on the companies

• **CONSEQUENCES:**

• Machines must be smarter.

• Machine users need more functionality in the machine.

• Machines must be networked to manage performance and service at all times.

• The machine complexity increases in areas that are new for machinery OEMs.

• There is more system information required (self-diagnostics, communication).
Objectives for an intelligent machine development with increasing complexity

- More control
- Simpler service
- Efficient designing
- Fewer risks
Topics to manage complexity

- Modularization
- Service Engineering
- Interdisciplinary collaboration
- Virtual Commissioning
Current Industrial engineering challenges

If this is "just" a loading door?

Solutions never refer exclusively to the mechanics!
Integrated Engineering (Machine Design) reduces the time from the first idea to the Machine

Siemens products already support modern development methods today
Integrated Engineering (Machine Design) reduces the time from the first idea to the Machine (Authoring systems)
Integrated Engineering (Machine Design) reduces the time from the first idea to the Machine Commissioning.

- Microsoft Office Integration
- Easy to use
- Simple structure of the product requirement and specifications
Integrated Engineering (Machine Design) reduces the time from the first idea to the Machine

- Requirements directly linked to the product structures
- Changes are tracked in all disciplines
Interdisciplinary Conception
Acquiring interdisciplinary aspects from the beginning

How should the machine work?

Operations

Motion Control

Mechanical

Reusing older components

Actuators

Sensors
Creation of a mechatronic concept with the MCD
Using CADENAS Intelligent catalog parts in the design

Using CADENAS Intelligent catalog parts in the design

• Directly in the engineering / conception software MCD or NX

• The Intelligent catalog items are considered as full-reusable parts in NX / MCD

• Editing of the catalog parts possible directly by right-clicking

→ Fast, Simple and with less change effort than before
Mechatronic Concept as a data source
Generating information for the following engineering disciplines

What data is provided from the Mechatronic Concept?

- Machine sequence
- 3D Geometry
- Electrical Cams
- Sensor-Actuator Lists
- Path-Time Charts
- Reference Designations
- Control Signals
- Force / Load Profiles
Stages of the simulation in the Conception
Continuous refinement of Concepts and Simulation

Simple Sequence

Detailed Sequence

Refined Sequence

Komplex Sequence

- Mechatronic simulation during design phase
- Validating the design idea
- Presentation
- Data basis for all derivatives
Integrated Engineering (Machine Design) reduces the time from the first idea to the Machine

- Requirements transparent in design disciplines
- Changes are Traceable
- Mechatronic simulation during design phase
- Validating the design idea
- Presentation
- Data basis for all derivatives

• Electrical / Fluid
• Mechanical
• Automation
• Real Machine Commissioning
Mechatronic Reuse Wizard
Replace the concept geometry with detailed mechanism
Design Alternatives

- Different design alternatives can easily be simulated
- Simulation instead of an animation

- Evaluating the options in the individual disciplines now much easier possible
Siemens Tool-Integration: NX/MCD – SIZER Interface

Transfer of 3D CAD data
Or Select fitting component from other product catalogs

Motor Library

3D-CAD

Force / Torque Data

Dimensioning of drive systems
Integrated Engineering (Machine Design) reduces the time from the first idea to the Machine Commissioning.

- **Requirements transparent in design disciplines**
- **Changes are Traceable**
- **Mechatronic simulation during design phase**
- **Validating the design idea**
- **Presentation**
- **Data basis for all derivatives**
- **Benefits of 3D design data**
- **Multi CAD functionality**
- **Behavioral model with logic, mass, acceleration-conditions, collisions ...**
MCD Schnittstelle ins ECAD
Einheitliche Datenbasis im ECAD und MCAD

Mechanical

1FT7108

Communicaton

==A1+F2-G1-M2

ECAD

1FT7108

==A1+F2-G1-M2

Electrical
Integrated Engineering (Machine Design) reduces the time from the first idea to the Machine

- Requirements transparent in design disciplines
- Changes are Traceable
- Mechatronic simulation during design phase
- Validating the design idea
- Presentation
- Data basis for all derivatives
- Benefits of 3D design data
- Multi CAD functionality
- Behavioral model with logic, mass, acceleration-conditions, collisions ... 
- Bi-directional Interface between ECAD and MCAD of sensors and actuators
- Device designations consistently across all derivatives
Communication of the machine sequence to the Automation department
Exporting timing chart and the Sequence Function Chart from the Sequence Editor

- Easy to use Sequence Editor (Gantt Chart)
- Export Chart of Operations (Timing Chart)
- Export of the SFC (Sequence Funktion Chart) as PLCOpenXML
Integrated Engineering (Machine Design) reduces the time from the first idea to the Machine

- **Requirements**
  - Requirements transparent in design disciplines
- **Mechatronic Concept**
  - Mechatronic simulation during design phase
  - Validating the design idea
  - Presentation
  - Data basis for all derivatives
- **Virtual Commissioning**
  - Benefits of 3D design data
  - Multi CAD functionality
  - Behavioral model with logic, mass, acceleration-conditions, collisions ...
  - Bi-directional Interface between ECAD and MCAD of sensors and actuators
  - Device designations consistently across all derivatives
  - Verification of test cases on digital twin
  - Early test of modules and code
  - Consistency: work on the real CAD data!
Virtual Commissioning (VC)

**Challenges**
- Prototypes are expensive and time consuming to manufacture.
- Changes in commissioning phase are very expensive.
- Non-operational machines in the workshop cost money.

**Main Benefits**
- Verify and validate system behavior
- Optimize automation program and prepare physical Commissioning
- Validate machine variants and options, for which no prototypes were created
VC with the Mechatronic Concept Designer

Virtual Commissioning (VC)
- HiL (Hardware in the Loop)
- SiL (Software in the Loop)

Motivation for Virtual Commissioning
- Real machine is not available
- Real commissioning is incalculable
- Concept errors usually appear at Commissioning
- Customer requirements are usually not available in detail
- Testing the program processes in the early phase

Digital Model (Digital Twin) → Real Controller → Real Machine
Interaction in the VC

Digital Model  <->  Behavior Model  <->  Real Controller

NX / MCD

SIMIT

PLCSim  <->  Simatic

SINUMERIK

Simotion

Various...

Real Controller
Applications for machine construction
Design, Configuration and Validation of the product idea

Mechatronic Concept

Mechanical Design

Electrical / Automation

Virtual Commissioning
Integrated Engineering (Machine Design) reduces the time from the first idea to the Machine

Digital Twin

The digital Twin enables:
... that the Product Requirements are met
....up to date Information in all disciplines
... manageable complexity

► Shorter innovation cycles
► Productivity improvements

• i-directional interface between ECAD and MCAD of sensors and actuators
• Device designations consistently across all derivatives
• verification of test cases on digital twin
• Early test of modules and code
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Digital Twin enables:
... up to date Information in all disciplines...

► Shorter innovation cycles
► Productivity improvements

Real Machine Commissioning Service

Virtual Commissioning
• verification of test cases on digital twin
• Early test of modules and code
• Consistency: work on the real CAD data!
Thank you!

Viktor Braun

Siemens Industry Software GmbH
Digital Factory Division
Product Lifecycle Management
PreSales
Liebknechtstr. 35
70565 Stuttgart, Germany
Tel. : +49 (711) 47099 137
Fax : +49 (711) 47099 199
Mobile : +49 172 3565158
braunviktor@siemens.com
www.siemens.com/plm