Balance productivity and energy-efficiency of industrial machinery and processes

LMS Imagine.Lab

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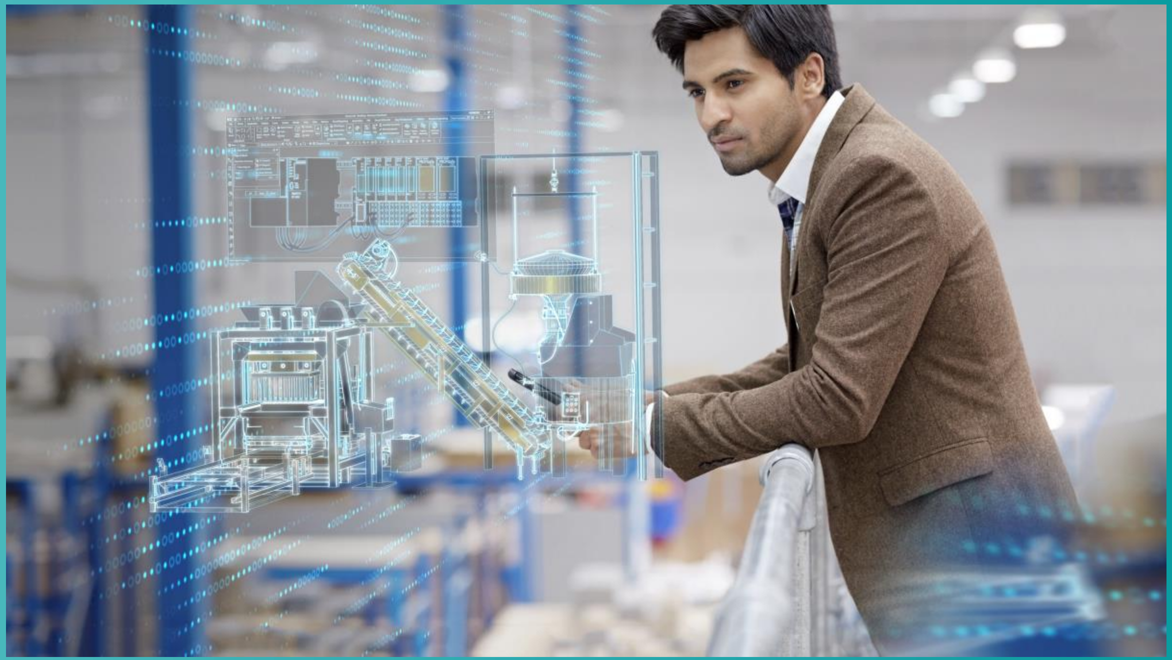
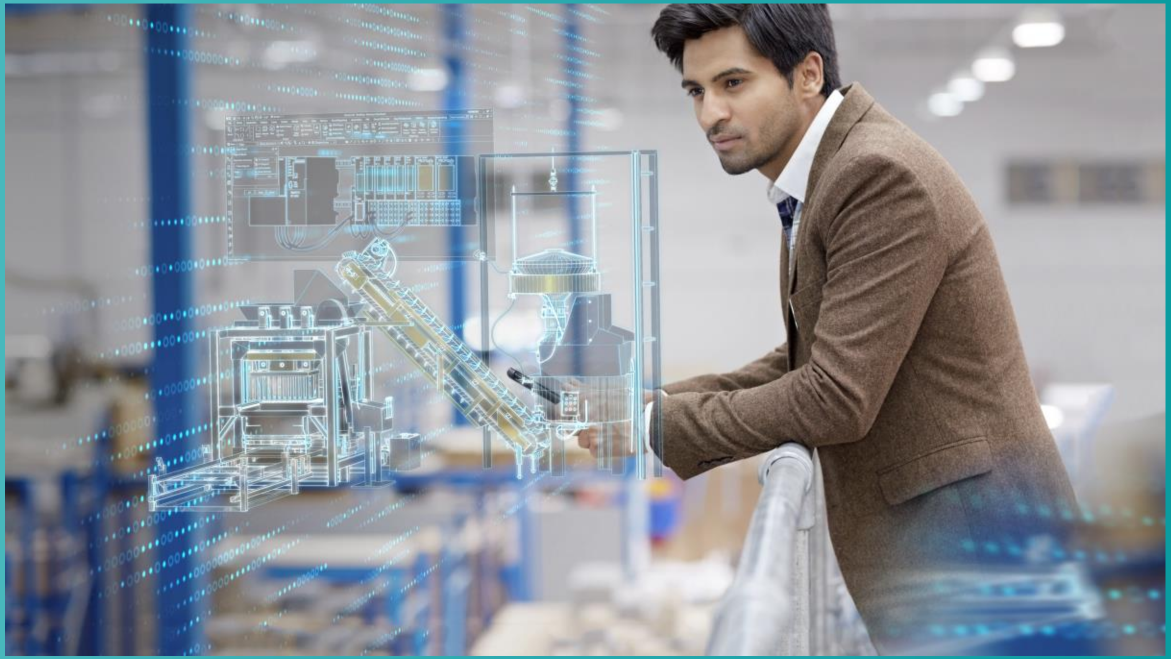
Agenda



- The industrial machinery industry is evolving
- Model-based systems engineering for industrial machinery applications
- The voice of our customers
- Conclusion

Agenda



- The industrial machinery industry is evolving
- Model-based systems engineering for industrial machinery applications
- The voice of our customers
- Conclusion

The industrial machinery industry is evolving

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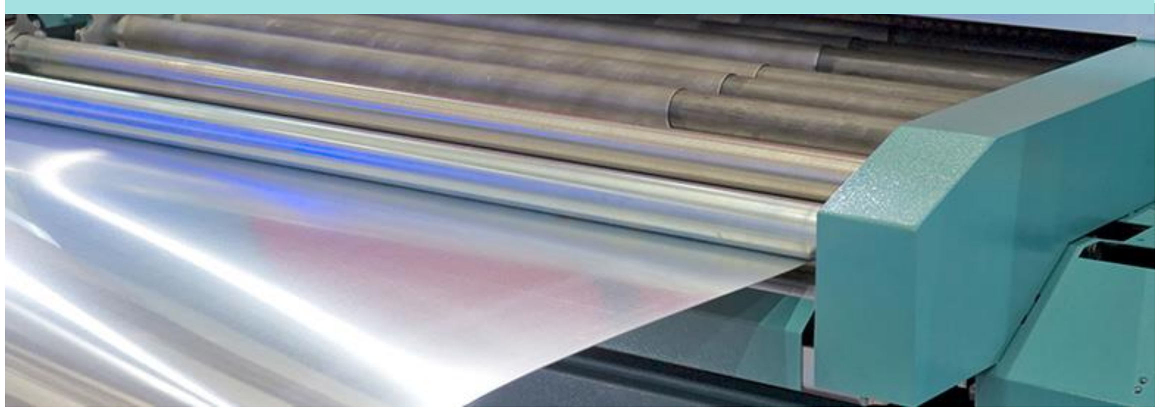
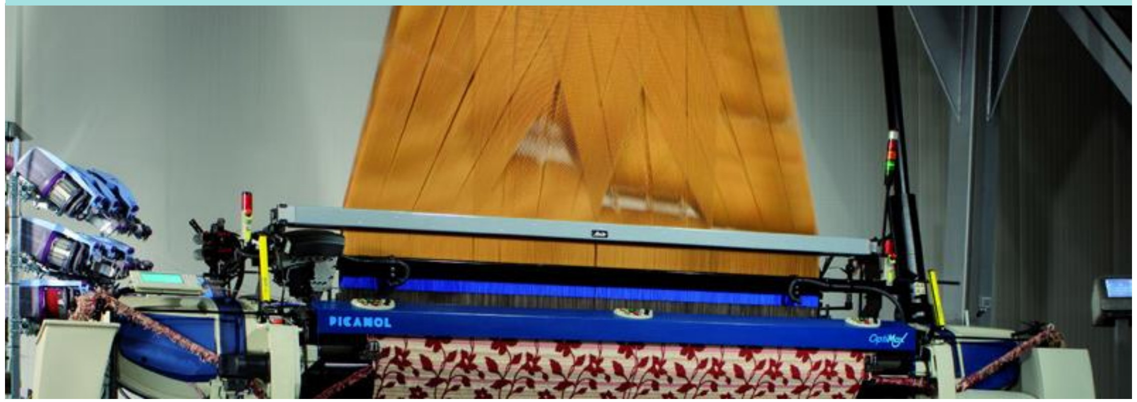
Productivity and reliability



Worldwide race for innovation



Energy efficiency

Optimize in-operation performance

Which implications for industrial machinery systems design?

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Productivity and reliability

- Optimize sizing of actuators and PLC code according to performance targets
- Check that vibrations are not introduced by actuator/structure coupling

Worldwide race for innovation

- Develop new machine: reduce the global time and cost of the development, limit the commissioning phase
- Retrofit of machines, migration to new controller: reduce the pause of production, reduce the risks

Energy efficiency

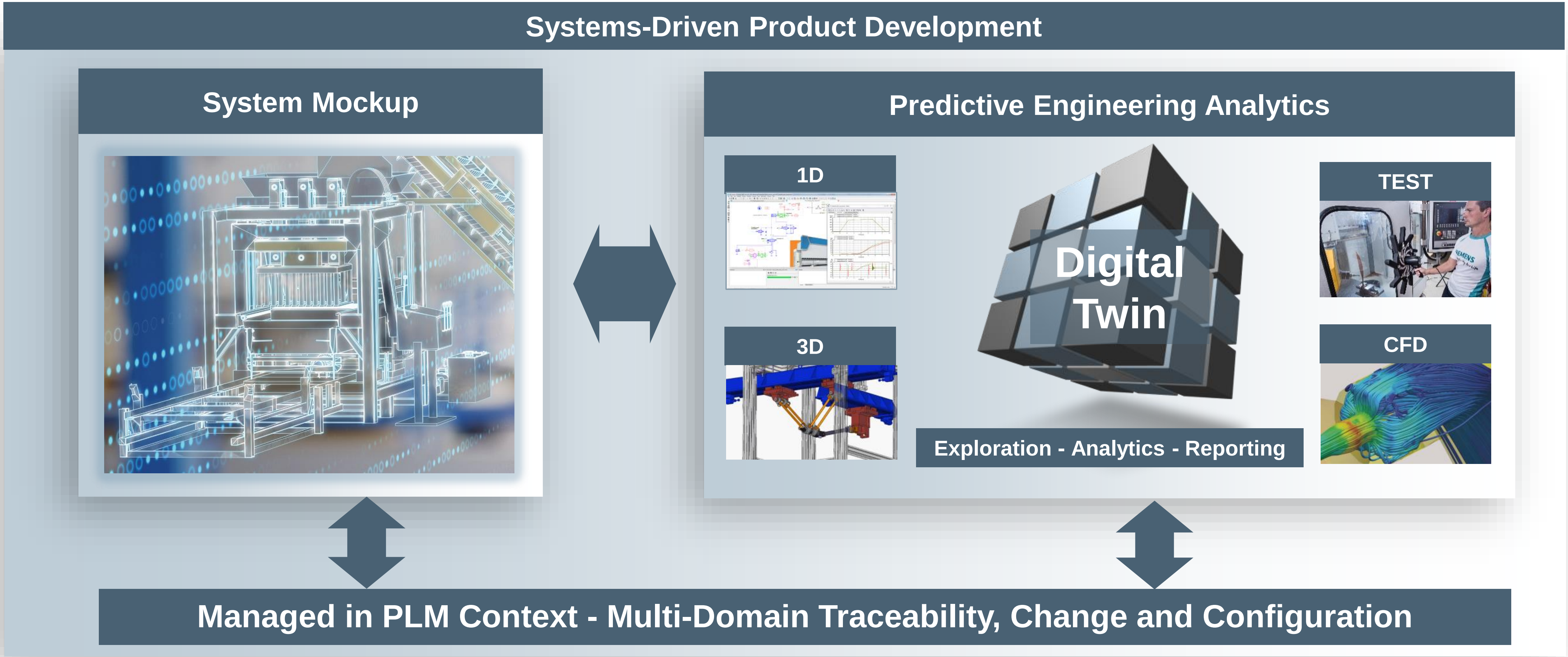
- Develop jointly subsystems (actuators, mechanisms, thermal…) and PLC code considering energy consumption targets
- Track energy losses and propose component or subsystem modification

Optimize in-operation performance

- Propose (decision support) or do (close-loop control) modification of the operating condition
- Detect the deviation of components/systems performances with the normal operations

Predictive Engineering Analytics

Role in Systems-Driven Product Development



Introducing Simcenter Portfolio for Predictive Engineering Analytics

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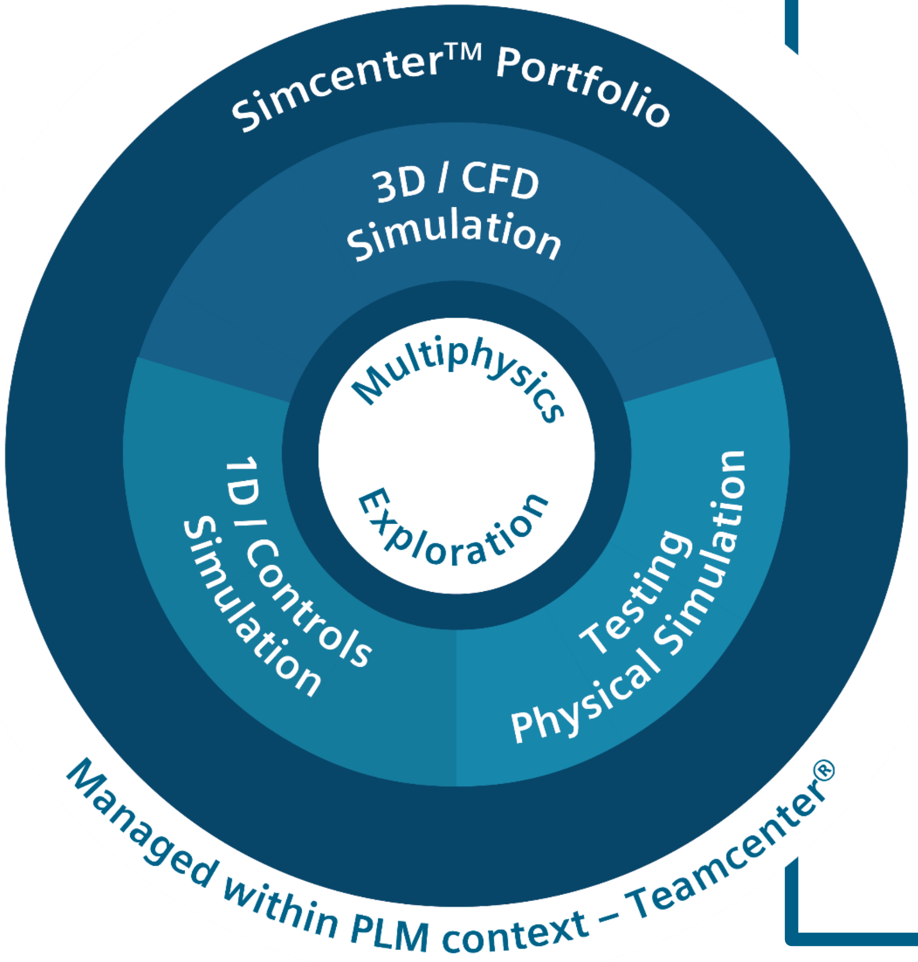

Simcenter™

Simcenter™ Portfolio for Predictive Engineering Analytics

LMS Imagine.Lab

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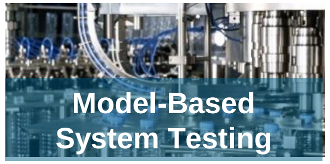


Industry specific

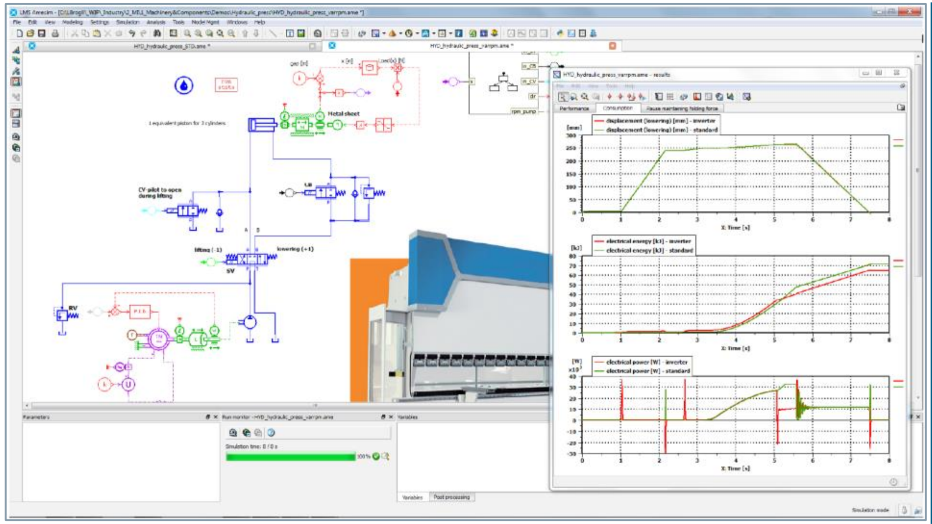
- Internal Combustion
- Transmission
- Thermal Systems
- Vehicle Dynamics
- Electrical Systems
- Engine Equipment
- Fuel Systems
- Pumps & Compressors
- Electro-Hydraulic Valves
- Fluid Actuation Systems
- Heat Exchangers
- Heat Pumps / Refrigerators

Pre-Design

Systems Sizing & Integration

Performance Balancing

Controls Validation

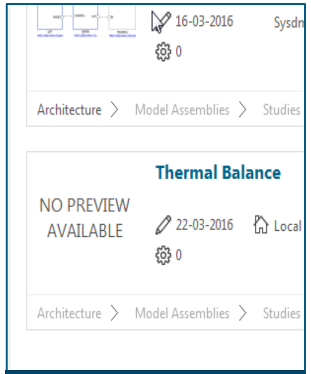


Scalable Simulation

Connecting "Mechanical" – "Controls"

Model reduction for real-time

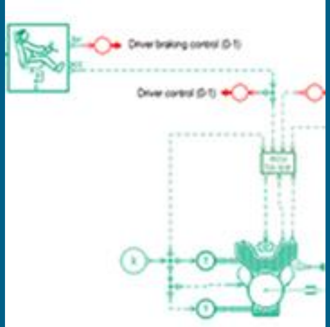
Open & Customizable

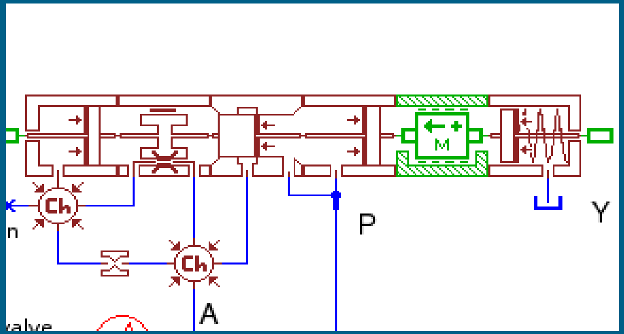


Process & Data Management

>30 Libraries

>4,000 Multi-physics Models





Hydraulics
Pneumatics
Thermal
Electrical
Mechanical
Signals

Engineering services – LMS & CD-adapco

Experience and global talent for valued customer partnerships

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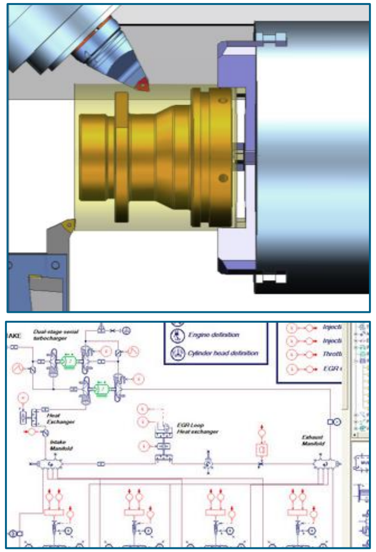
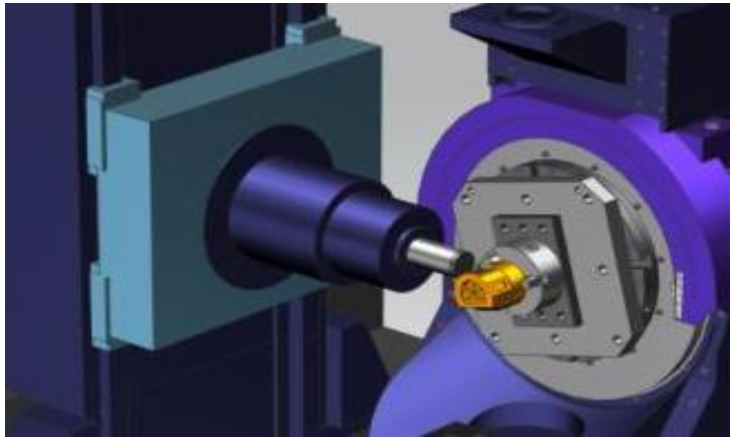
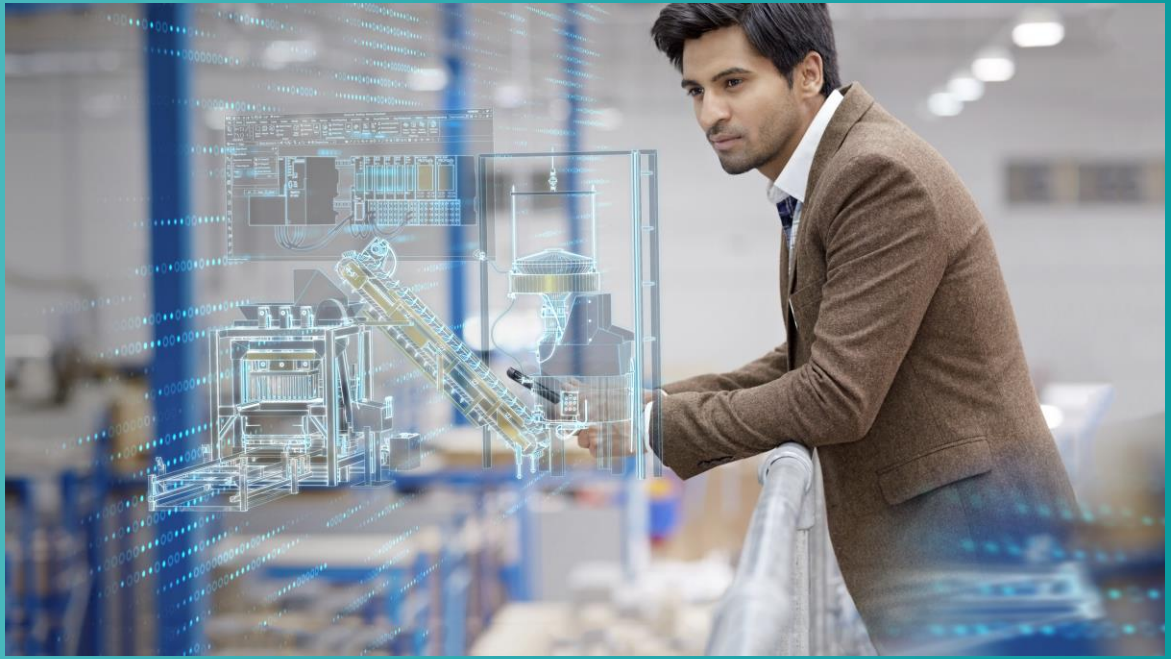


LMS Engineering



CD-adapco Engineering

Agenda



The industrial machinery industry is evolving

Model-based systems engineering for industrial machinery applications

The voice of our customers

Conclusion

Size multi-domain systems

Increase speed without loosing accuracy and reliability, reduce energy consumption

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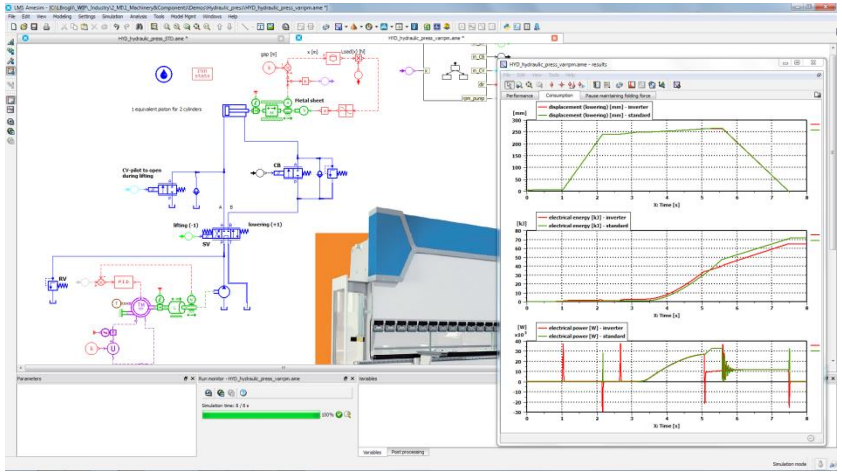
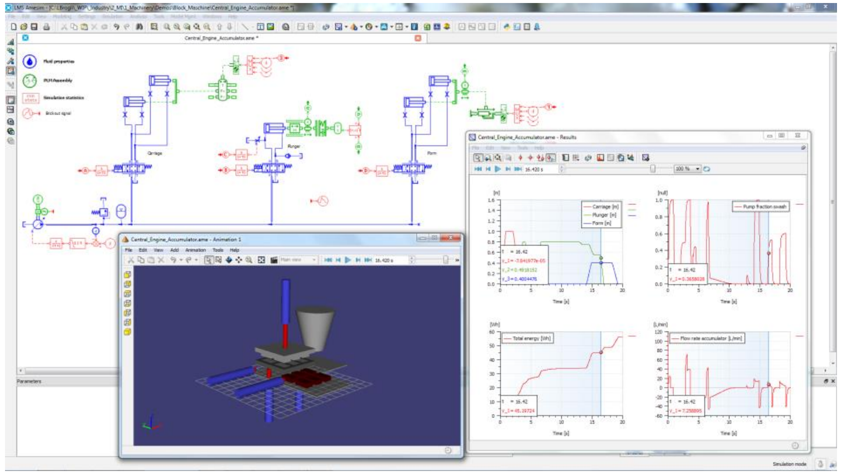
- Simulate the transient behavior of multi-domain system to estimate the **cycle duration, check that vibrations will not be introduced** that may affect quality and reliability, estimate **heat exchanges**

- Simulate the energy exchanges in the machine to **track energy losses** and **optimize existing systems** and **develop new energy efficient ones**

- Physics simulated:
  - **Mechanisms**: from 1D to 3D
  - **Fluids**: hydraulic, pneumatic and two-phase
  - **Electrical**: motors and inverters
  - **Thermal**: heat generation and cooling

- Energy and losses: for each physical domain, **losses can be** either **predicted or** defined as a **parameter**





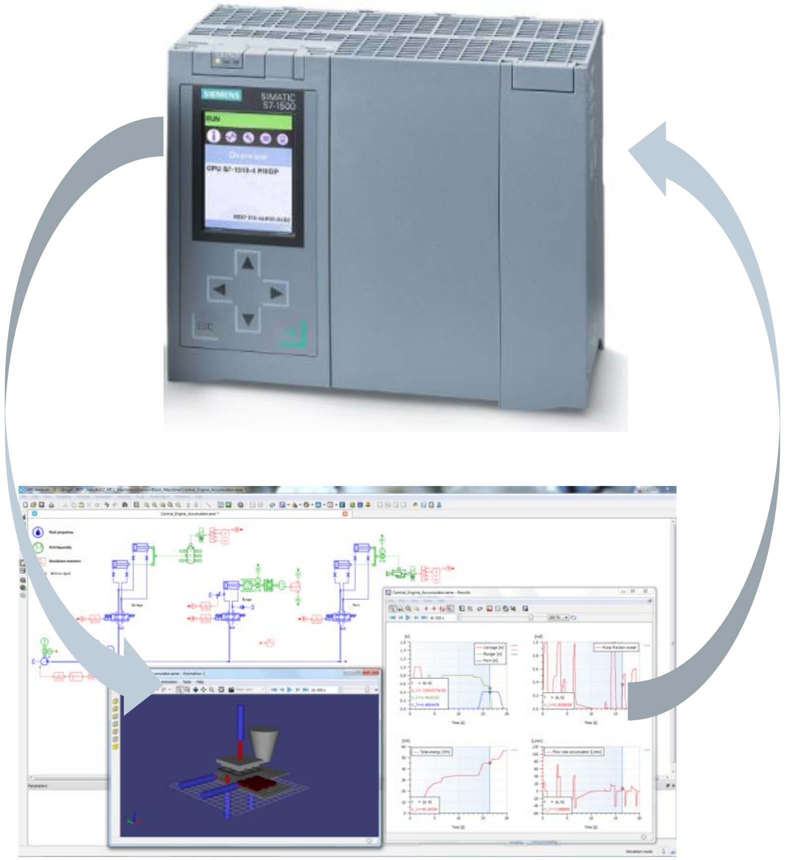
Validate and calibrate PLC programs

Reduce the total time and cost of the development of industrial machines/processes

- Simulate de transient behavior of the multi-domain systems of the machine and couple with the automation code (SIL) and real PLC (HIL) to **evaluate the impact of PLC code modification on general and energetic performances of the machine**

- Case 1: Development of a new machine
  - Reduce the global time and cost of the development
  - Limit the commissioning phase

- Case 2: Retrofit of the machine, migration to new controller
  - Reduce the pause of production
  - Reduce the risks



LMS Imagine.Lab value proposition

- Perform multi-domain systems sizing
- Simulate transient behavior and ensure quality and reliability over a cycle duration
- Validate and calibrate PLC programs using a model of the machine
- Spotlight the sources of loss and high consumption for design improvement

Examples of typical applications

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1. Improving the energy consumption of a press brake

2. Optimizing the energy consumption of an electric winch

3. Virtually commissioning using system simulation

Examples of typical applications

1. Improving the energy consumption of a press brake

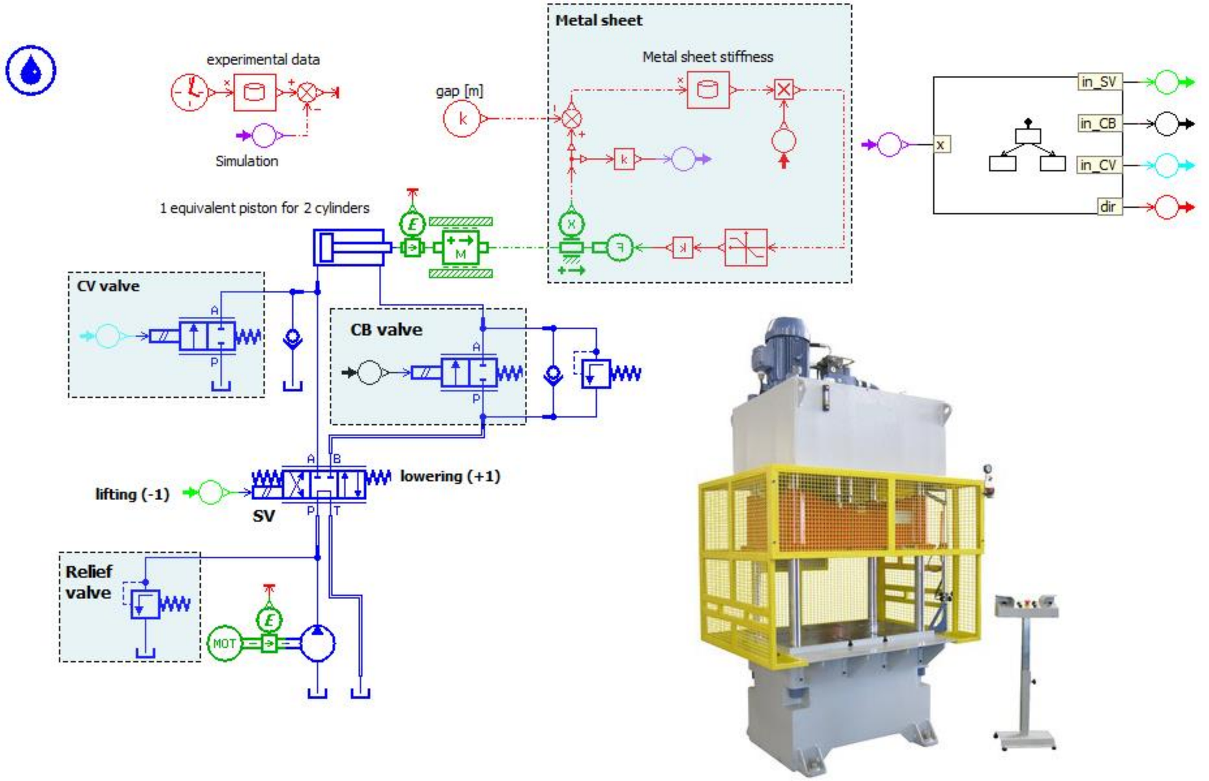
2. Optimizing the energy consumption of an electric winch

3. Virtually commissioning using system simulation

Application #1
Improving the energy consumption of a press-brake

Objectives
Simulate hydraulic system of a press brake to proceed to energetic analysis in order to:
- Optimize its energy efficiency
- Maintain its performance

Means
- Pinpoint the energetic losses
- Propose modification
- Check the improvement by simulation



Application #1

Methodology – Analysis

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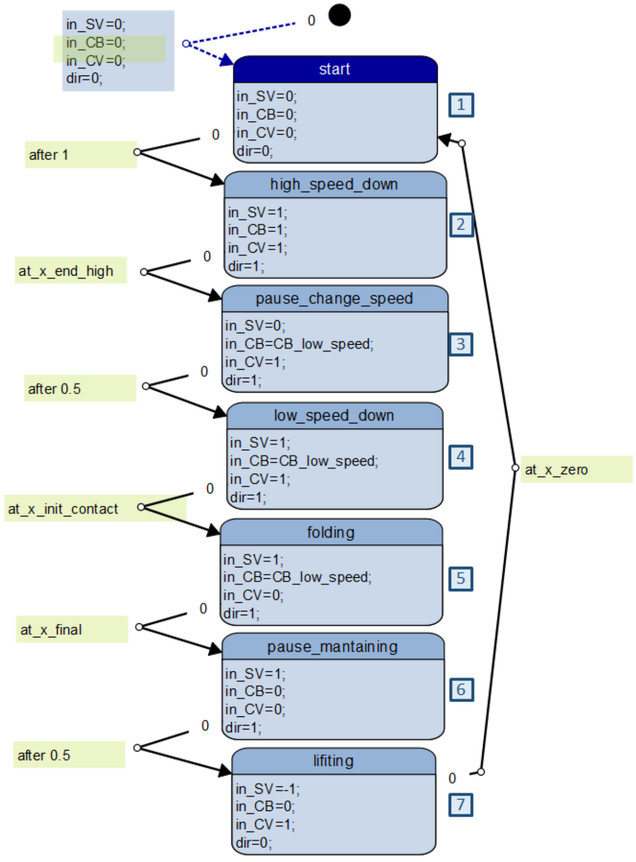
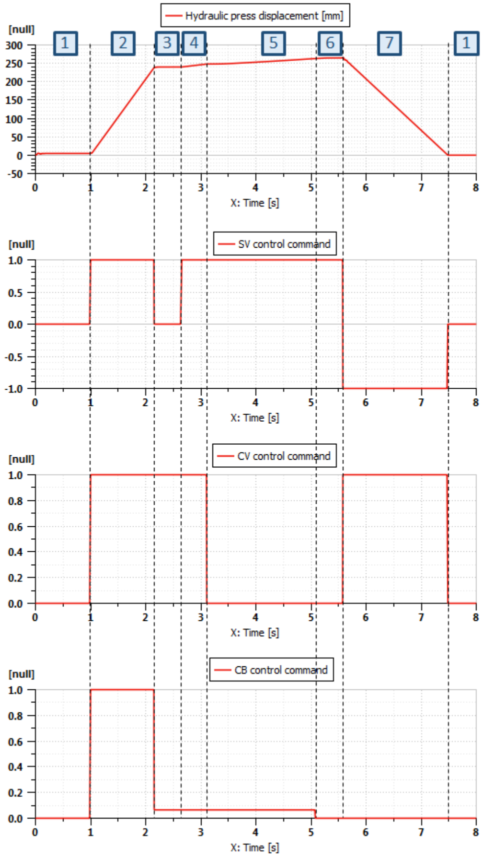
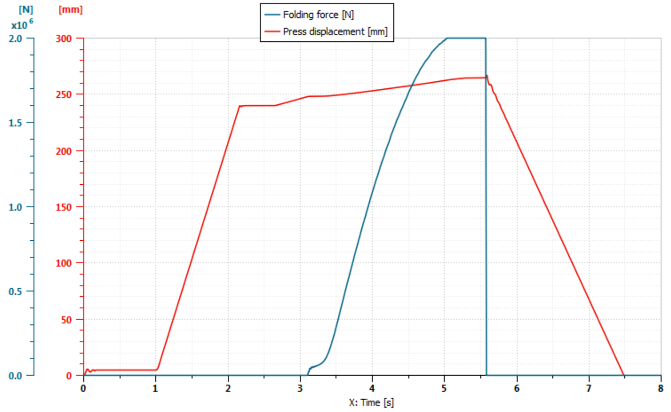
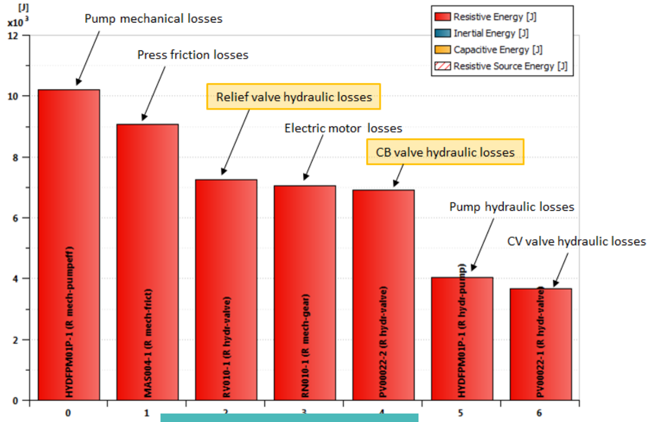




Hydraulic press command inputs



Press displacement and folding force



Energy losses

Application #1

Improving the energy consumption of a press brake

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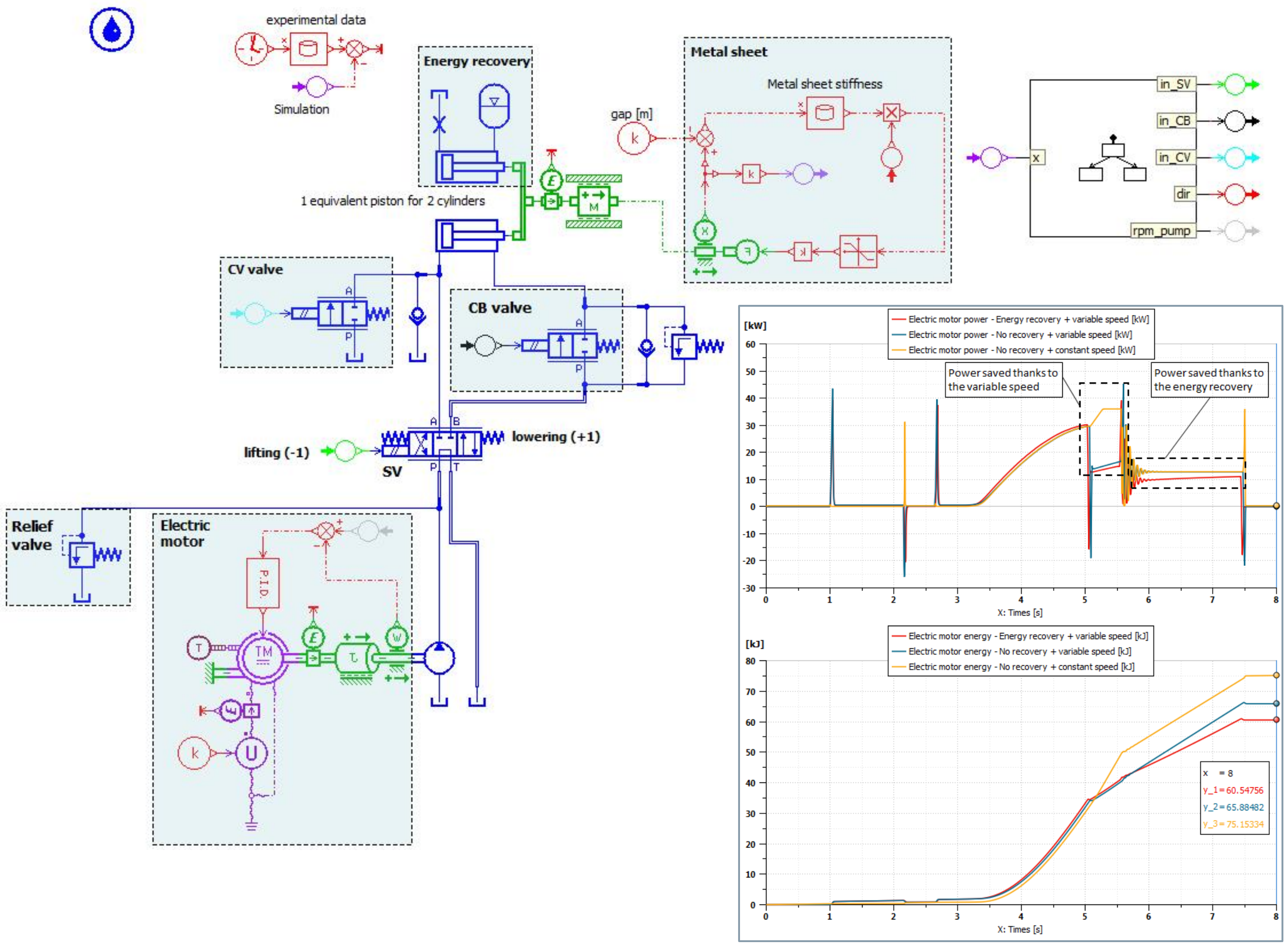
Results

Proposed modification

- Reduce the velocity of the pump during the folding phase using an inverter to improved energy consumption
- Add an accumulator to store energy when hydraulic press goes down

Achievements

- 12% of energy reduction with variable pump speed
- 19% of energy reduction with variable pump speed and energy recovery



Examples of typical applications

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1 Improving the energy consumption of a press brake

2 Optimizing the energy consumption of an electric winch

3 Virtually commissioning using system simulation

Application #2

Optimizing the energy consumption of an electric winch

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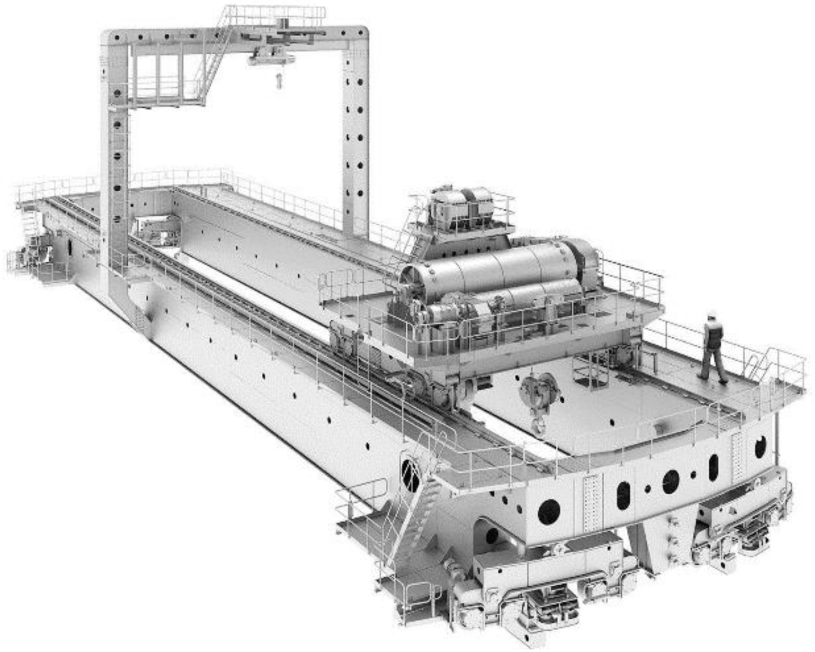
Objectives

Support the system development process, by answering the following questions:

- What is the **power rating** required for my motor?
- How to fine tune its torque / motion **control** considering time response and energy consumption targets?
- Is the motor correctly **protected** against power supply variations?
- What will be the **movement** of the payload?



Means

Multi-physics modeling for virtual design, testing, and verification

- Motor control
- Motor internal electrics
- Mechanical components
- Payload vertical movement

Application #2
Methodology – Analysis

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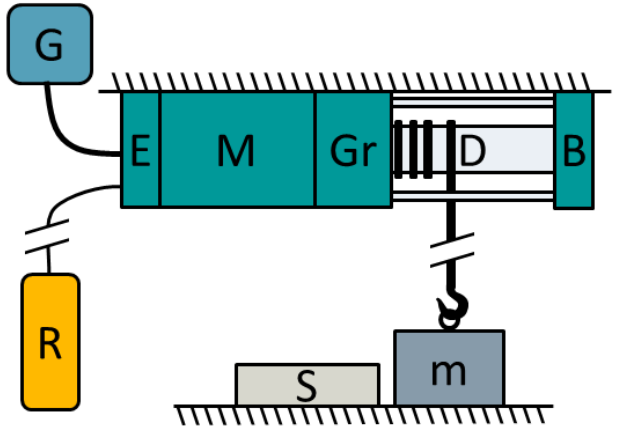
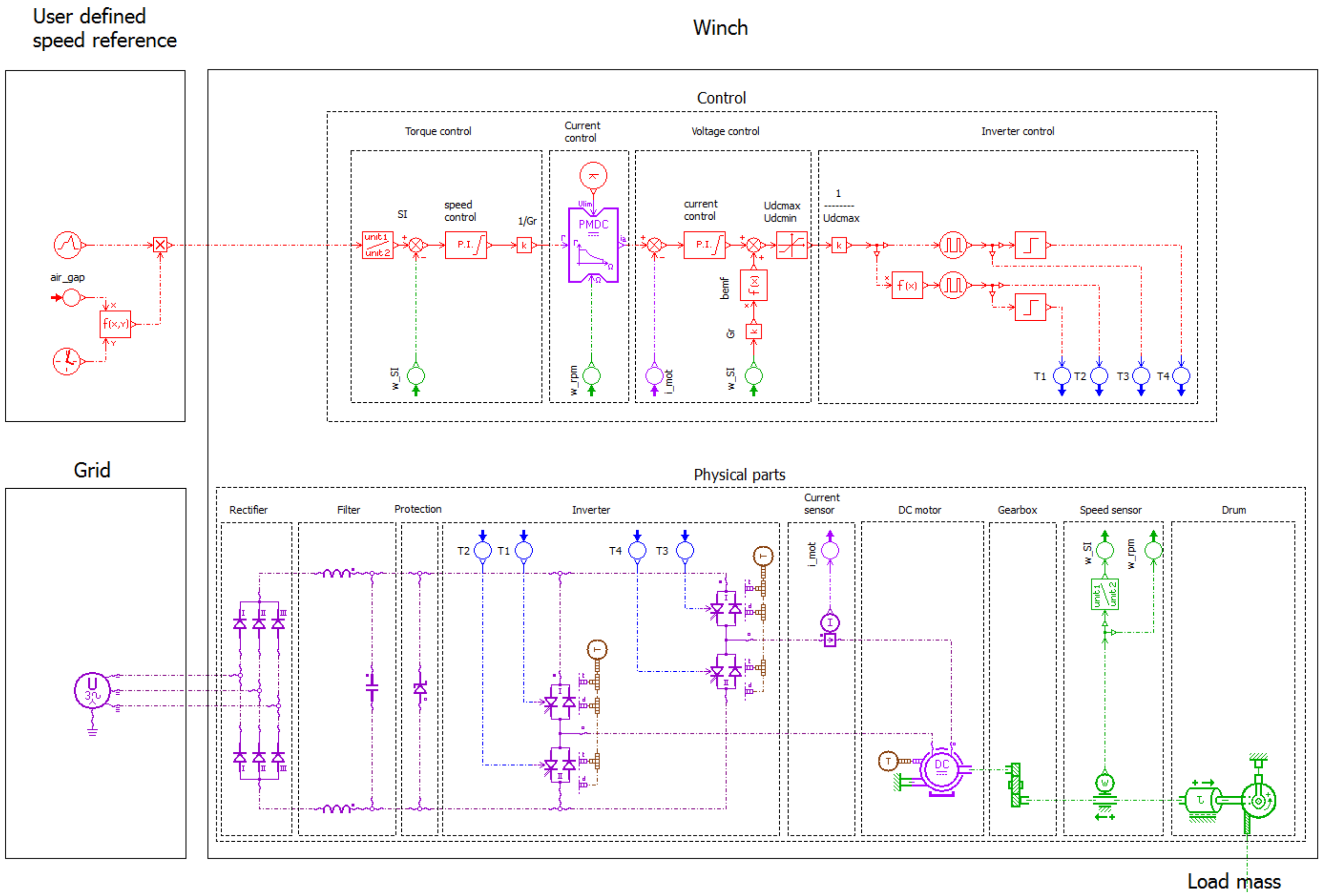


Electric winch: schematic and LMS Amesim model



Application #2

Power electronic parametrization starting from data sheets of the machine control

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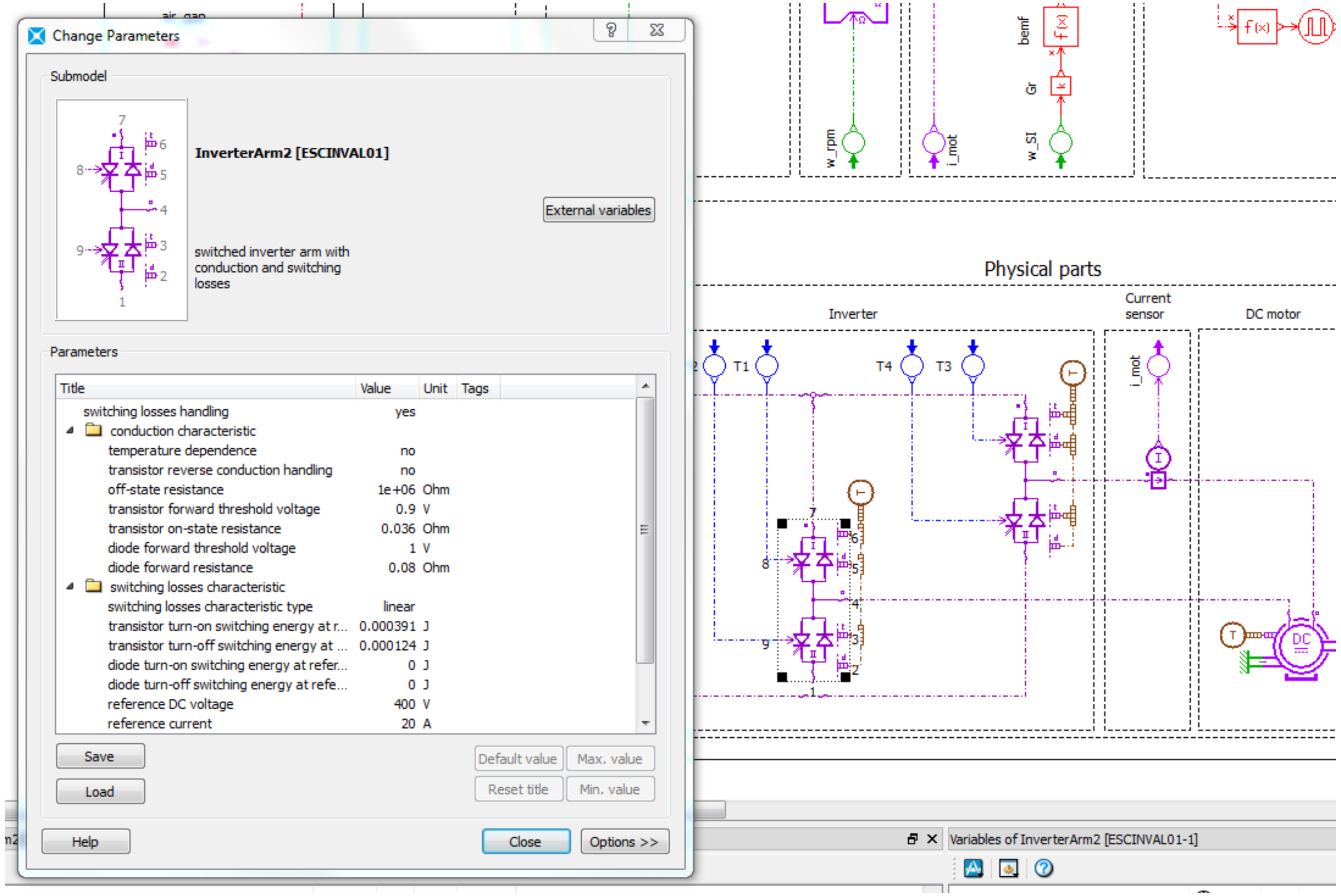

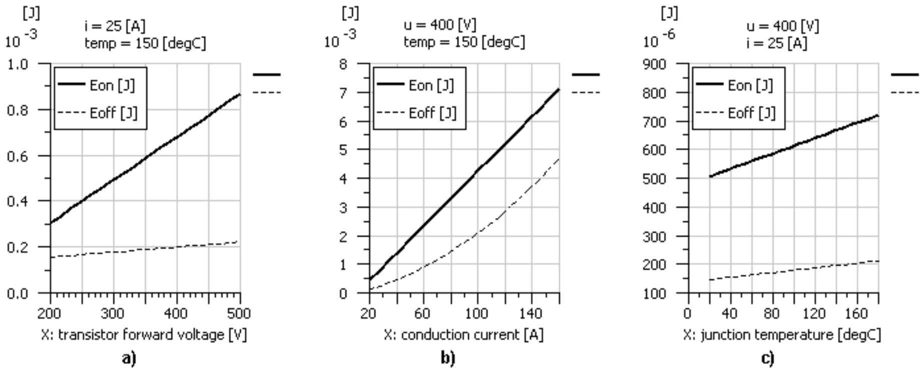

Figure 2: switching energy losses as a function of:
a) forward voltage, with current at 25 [A] and temperature to 150 [degC]
b) conduction current, with voltage at 400 [V] and temperature to 150 [degC]
c) junction temperature, with voltage at 400 [V] and current to 25 [A]

Application #2

Optimizing the energy consumption of an electric winch

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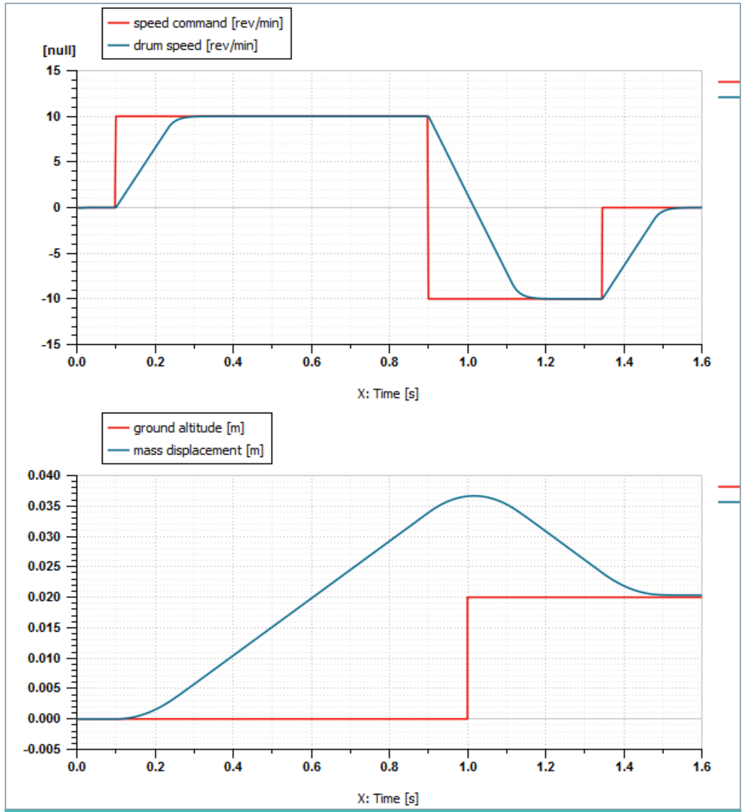
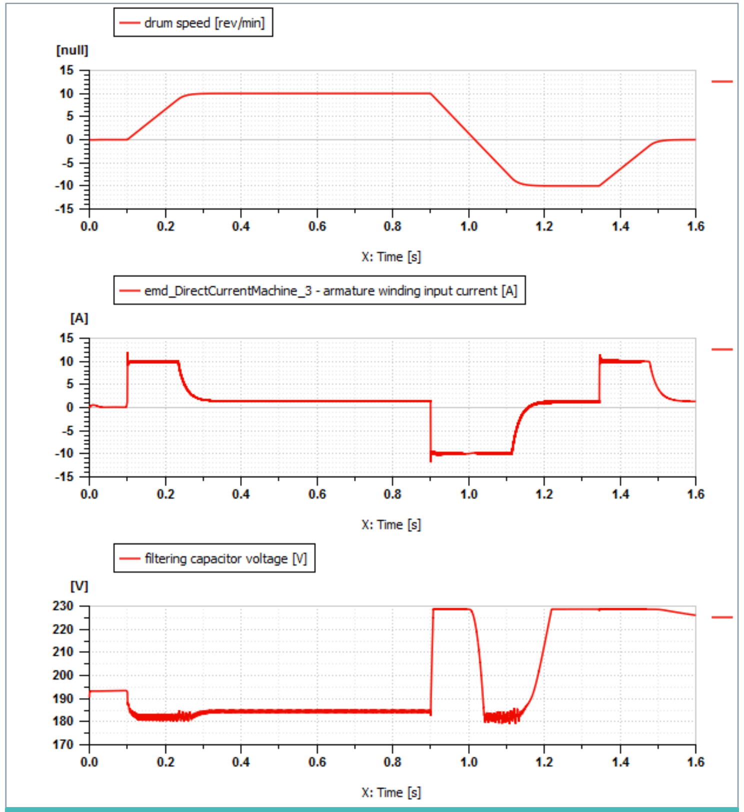
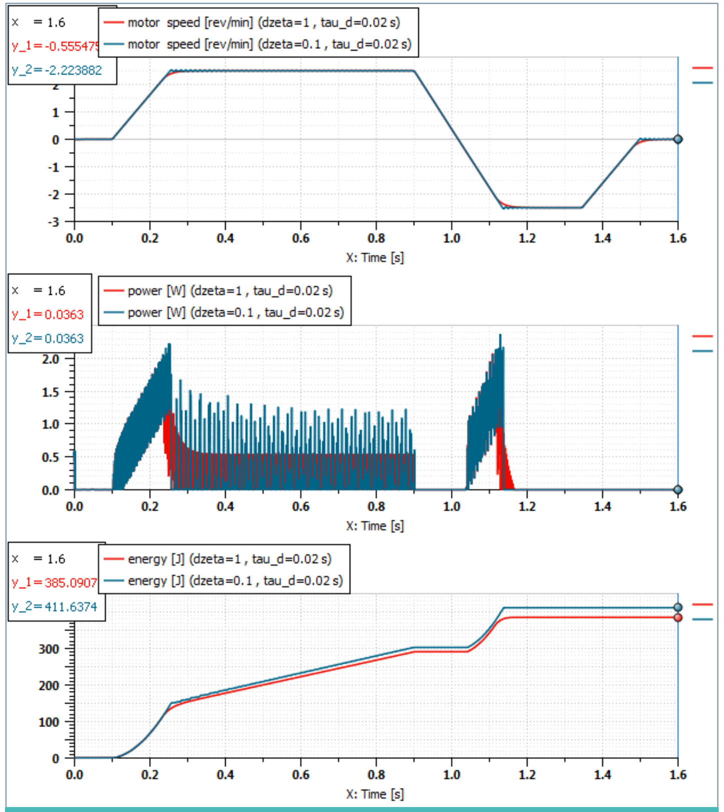
Results



Drum speed, mass displacement and ground altitude



Drum speed, motor current and filtering capacitor voltage



Impact of torque control parameters on performance and consumption

Examples of typical applications

SIEMENS
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1 Improving the energy consumption of a press brake

2 Optimizing the energy consumption of an electric winch

3 Virtually commissioning using system simulation

Application #3
Virtually commissioning PLC using system simulation

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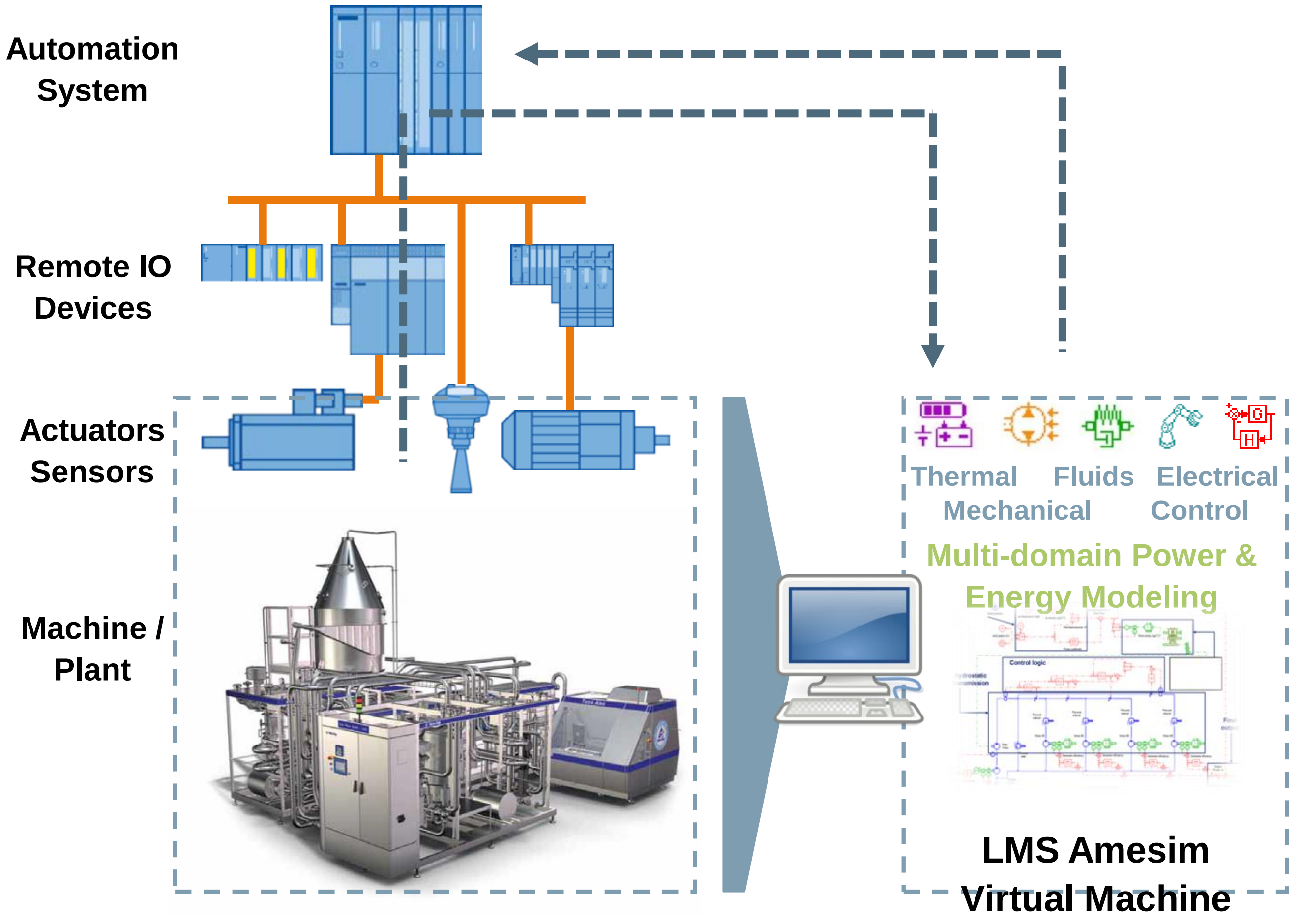
Objectives

- Optimize PLC code according to performance and energy consumption targets
- Limit the commissioning phase
- Reduce the pause of production
- Reduce the risks and fixing / repair costs

Means

- Simulate de transient behavior of the multi-domain systems of the machine and couple with the automation code (SIL) and real PLC (HIL)
- Evaluate the impact of PLC code modification on general and energetic performances of the machine



Application #3
Coupling with PLCs

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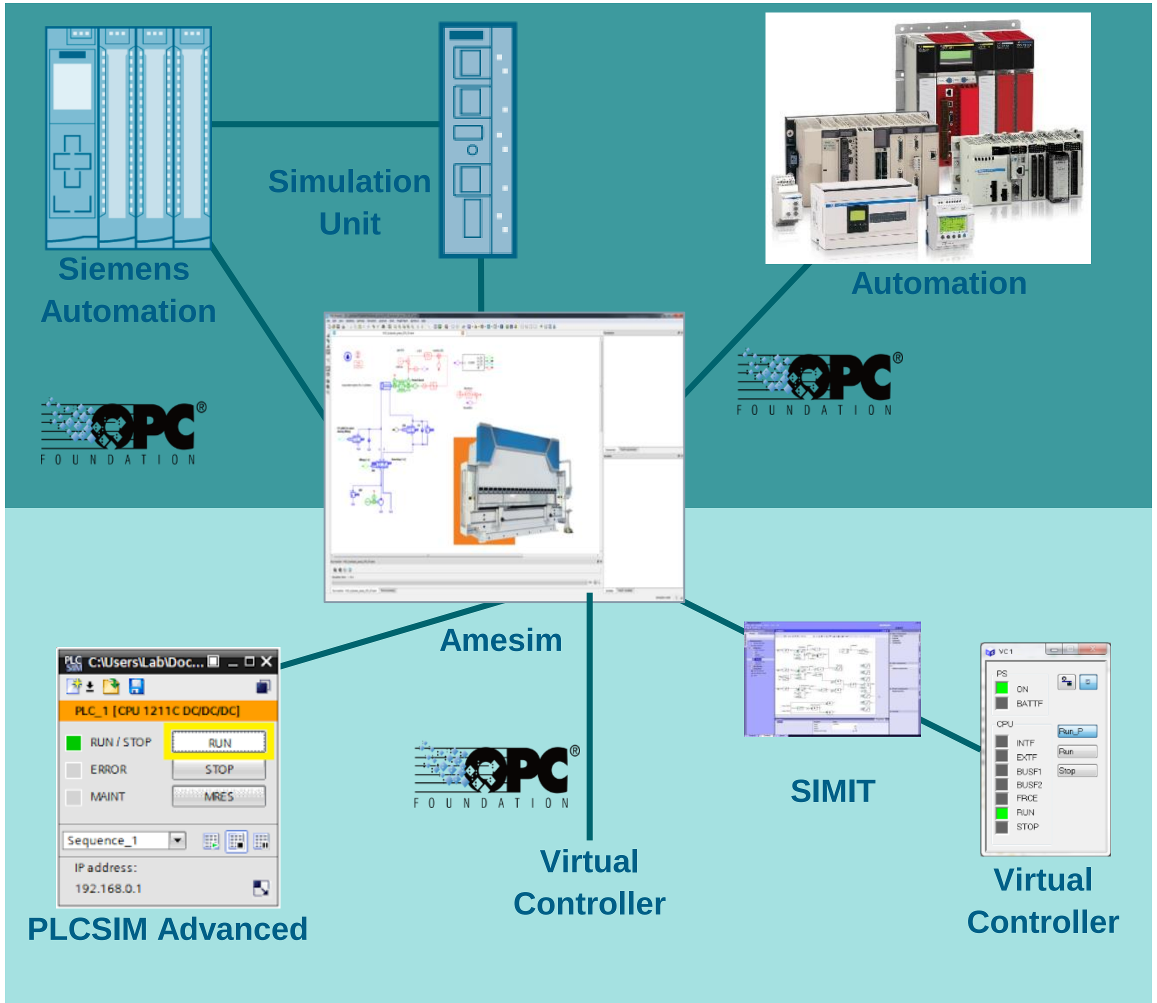


An interface for everything

HiL: exchange of data between a real PLC and LMS Amesim

- Coupling with Siemens PLCs: through the Siemens Simulation unit (simulated peripheral) or using OPC UA
- Coupling with other PLCs: using OPC UA

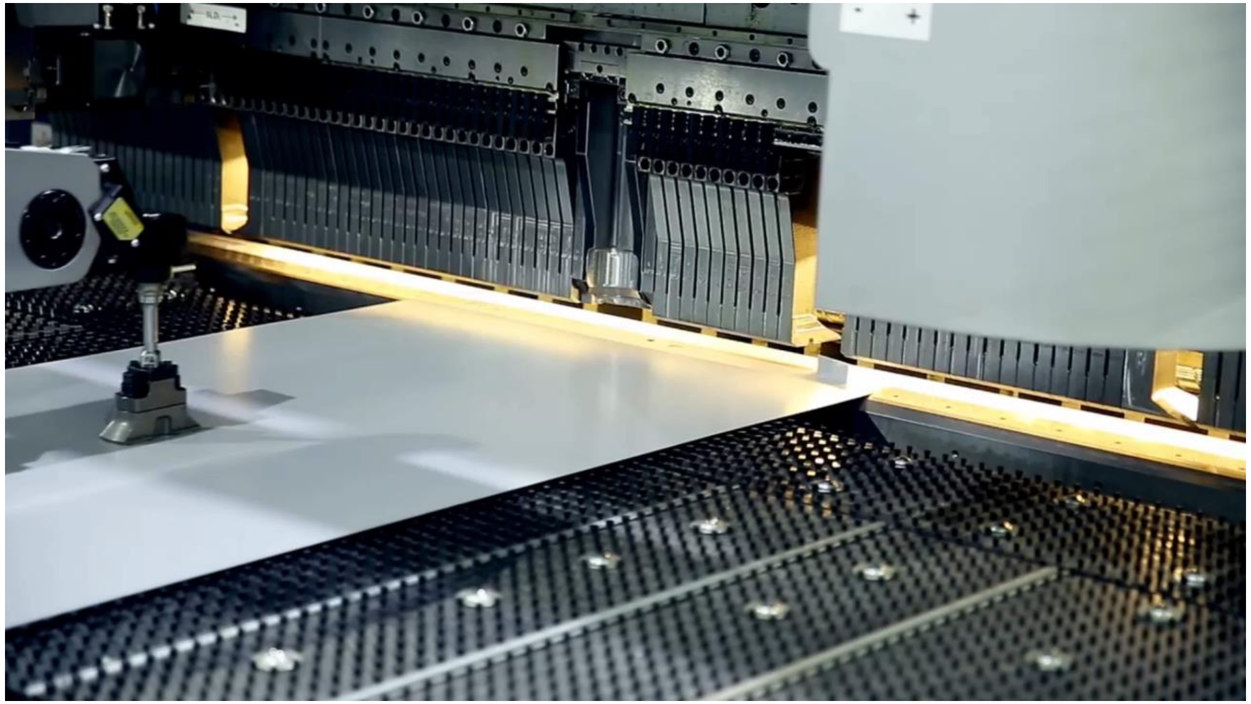
SiL: exchange of data between an emulated PLC and LMS Amesim

- Interface with Siemens SIMATIC STEP 7
  - Through SIMATIC S7-PLCSIM Advanced
  - Support of controller of the type S7-1200 and S7-1500
- Interface with Siemens SIMATIC PCS7
  - Through SIMIT
  - Support of controller of the type S7-300 or S7-400
- Interface with non-Siemens PLC
  - Through OPC-UA

Application #3
Virtually commissioning PLC using system simulation
Example on an hydraulic press

Objective

- Validation of automation code without the real machine



Setup for hardware-in-the-loop simulation

- Hardware:
  - SIMATIC S7 1500
  - Simulation Unit
  - HMI Panel
  - PC Workstation
- Software:
  - TIA Portal V13
  - LMS Amesim
  - Automation Connect tool

Agenda

- The industrial machinery industry is evolving
- Model-based systems engineering for industrial machinery applications
- **The voice of our customers**
- Conclusion

Ronchi Mario
Optimize its Filling Machines Performance with LMS Imagine.Lab Amesim

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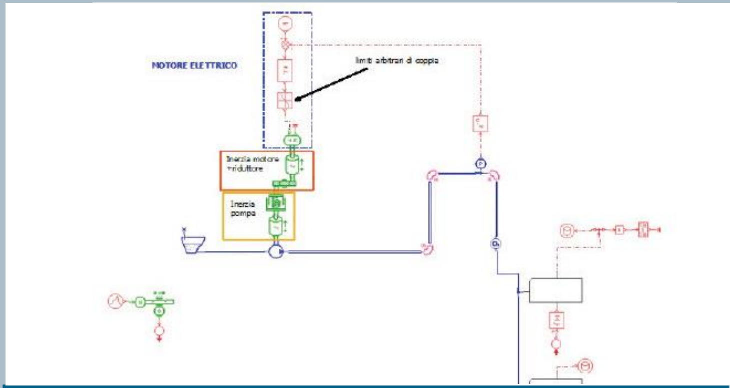
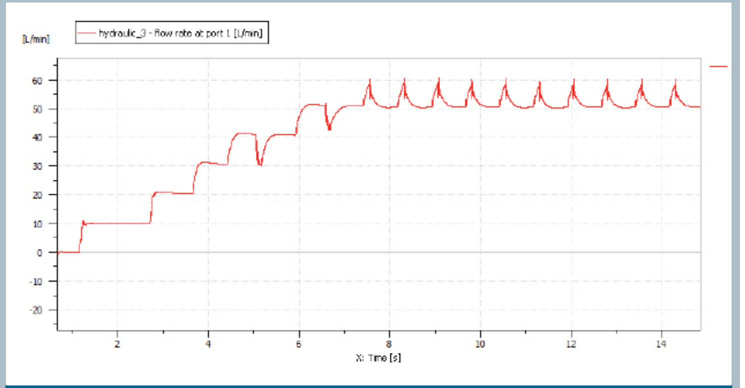
- **Reduced the number of prototypes by 20 percent**
- **Increased design accuracy**
- **Saved weeks in maintenance**

Improve filling machine system design to ensure filling quality



Model of a filling machine, with valves modeled as "supercomponents"



Flowrate through the filling machine.

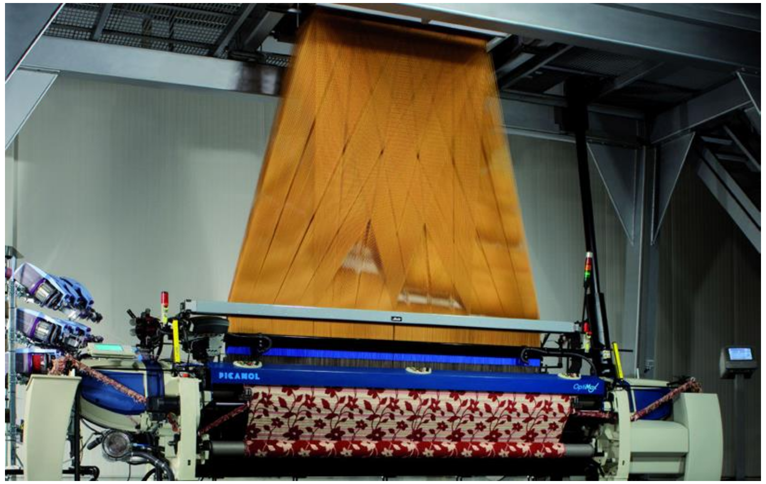
- Evaluate machine's parameters to determine the best design and ensure filling quality
- Determine the pressure loss and filling behavior during the filling dynamics
- Simulate the machine process to adapt filling valves design

"If you are interested in the global parameters of the system, a 1D simulation tool, such as LMS Imagine.Lab Amesim, is the best option, because it is fast, reliable and easy-to-use."

Gabriele Pastrello, R&D Engineering at RONCHI MARIO

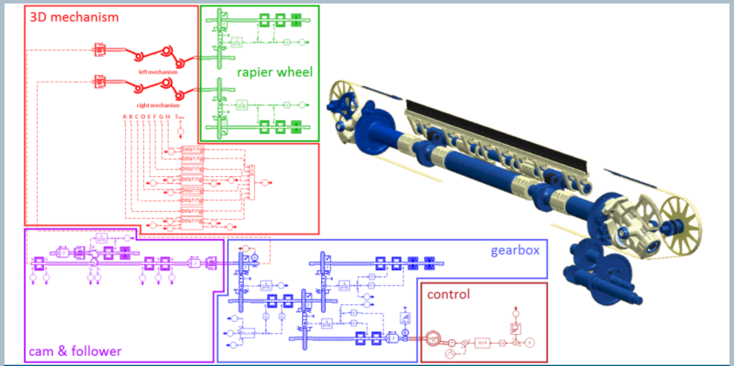
Picanol

Launching a highly energy-efficient loom thanks to LMS Amesim

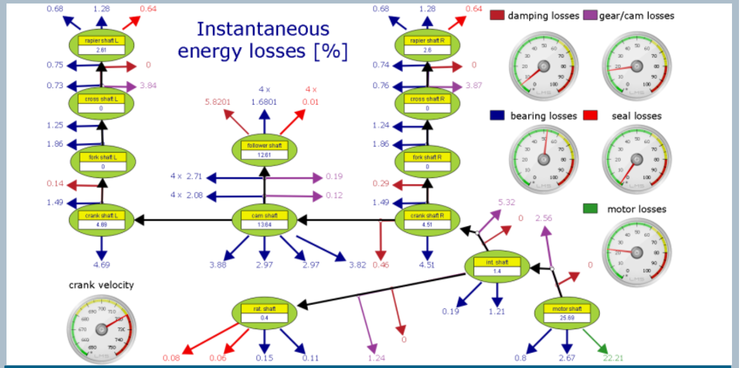


- **Designed the "most energy-efficient weaving looms on the market"**
- **Balanced performance, durability, noise and vibration parameters while minimizing energy consumption**
- **Implemented advanced model-based system engineering**

Optimizing the design towards energy performance



Co-simulation with Simcenter 3D Motion



Flow chart of instantaneous energy losses

- Support the scalable optimization of energy flows
- Use energy efficiency and total cost of ownership as key performance criteria

"A platform like LMS Amesim offers extensive libraries of components that also connect to describe complete multiphysics systems, a prerequisite for advanced model-based system engineering."

Kristof Roelstraete, Manager Research and Development

CETIM – French Technical Center of Mechanical Industries

Simulation of power losses in textile machineries with LMS Amesim

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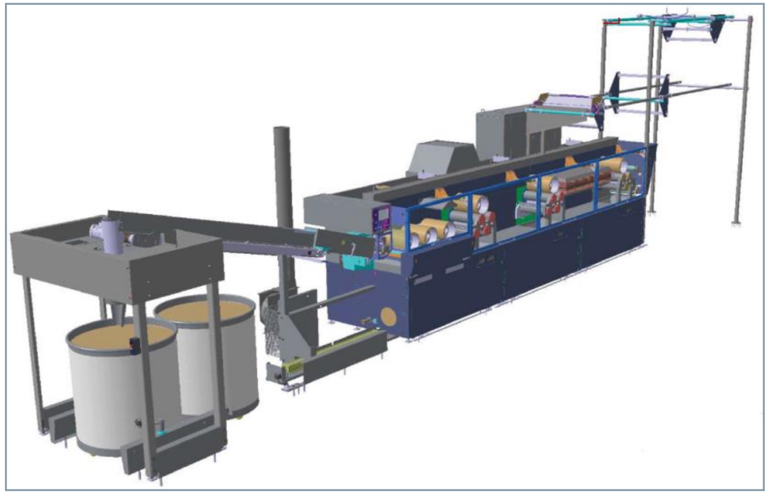
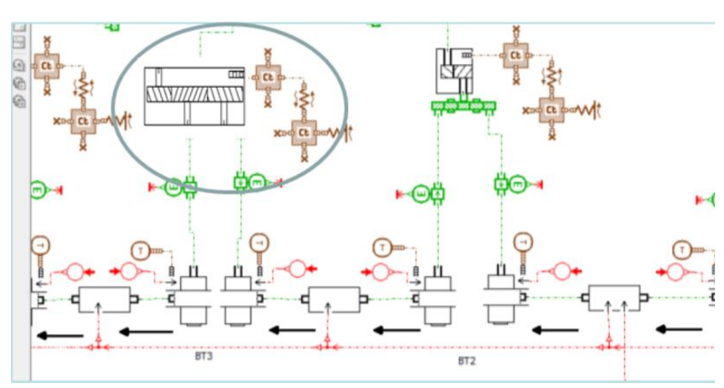
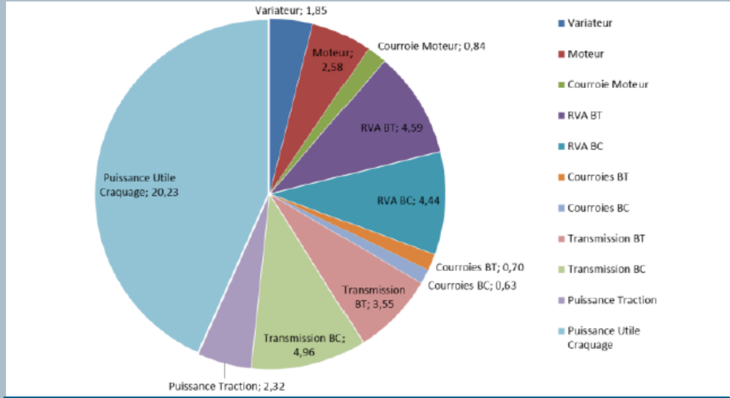


Predictive modelling of the entire transmission chain



Multi-domain system schematic: mechanical, thermal and electric fluxes



Power losses distribution for L700 Steam

- **Predict the impact of operating functions and settings on system performances**
- **Early evaluation of power losses within the full transmission chain**
- **Reduced number of test campaigns**

- Modeling of all textile machinery functions
- Torques, power losses and thermal transients estimated as function of main parameters
- Definition of performance indicators to characterize the machine

"With LMS Amesim, we were able to analyze the complete behavior of the machine - much better than on a real machine where some areas are inaccessible for installing sensors"

Antoine Michon

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Ingenuity for life

Agenda

The industrial machinery industry is evolving

Model-based systems engineering for industrial machinery applications

The voice of our customers

Conclusion

Balancing productivity and energy-efficiency of industrial machinery and processes

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Ingenuity for life

Predict the impact of operating functions and settings on system performance	Reduced number of test campaigns and prototype	Increased design accuracy
Balanced performance, durability, noise and vibration parameters while minimizing energy consumption	Spotlight the sources of loss and high consumption for design improvement	Validate and calibrate PLC programs using a model of the machine

Explore how the Simcenter portfolio can help you optimize designs and deliver innovations faster, with greater confidence

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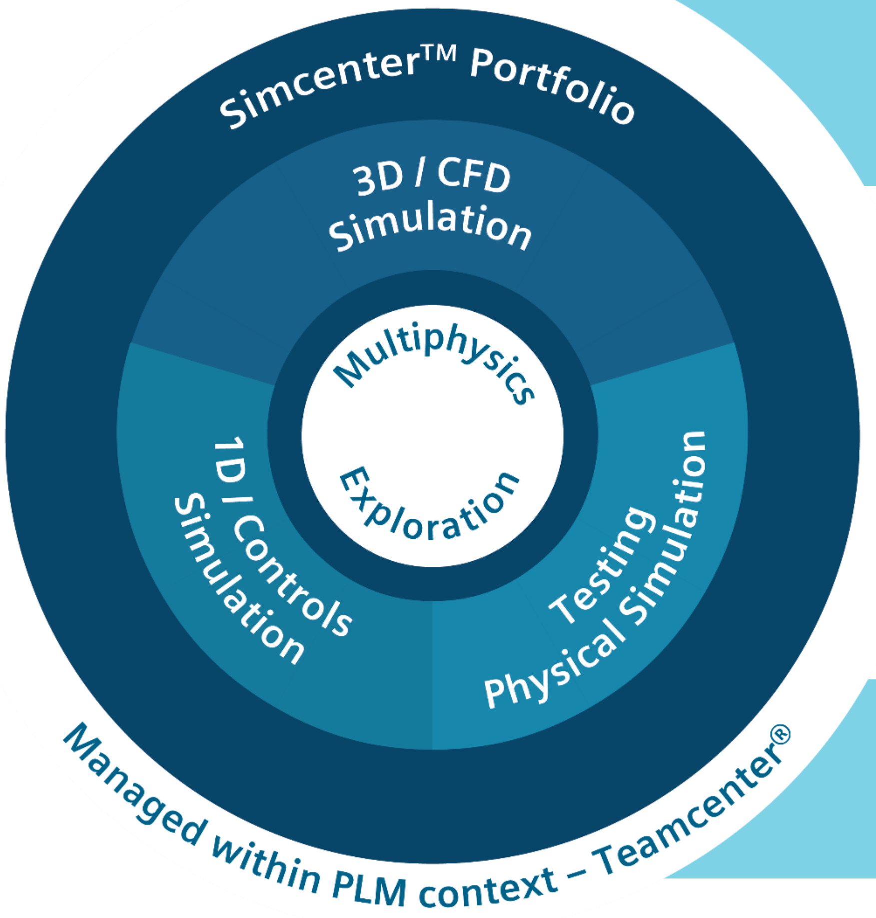
Ingenuity for life



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