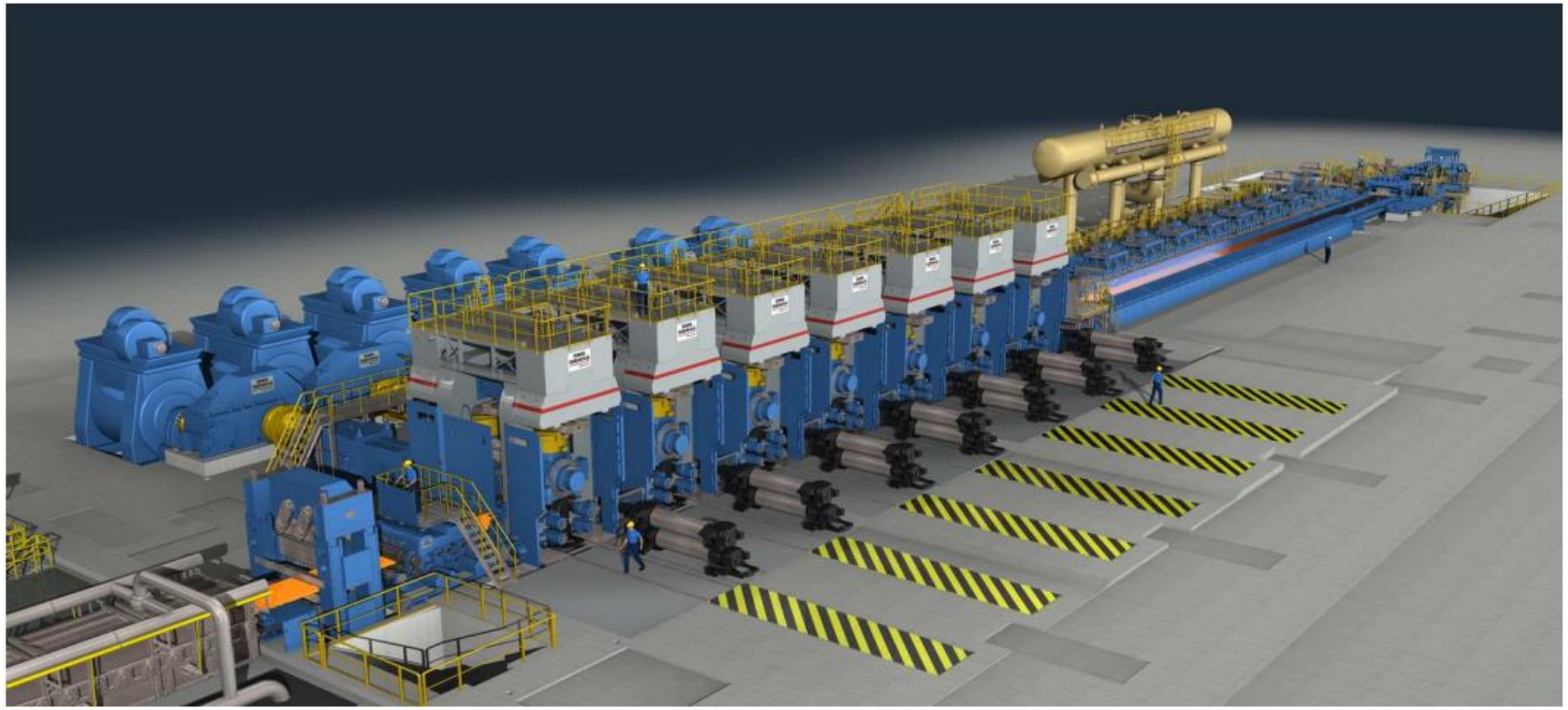
MATLAB EXPO

Designing and Deploying Embedded Algorithms on PLCs and other Industrial Controllers

Why System Control Design more than Ever

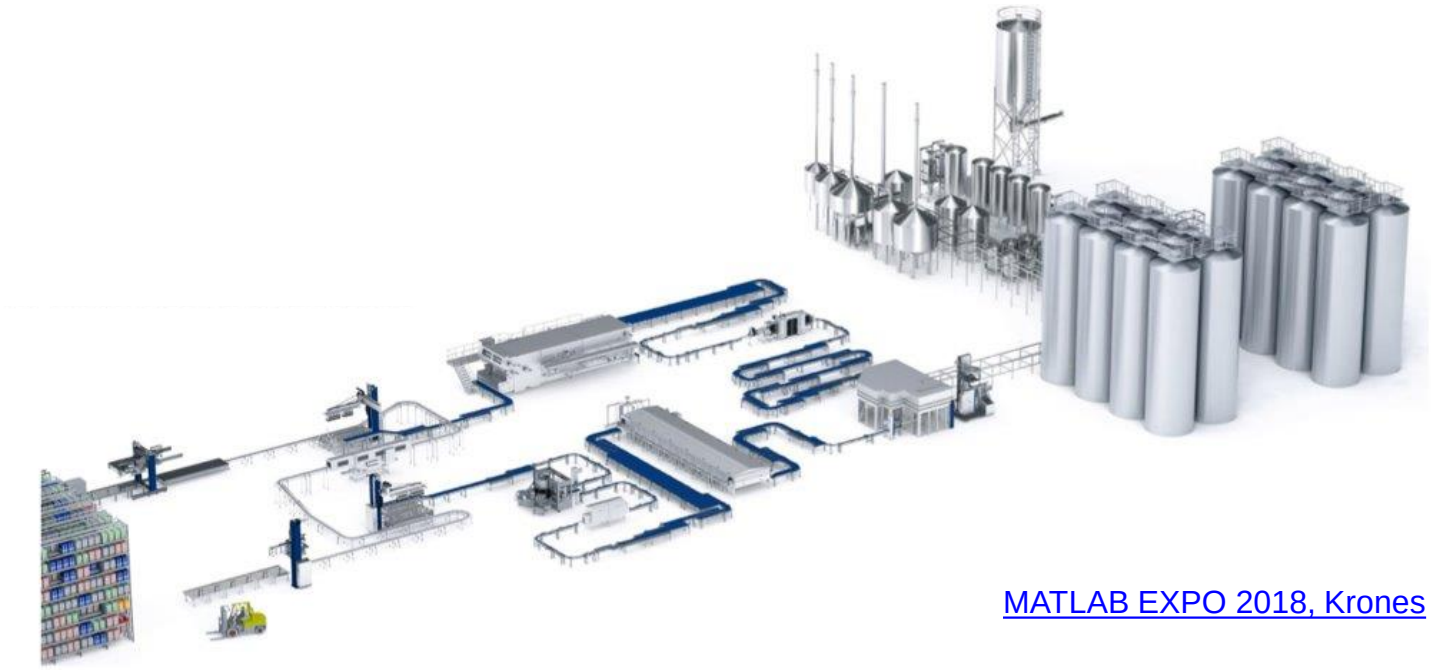
- **Reliability:** Many industrial applications require high maintenance costs. Control Design helps to reduce wearing and lower the risk of malfunctions.



MATLAB EXPO 2017, SMS Group

Why System Control Design more than Ever

- **Flexibility:** The same system can be used to answer specific market requests or tailored solutions.

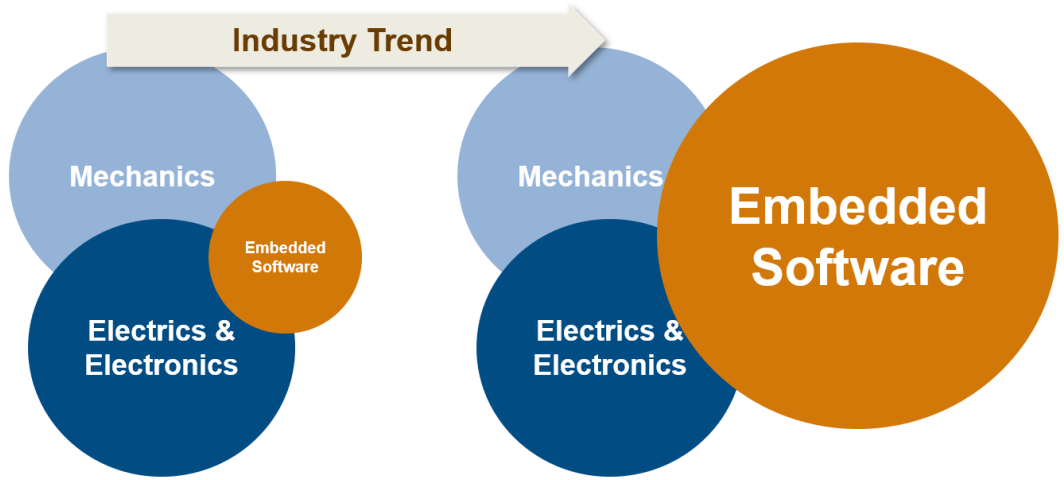


MATLAB EXPO 2018, Krones

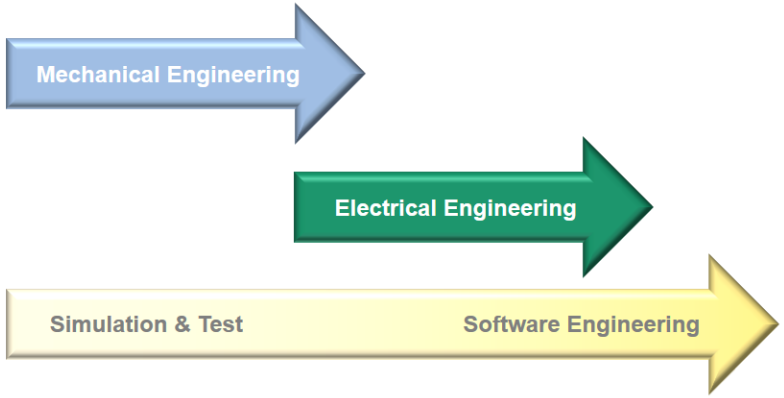
Digital Transformation drives Software Complexity

- **Digital Transformation** and flexible production lead to increasingly complex equipment that involves **multidisciplinary fields** (software, mechanics, hydraulics, pneumatics, electronics, etc.)

- **Design and commissioning of industrial equipment** require simulation, virtual commissioning and code generation for industrial controllers (e.g. PLCs and industrial PCs)



Growing complexity



Growing complexity of mechatronic systems based on industrial controllers

…requires new design methods.

Model Based Design

Metso Develops Controller for Energy-Saving Digital Hydraulic System for Papermaking Equipment Using Model-Based Design

Metso's papermaking equipment. The machine's calender is controlled by a digital hydraulic system.

Challenge

Precisely control the speed, position, and pressure of calendar rolls in paper finishing equipment

Solution

Simulate, prototype, and implement advanced controls for a digital hydraulic system using Model-Based Design

Results

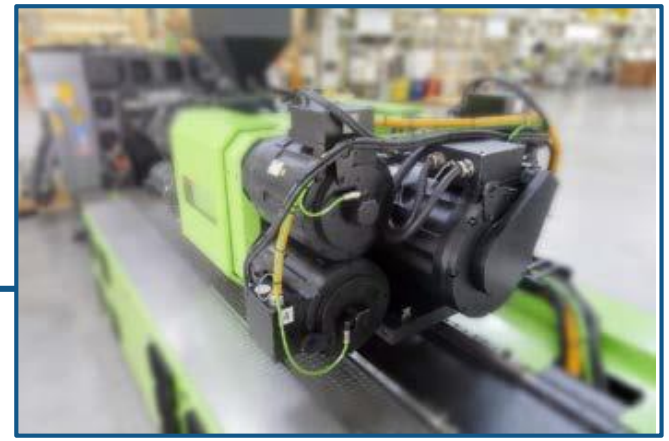
- Months of design time saved
- Weeks of customer startup time eliminated
- System reliability increased

"Using Model-Based Design with MATLAB and Simulink, we achieved multiple goals simultaneously. We developed a sophisticated controller for digital hydraulics that is more reliable, accurate, and efficient than previous systems, and we accelerated development, which gives us a competitive advantage."

Kari Leminen
Metso

Link to user story

ENGEL Speeds Development of Injection Molding Machine Controllers



The injection unit, which is driven by four synchronized drives.

Challenge

Accelerate the development of control systems for injection molding machinery

Solution

Use Model-Based Design with MATLAB and Simulink to model controllers and plants, run closed-loop simulations to minimize hardware testing, and generate PLC Structured Text

Results

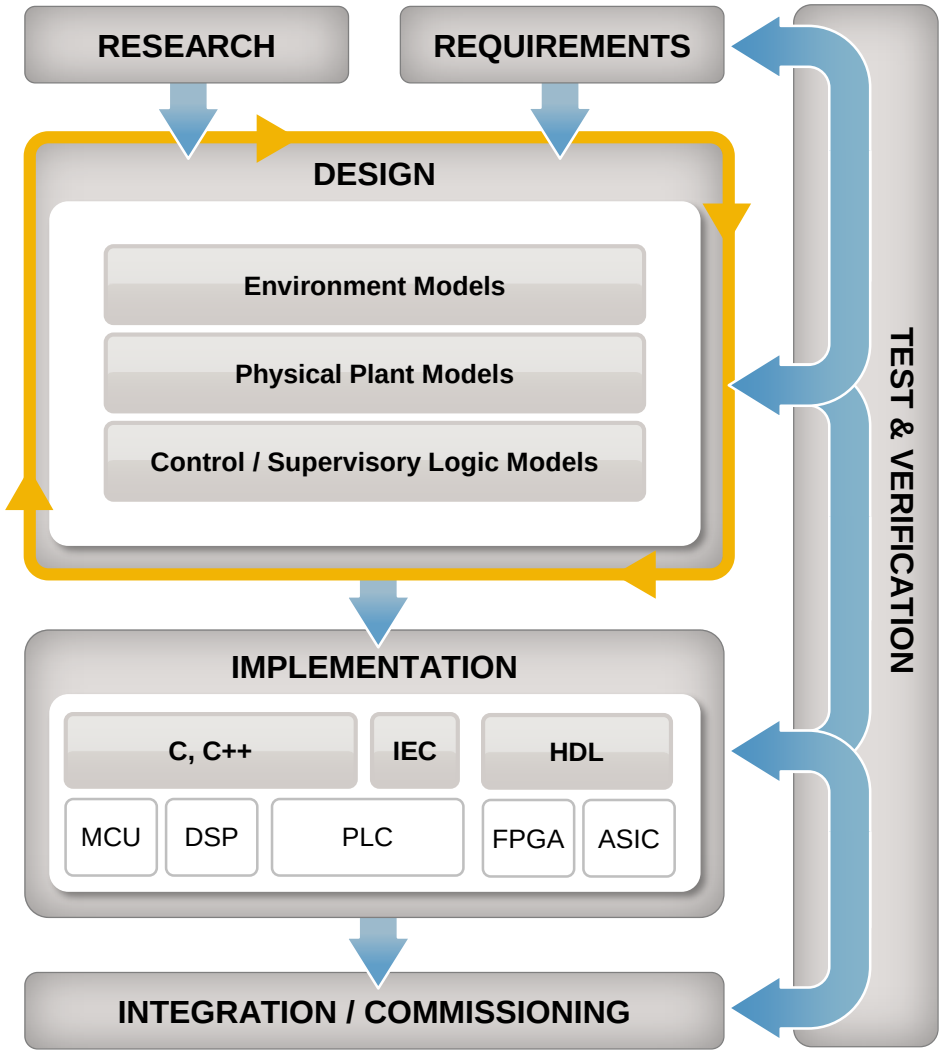
- Control algorithms developed and debugged without hardware
- Controller quality improved
- Test data analysis accelerated

"Model-Based Design reduces the time needed to produce quality control algorithms. Simulations help us understand the system, and code generation enables us to maintain a single source for the design. The results are faster development and higher-quality systems."

Hannes Bernhard
ENGEL

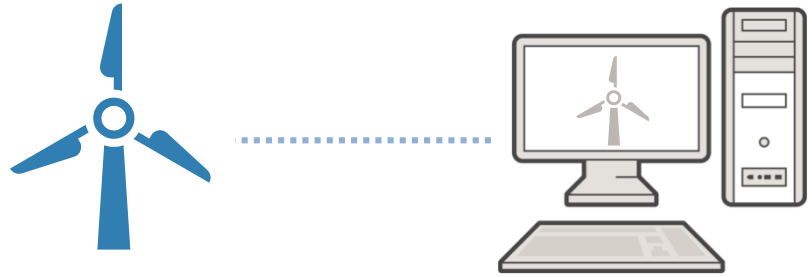
Link to user story

Model-Based Design for Industrial System Control Design



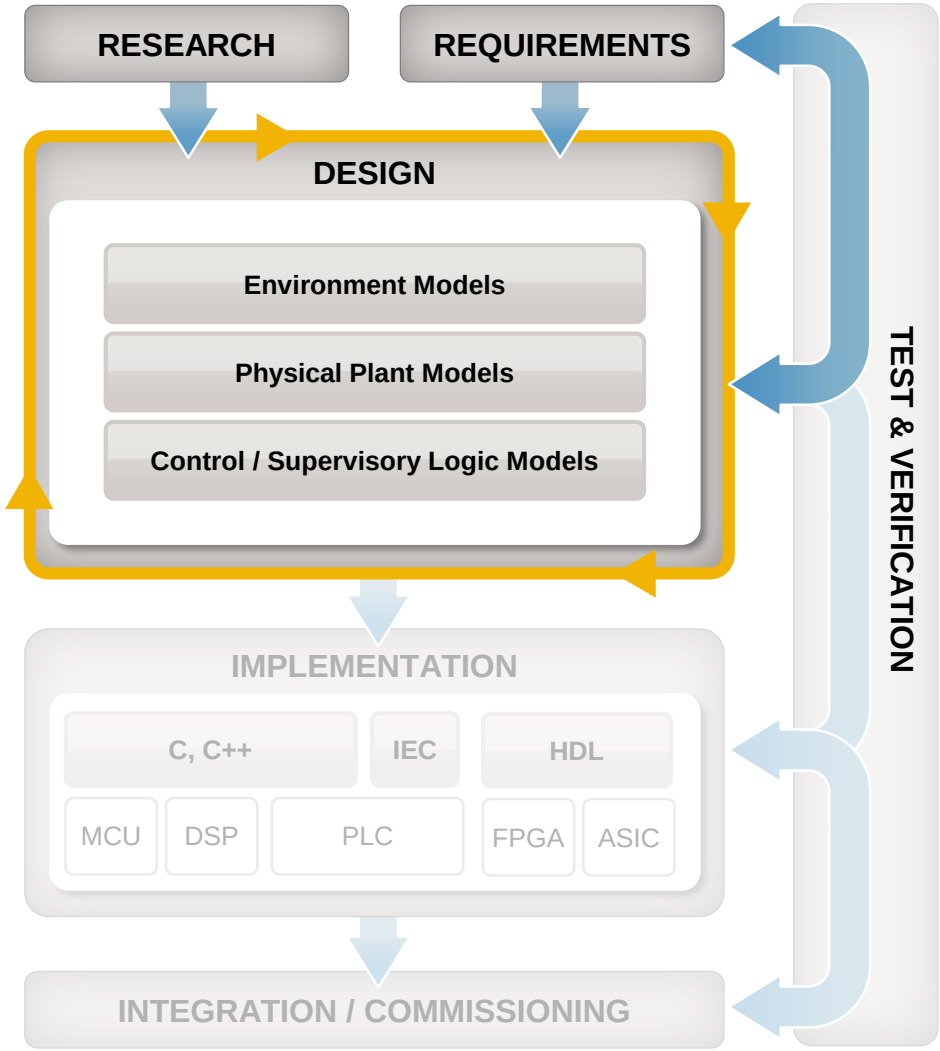
What if you were able to verify your system's behavior **through the entire design process**?

What if you could use your models not only for design simulation but also as a **Digital Twin** during lifetime of your system?



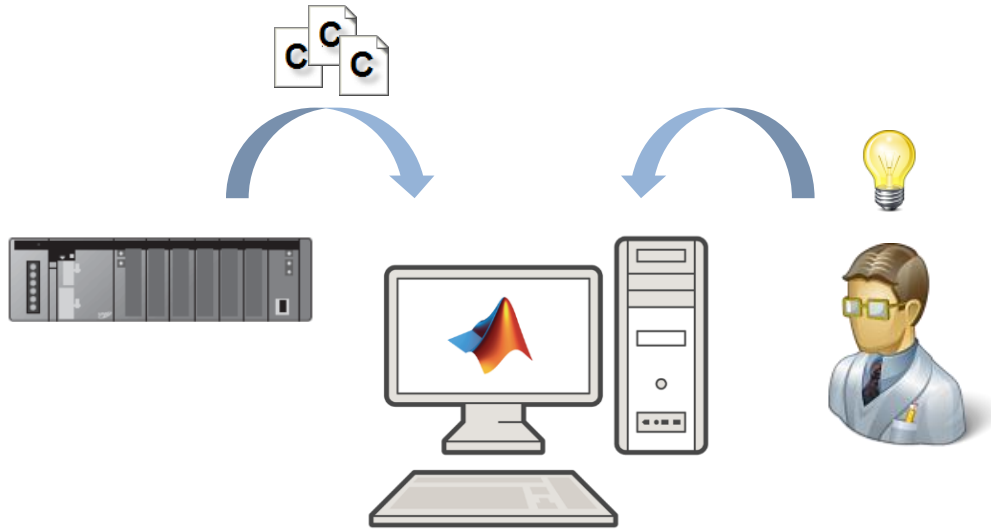
Model Based Design

Model-Based Design for Industrial System Control Design

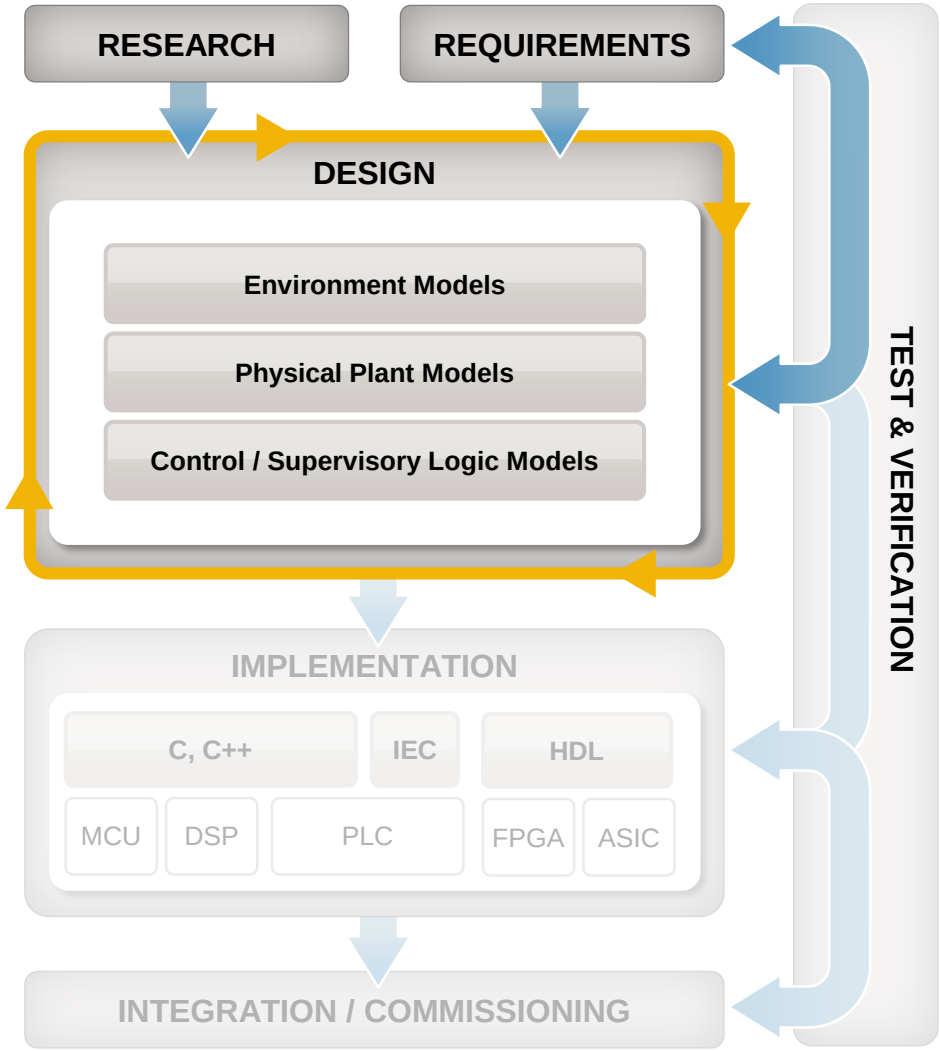


Step 1: Desktop Simulation

- Prototype new functionality and combine with existing code



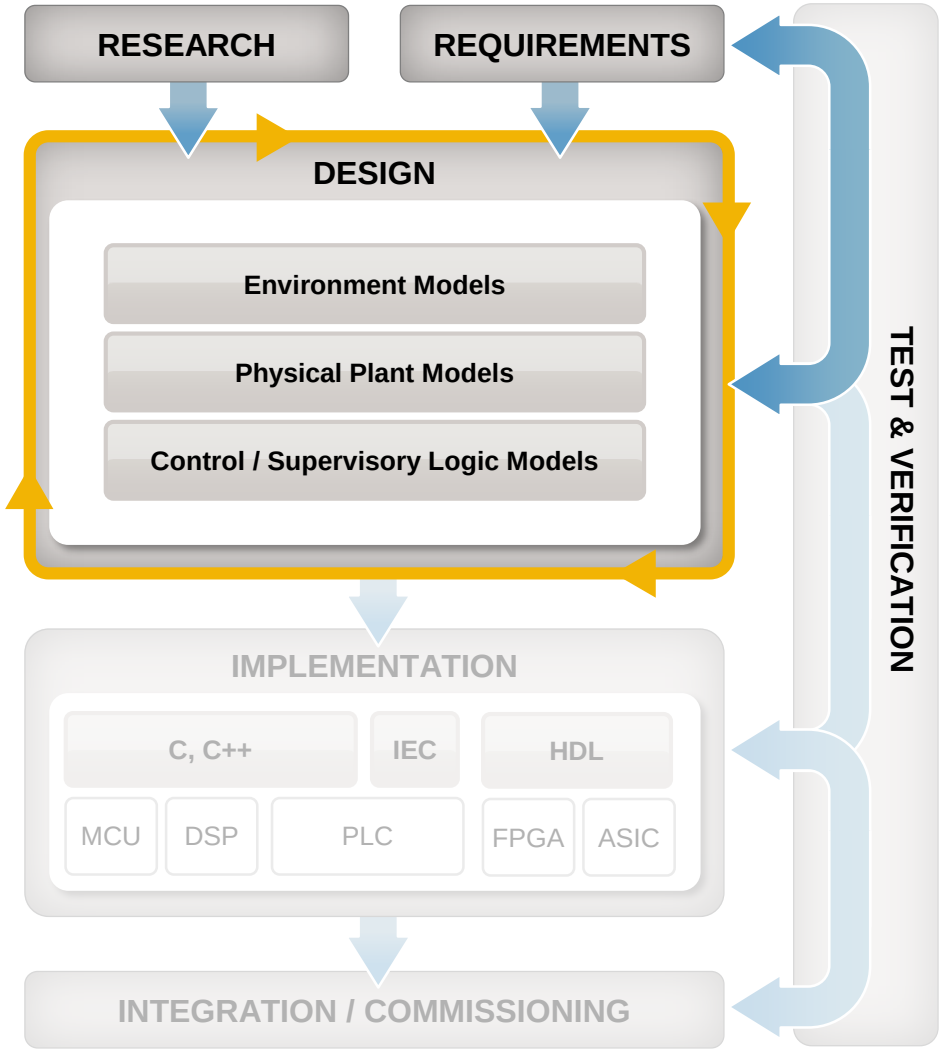
Model-Based Design for Industrial System Control Design



Step 1: Desktop Simulation

- Prototype new functionality and combine with existing code
- Perform (automated) system tests that would not be feasible outside of simulation

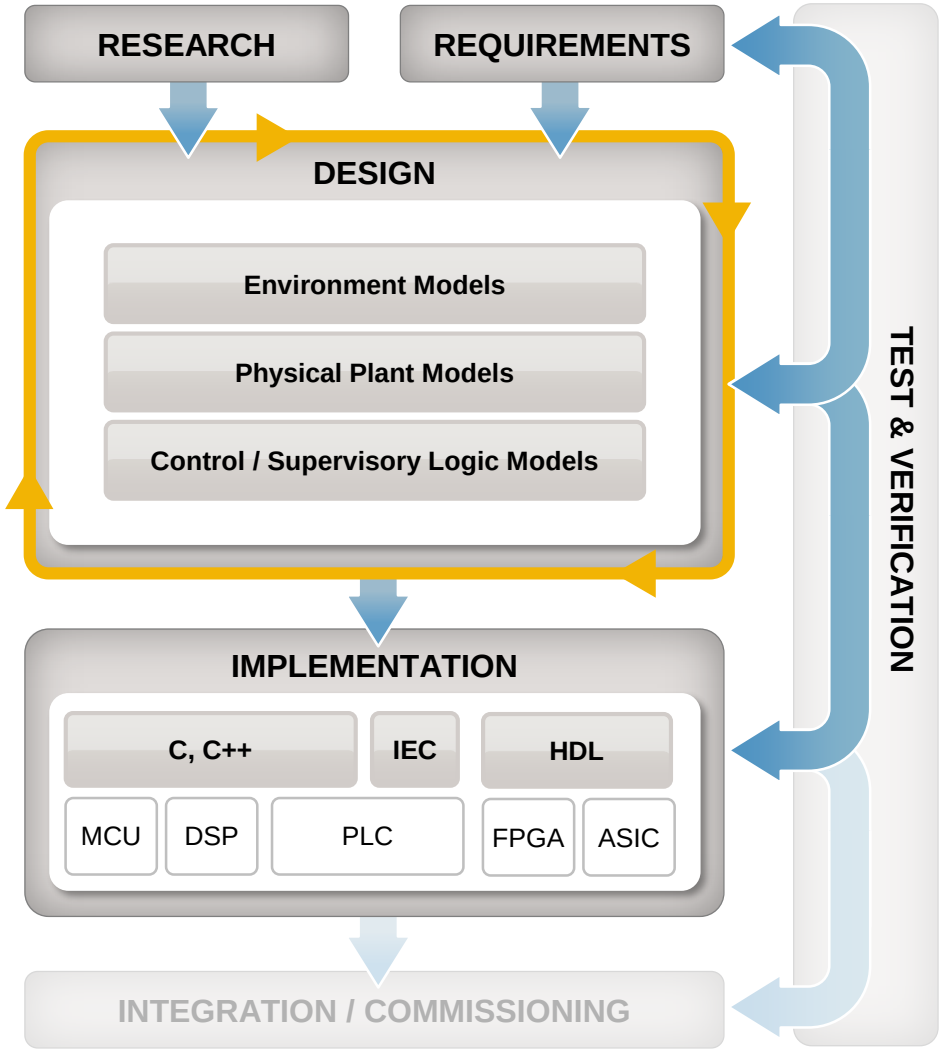
Model-Based Design for Industrial System Control Design



Step 1: Desktop Simulation

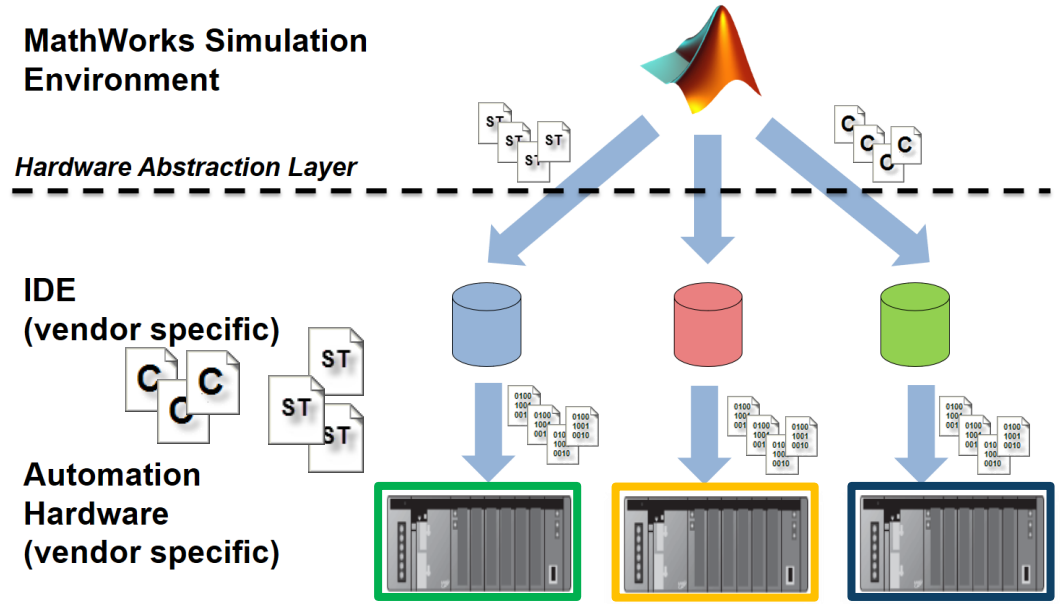
- Prototype new functionality and combine with existing code
- Perform (automated) system tests that would not be feasible outside of simulation
- Optimize parameters (software, mechanics, hydraulics, etc.)

Model-Based Design for Industrial System Control Design

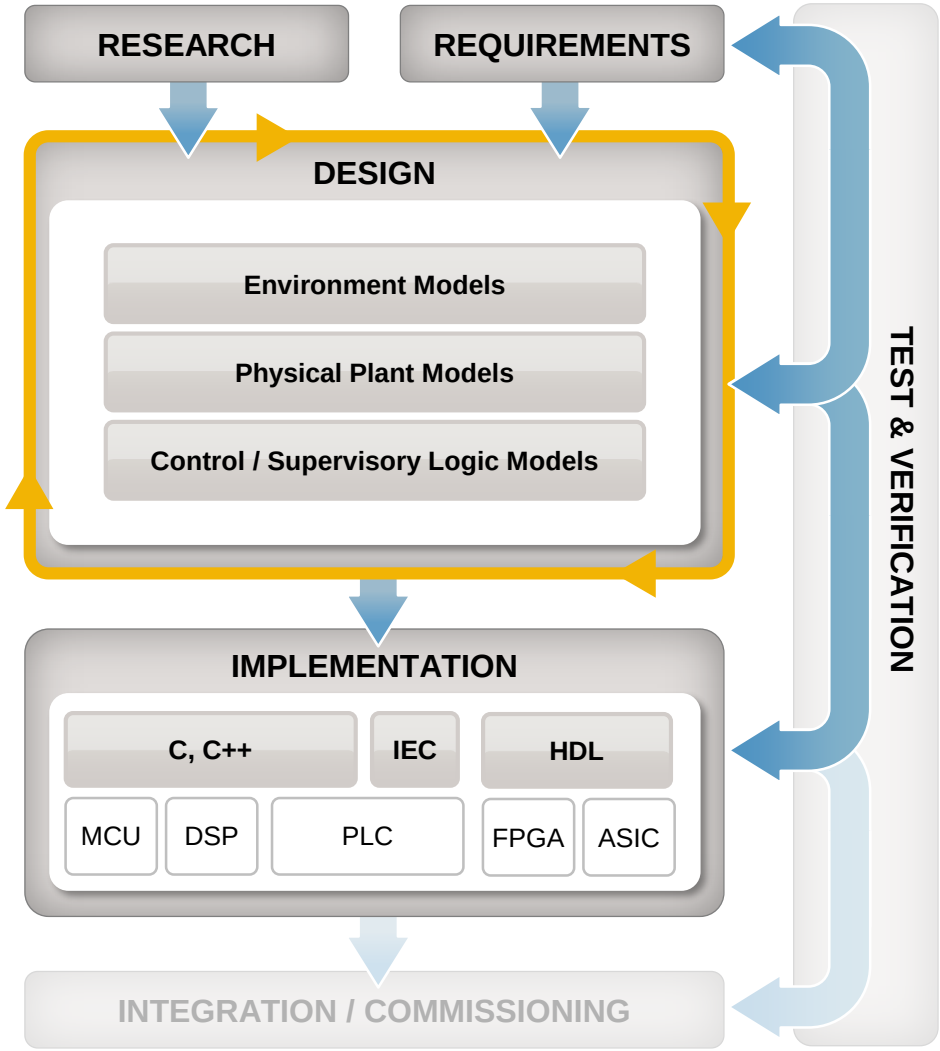


Step 2: Code Generation

- Design and test hardware independent functionality (C/C++, IEC 61131-3, HDL)



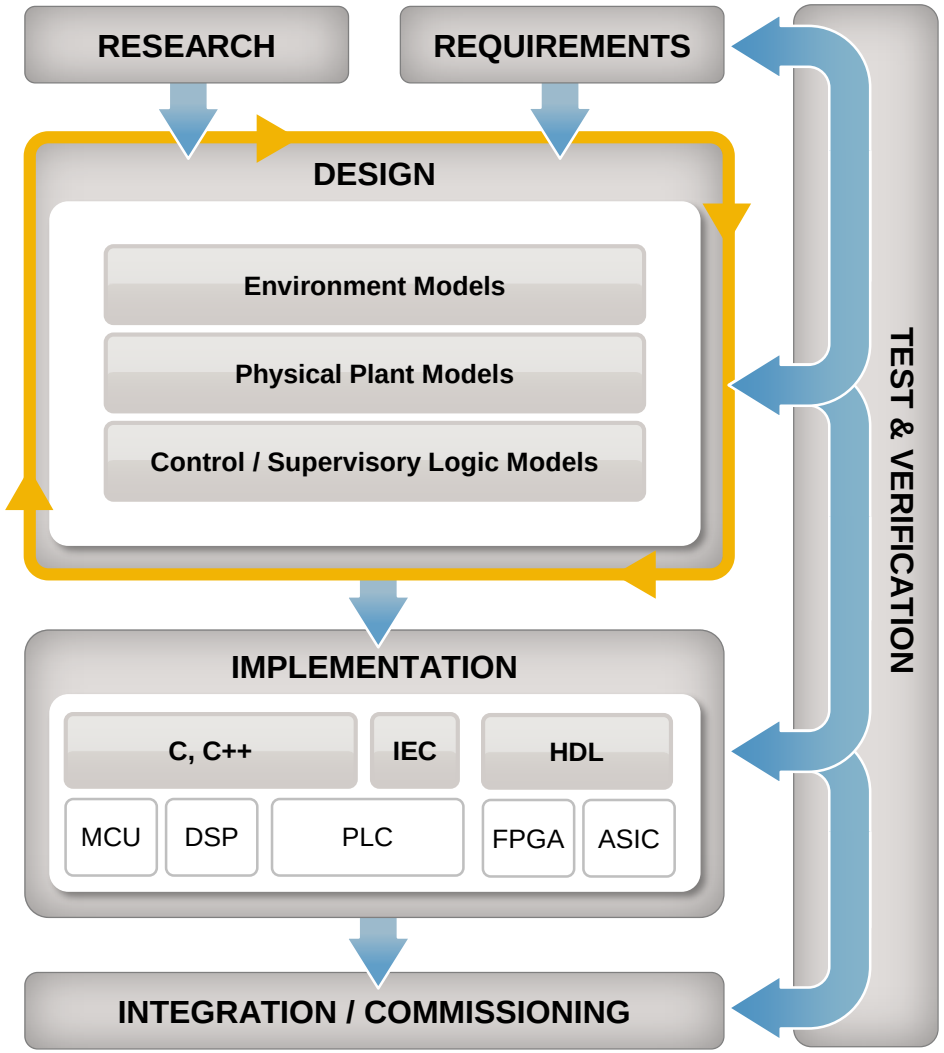
Model-Based Design for Industrial System Control Design



Step 2: Code Generation

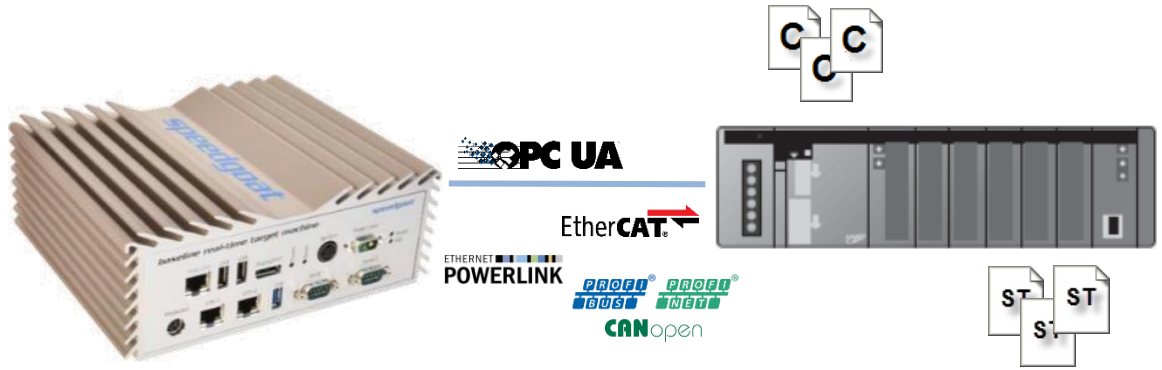
Vendor	IDE	IEC 61131-3	C/C++
3S - Smart Software Solutions	CODESYS	✓	
ABB / B&R Industrial Automation	Automation Studio	✓	✓
Bachmann Electronic	SolutionCenter	✓	✓
Beckhoff Automation	TwinCAT	✓	✓
Bosch Rexroth	IndraWorks	✓	✓
Mitsubishi Electric	CW Workbench		✓
Ingeteam	Ingesys IC3		✓
Omron	Sysmac Studio	✓	
Phoenix Contact	PC WORX	✓	✓
Rockwell Automation	RSLogix / Studio 5000	✓	
Schneider Electric	Control Expert / Unity Pro	✓	
Selectron	CAP1131	✓	
Siemens	TIA Portal / STEP 7	✓	✓

Model-Based Design for Industrial System Control Design



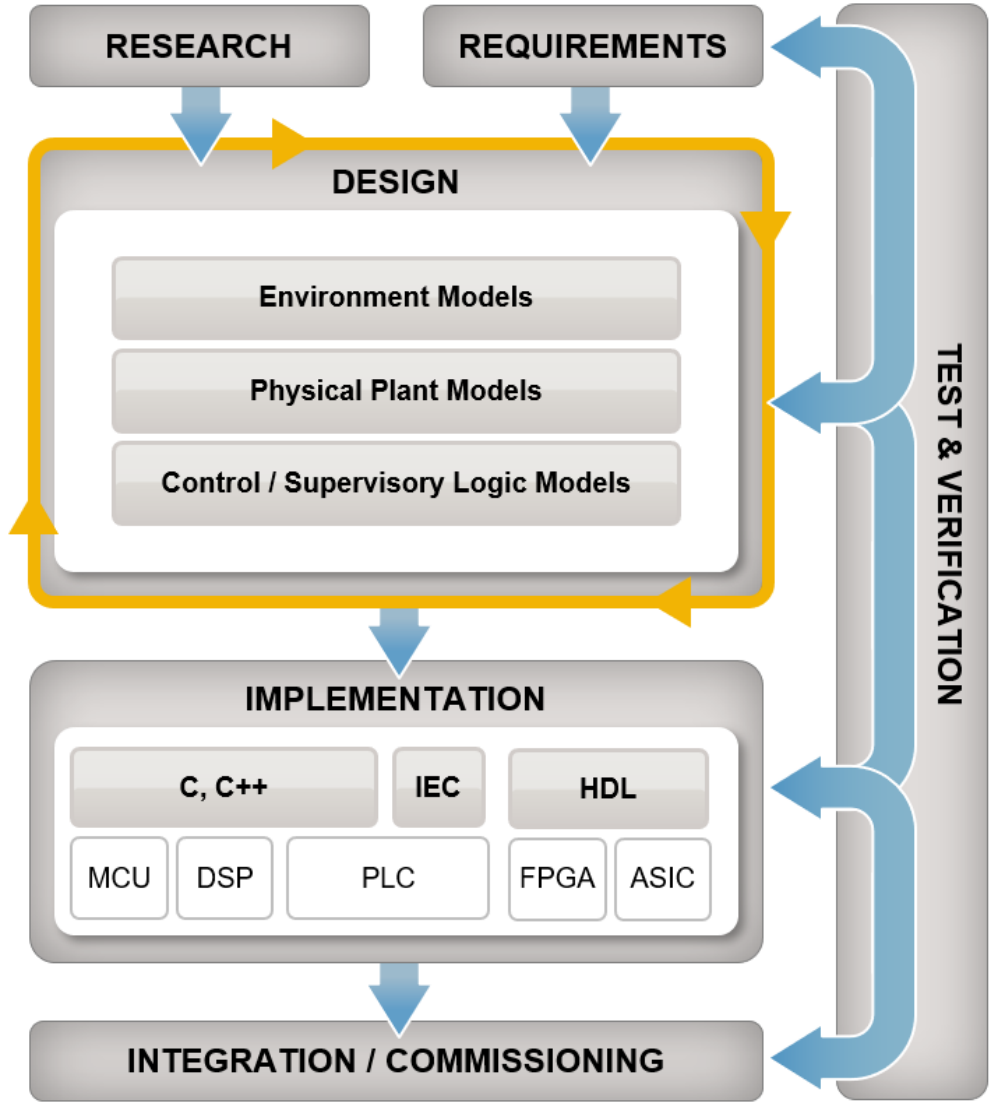
Step 3: Hardware in the Loop

- Emulate the behavior of the physical system (plant model) in real-time
- Connect the virtual plant to your PLC or industrial PC (e.g. over an industrial fieldbus)



Conclusion

- Model-Based Design helps to **embrace the growing complexity** on equipment based on industrial controllers



Conclusion

- Model-Based Design helps to **embrace the growing complexity** on equipment based on industrial controllers

- Code generation from MATLAB, Simulink, Stateflow and Simscape is available for **all major industrial controls platforms**

  Approach us if you don't find your vendor in this table.

Vendor	IDE	IEC 61131-3	C/C++
3S - Smart Software Solutions	CODESYS	✓	
ABB / B&R Industrial Automation	Automation Studio	✓	✓
Bachmann Electronic	SolutionCenter	✓	✓
Beckhoff Automation	TwinCAT	✓	✓
Bosch Rexroth	IndraWorks	✓	✓
Mitsubishi Electric	CW Workbench		✓
Ingeteam	Ingesys IC3		✓
Omron	Sysmac Studio	✓	
Phoenix Contact	PC WORX	✓	✓
Rockwell Automation	RSLogix / Studio 5000	✓	
Schneider Electric	Control Expert / Unity Pro	✓	
Selectron	CAP1131	✓	
Siemens	TIA Portal / STEP 7	✓	✓

Conclusion

- Model-Based Design helps to **embrace the growing complexity** on equipment based on industrial controllers
- Code generation from MATLAB, Simulink, Stateflow and Simscape is available for **all major industrial controls platforms**
- Real -Time testing using connectivity to all relevant **industrial fieldbus and ethernet protocols**

Communication Protocols

CAN FD	EtherCAT
CAN & SAE J1939	EtherNet/IP
SENT SAE-J2716	Real-Time UDP
LIN	PTP IEEE 1588
FlexRay	TCP/IP
XCP over Ethernet	UART / Serial
Shared Memory	Modbus RTU
Aurora	Modbus TCP
ARINC 429 & 629	POWERLINK
AFDX (ARINC 664 P7)	PROFIBUS
MIL-STD-1553	PROFINET
I2C	GNSS (GPS, ...)
SPI	Camera Link
SSI	USB Webcams
SDLC/HDLC	Automotive Communication Protocols
MVB/WTB	Dshot

https://www.speedgoat.com/products-services/i-o-connectivity/communications-protocols

Conclusion

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Learn More

- White Paper
  - Virtual Commissioning with Model-Based Design
- Webinars
  - Virtual Commissioning with Simulink
  - Virtual Commissioning of Production Machines
- User Stories
  - Metso Develops Controller for Energy-Saving Digital Hydraulic System for Papermaking Equipment Using Model-Based Design
  - ENGEL Speeds Development of Injection Molding Machine Controllers