KENDRION

3T electronics & embedded systems

HOW TO USE MODEL-DRIVEN DEVELOPMENT FOR SMART HOSPITAL BOOMS AND SENSORLESS MOTOR CONTROL

High System Efficiency

High-precision applications

Working in Harsh Environments

Let's Connect!

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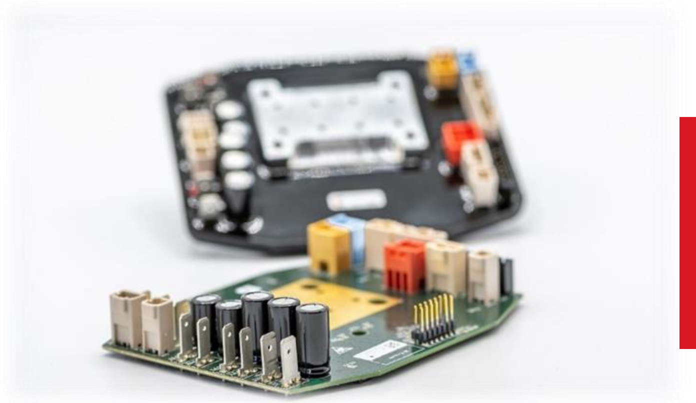
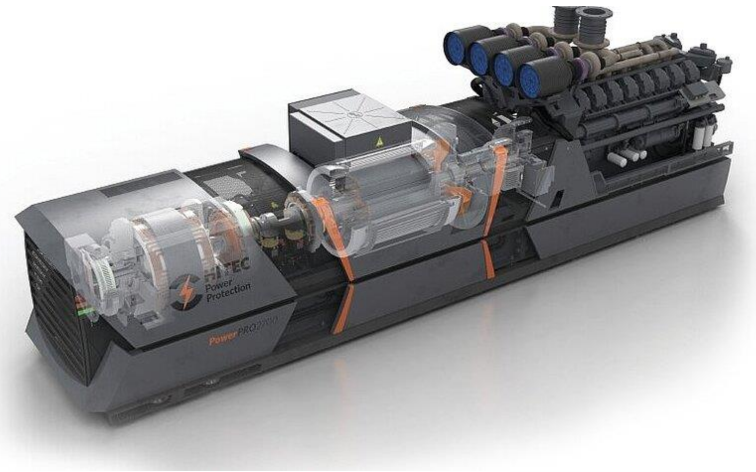
Learn more about Power & Motion Control

DEVELOPMENT SERVICE
MISSION-CRITICAL APPLICATIONS





ABOUT 3T

Our mission:

We continuously invest in our expertise in electronics and embedded systems to enable our clients offering the best possible product to the market.

- 100+ innovators
- 40+ years
- Enschede, Eindhoven & Drachten
- Since 2021 part of Kendrion

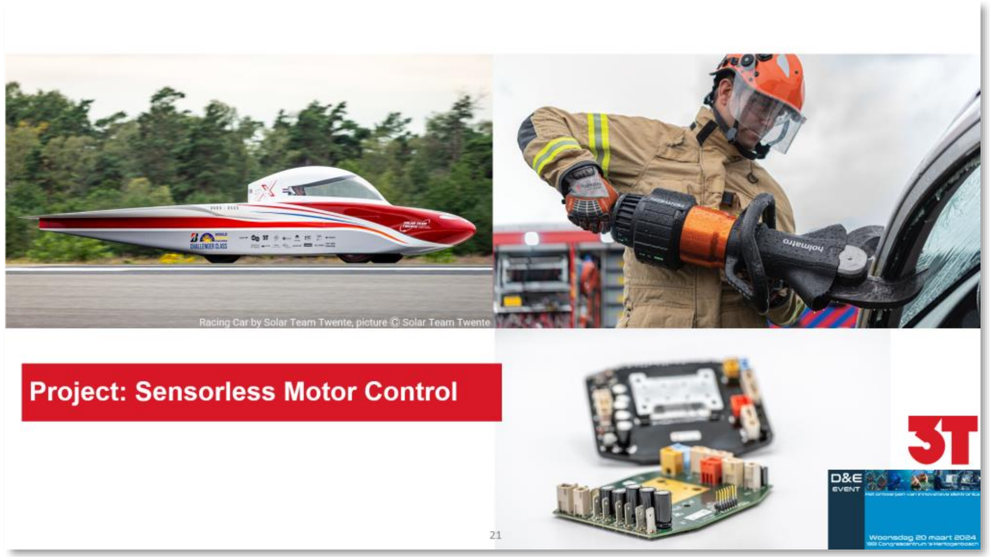
CERTIFIED ISO 9001

CERTIFIED ISO 13485

Co-development
Development through cooperation

Qualified supply
Product to volume production

Innovation & support
Maintain product during life cycle



Demonstration of MDD and Code Generation by two project examples.

Co-development
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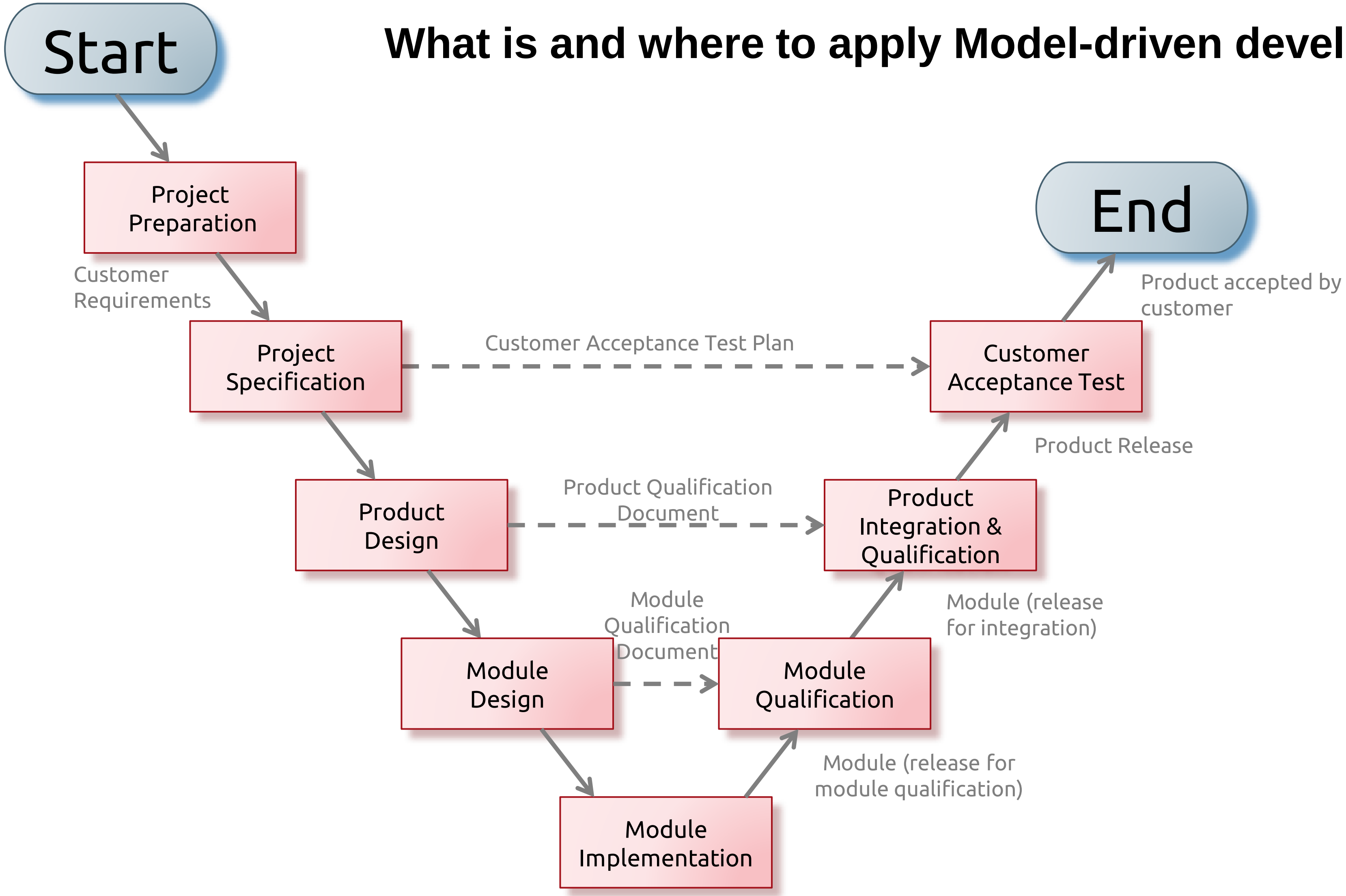
THE DEVELOPMENT PROCESS

What is and where to apply Model-driven development (MDD)



MDD as a framework to manage:

- Requirements
- Complexity
- Failure analysis

Project: Skytron Freedom

PROJECT: SKYTRON FREEDOM

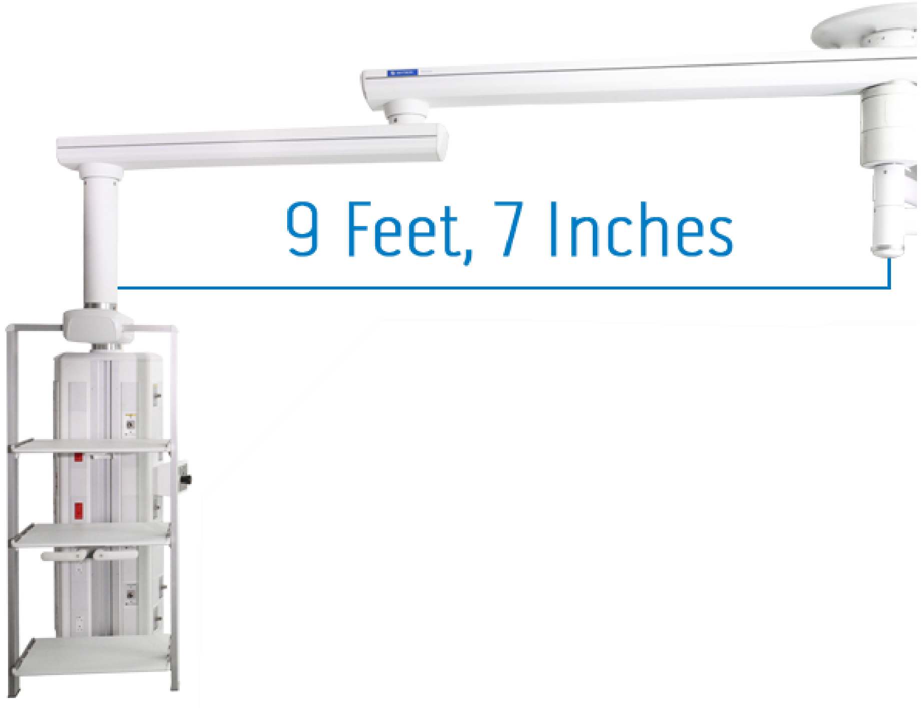
The Challenge

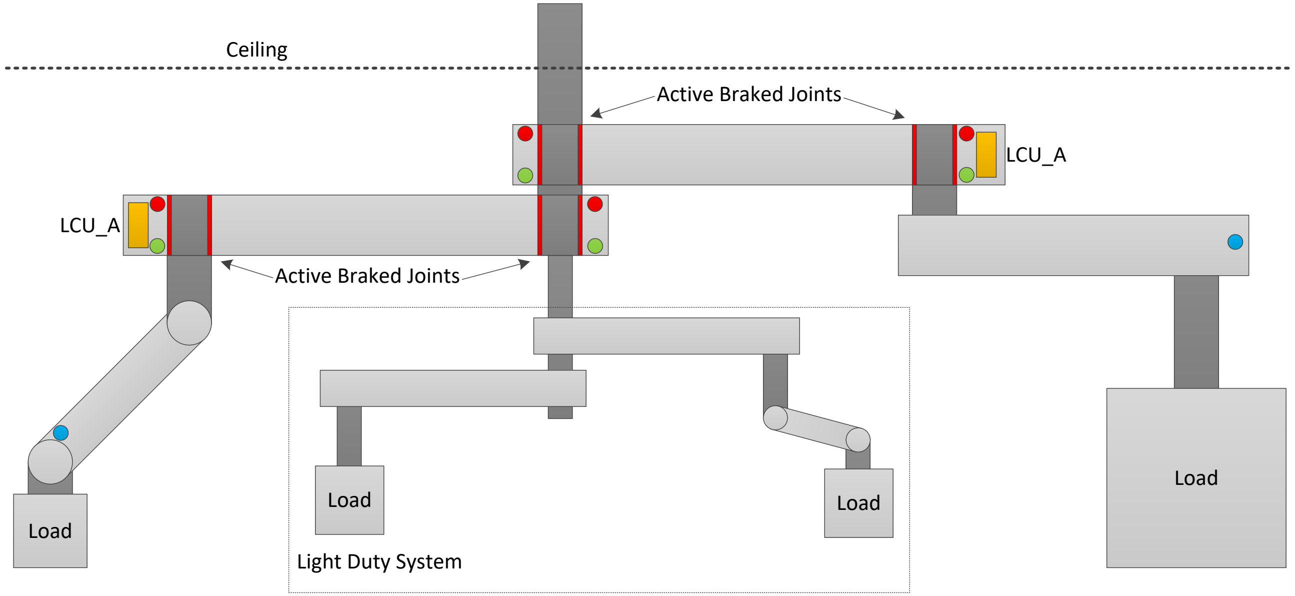
- Easy positioning and movement of arm
  - Drift due to mechanical bending
  - Interacting with devices on arm cause movement
  - Accidental impacts may have large consequences
- Intentional friction in joints
  - Takes quite some effort to move arm around
  - Wear on friction mechanism

PROJECT: SKYTRON FREEDOM

The Solution:

- Smart Braking System
  - Easy to move when needed
  - Stable when stationary
  - No special user interaction needed
  - Sensor system to detect user intention



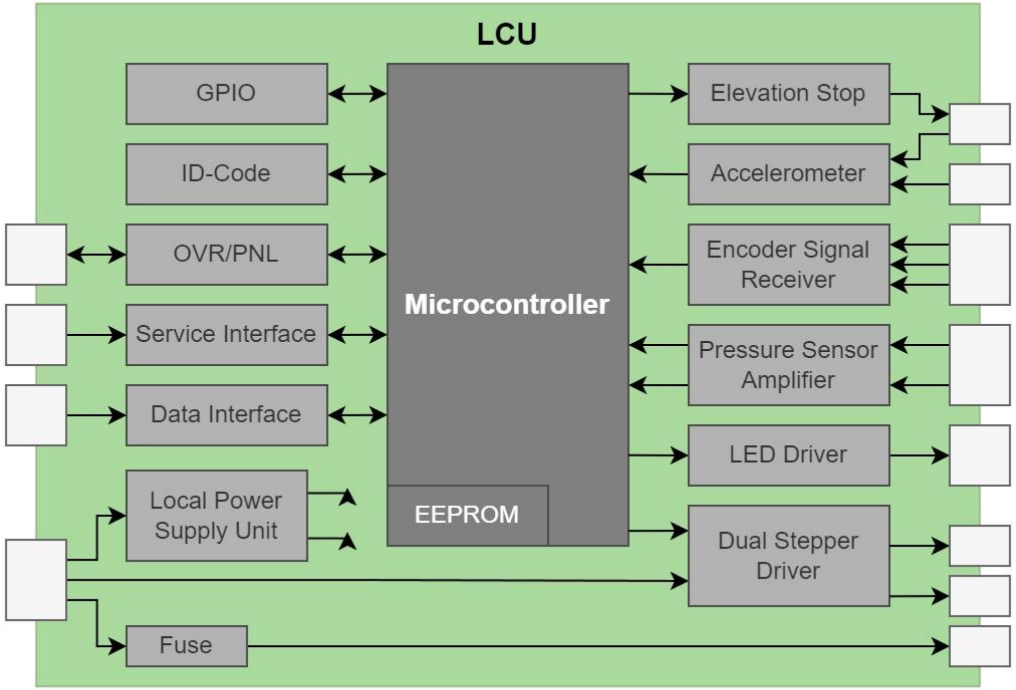


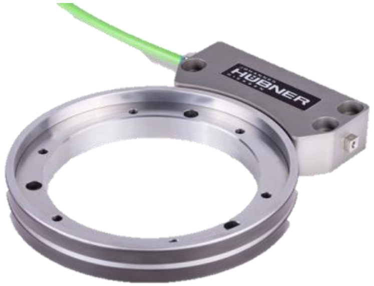
PROJECT: SKYTRON FREEDOM

Specification

- Ensure all hardware interfaces are accessible and controllable
- The desired “Excellent user experience” of the end-product

Mechanical design of brakes and arm were not available at the start of the project.

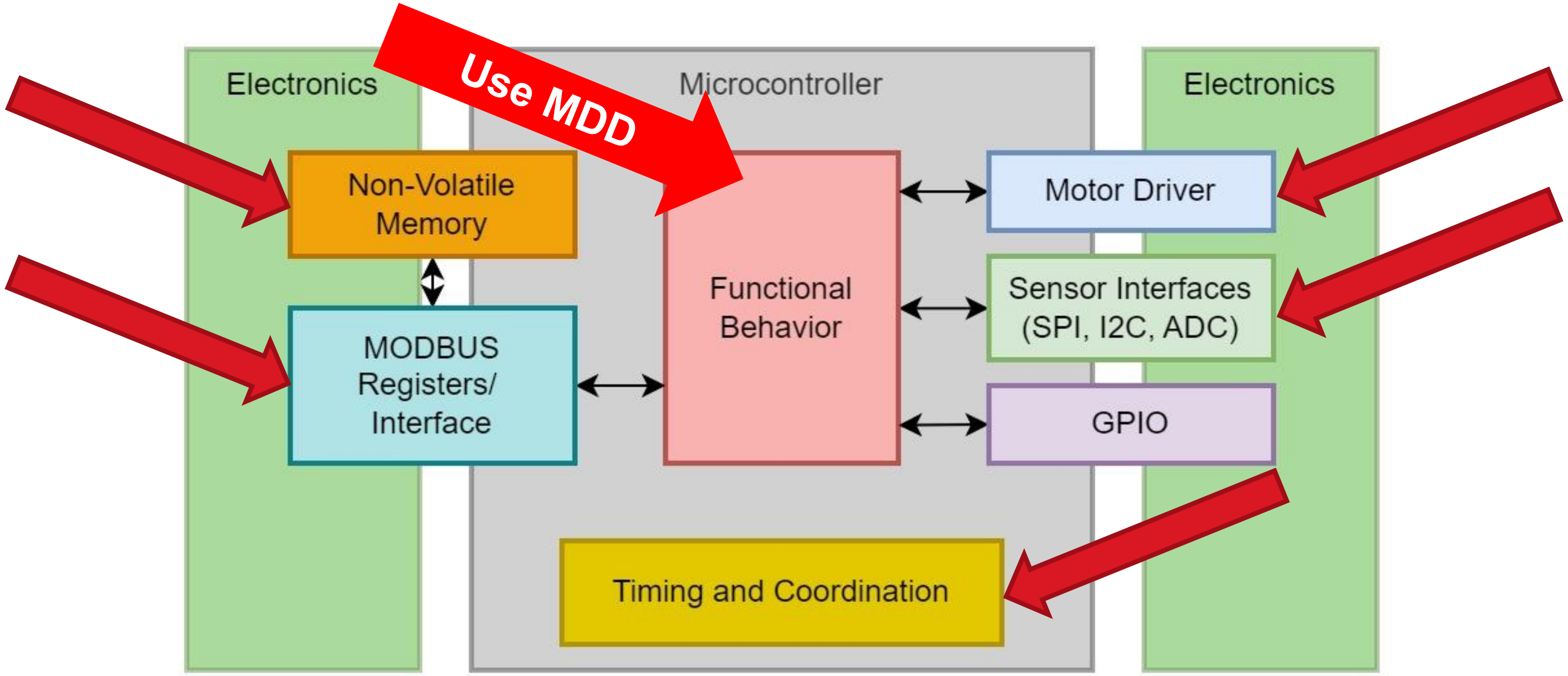




PROJECT: SKYTRON FREEDOM

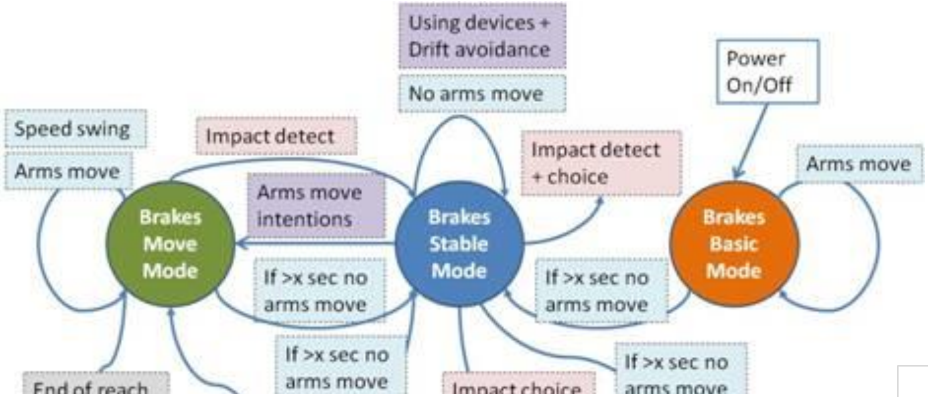
Development Strategy: Reduce development time and risk

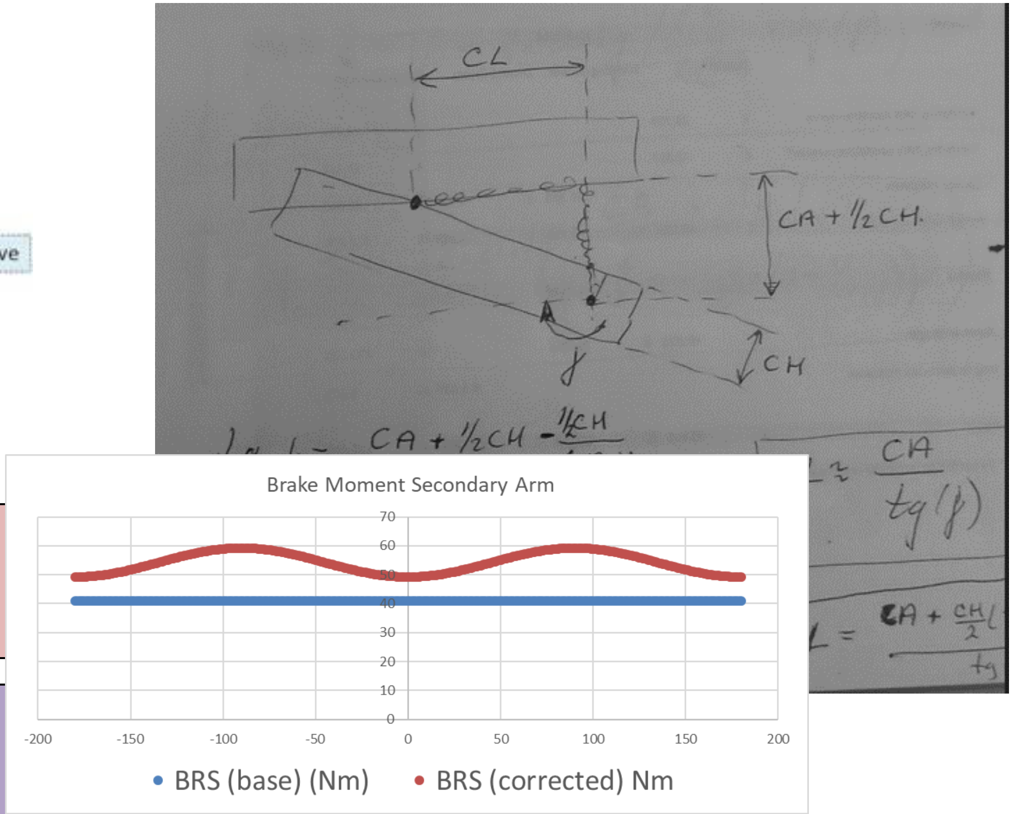
- Use of existing design experience for electronics and software
- Use MDD for functional behavior design and implementation



PROJECT: SKYTRON FREEDOM

Customer's Language





Aanpassen Brake Moment:

BRP-mimp: Brake = ALS(IMDM=true; *BRP-brake-max; Brake (last)*)

BRP-stab: Brake = ALS(STAB=true; BRP-stab; *Brake (last)*)

Aanpassen Brake Moment:

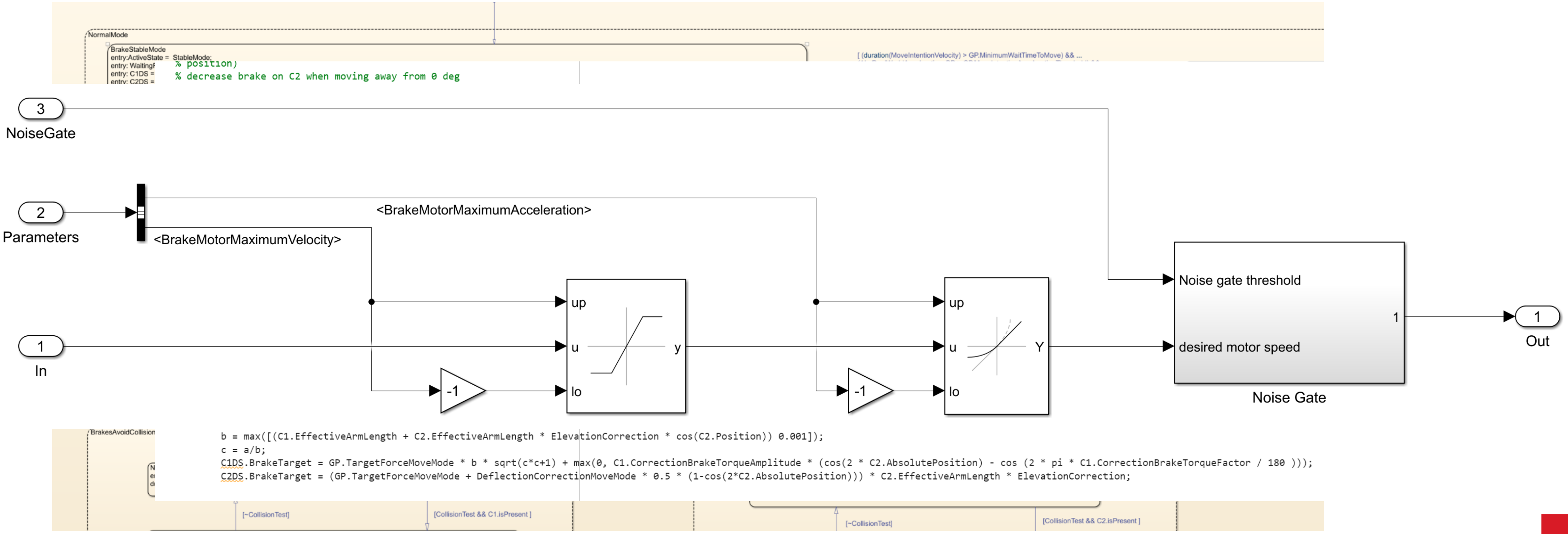
BRS-mimp: Brake = ALS(IMDM=true; *BRS-brake-max; Brake (last)*)

BRS-stab: Brake = ALS(STAB=true; BRS-stab; *Brake (last)*)

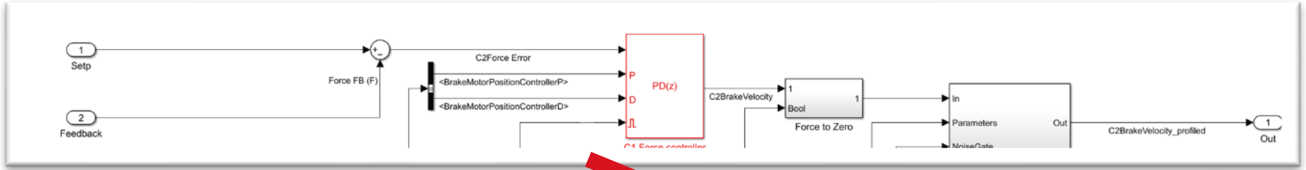
	(mg) Ax	(mg) Ay	(mg) Az	(rad) Ha	(rad) Hb	(rad) Hc	(rad/msec) Ha	(rad/msec) Hb	(rad/msec) Hc		MOVE intent	MOVE active	ROTATE pendant	ROTATE carrier		STABLE pendant	D H
47	3.267	-1.930	0.000	-1.300	-1.981	-1.539	3.728	22.371	22.371							JA	
48	3.118	-1.782	0.000	-1.300	-1.981	-1.545	3.728	26.099	22.371							JA	
49	2.970	-1.633	-0.015	-1.300	-1.969	-1.545	0.000	33.556	26.099				JA				
50	3.118	-1.782	0.000	-1.300	-1.969	-1.551	0.000	37.284	29.827				JA				

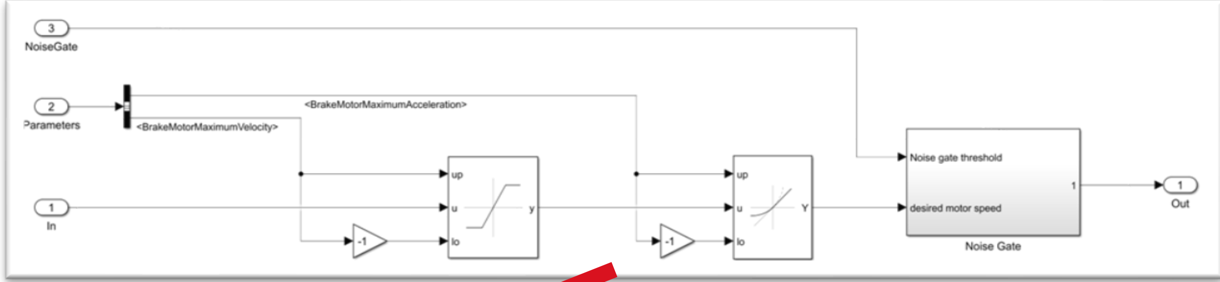
PROJECT: SKYTRON FREEDOM

Translation to model

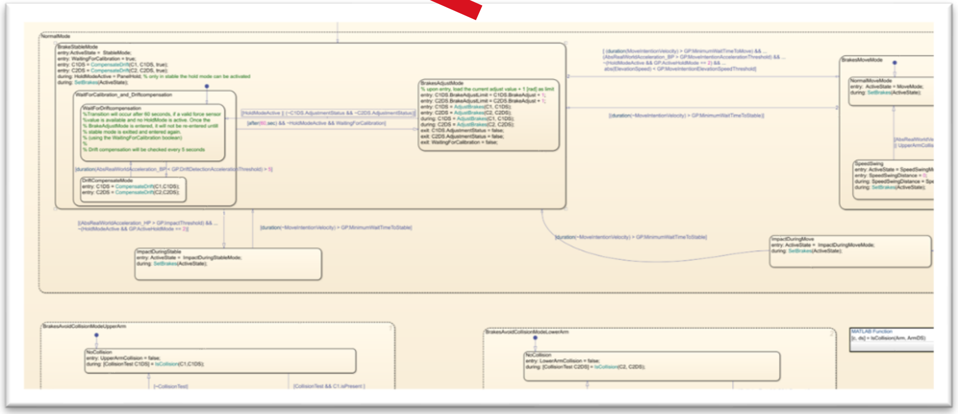


PROJECT: SKYTRON FREEDOM





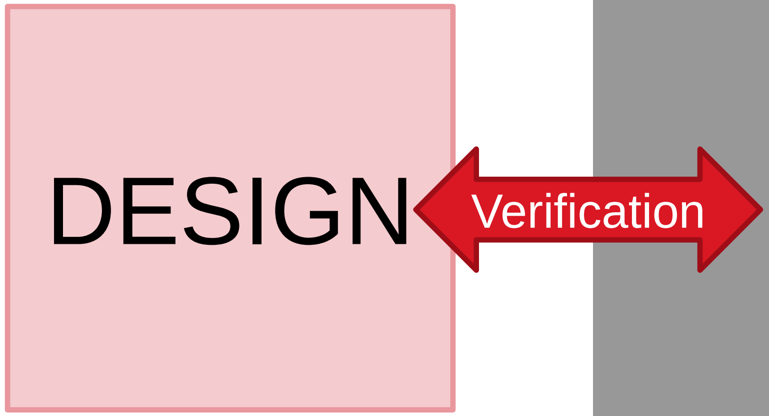
The Design of the Functional Behavior

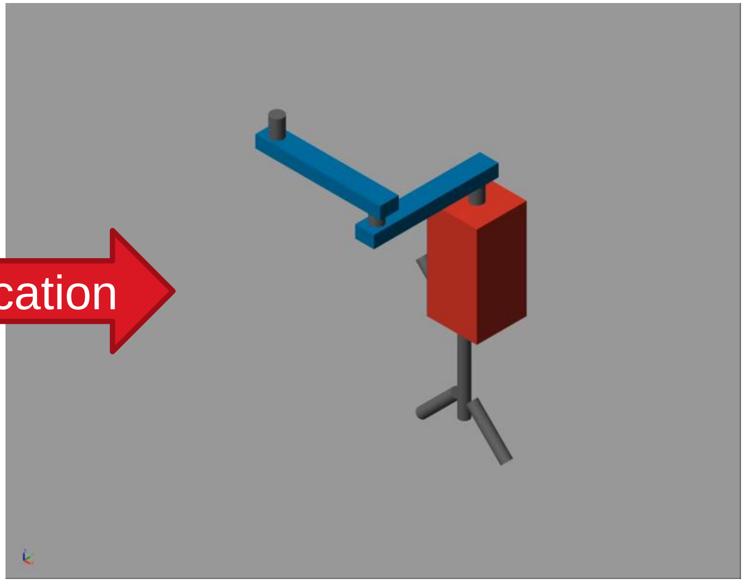


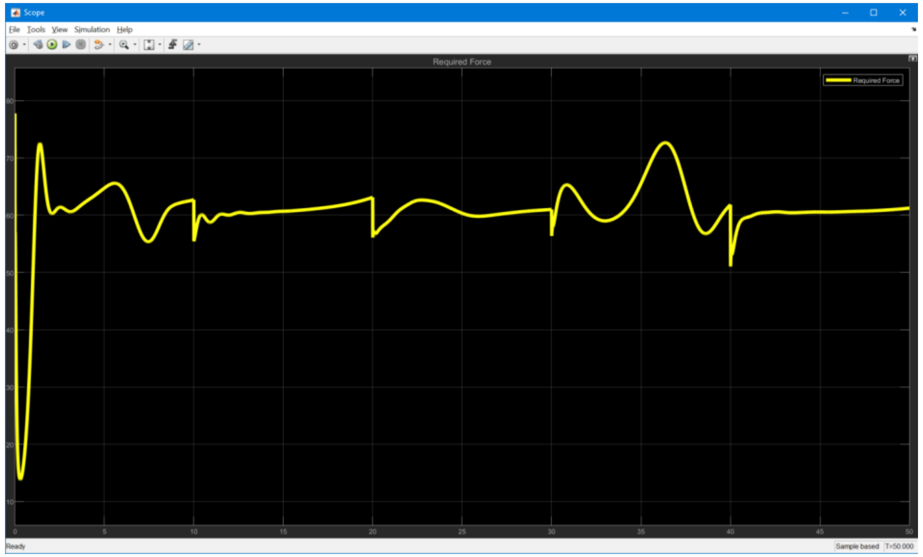
D&E EVENT
Het ontwerpen van innovatieve elektronica
Woensdag 20 maart 2024
1931 Congrescentrum 's-Hertogenbosch

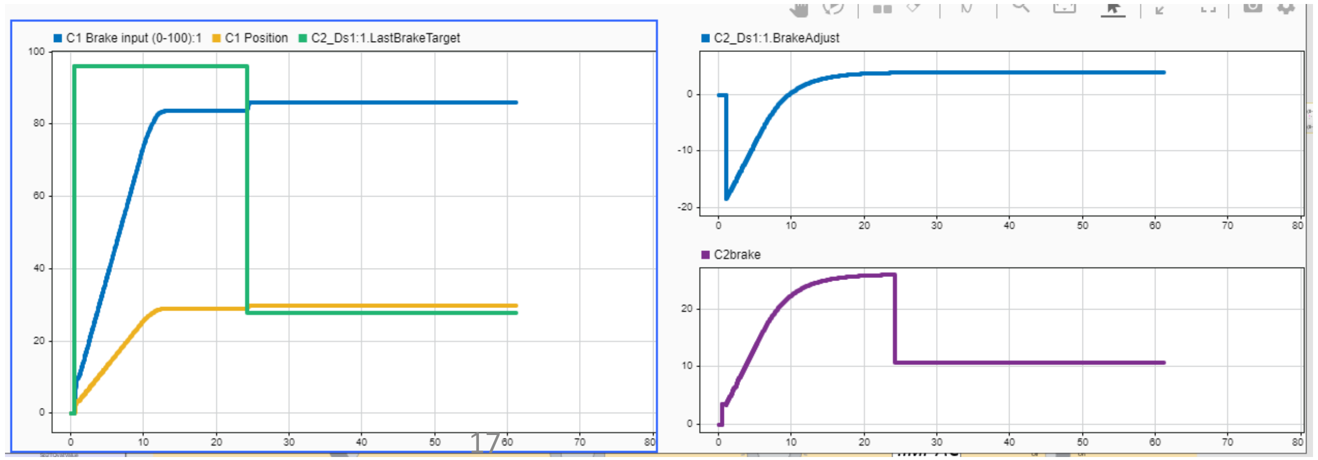
PROJECT: SKYTRON FREEDOM

Verification



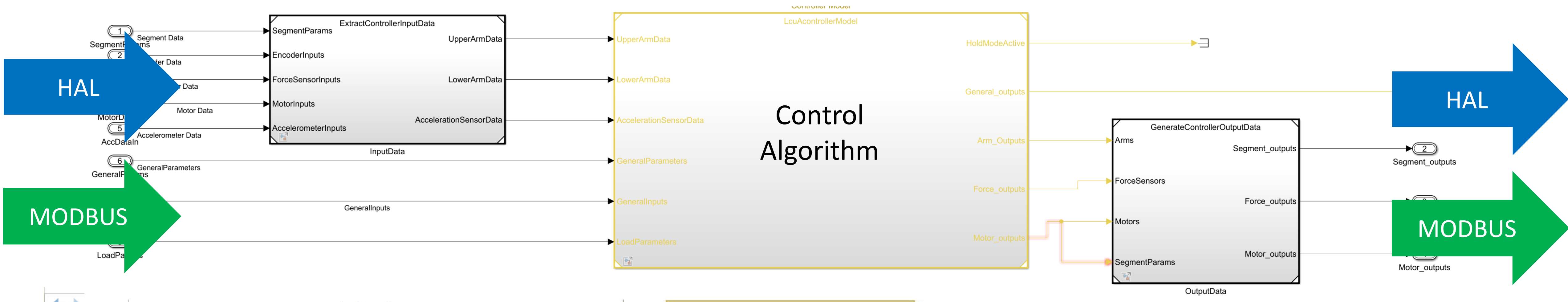


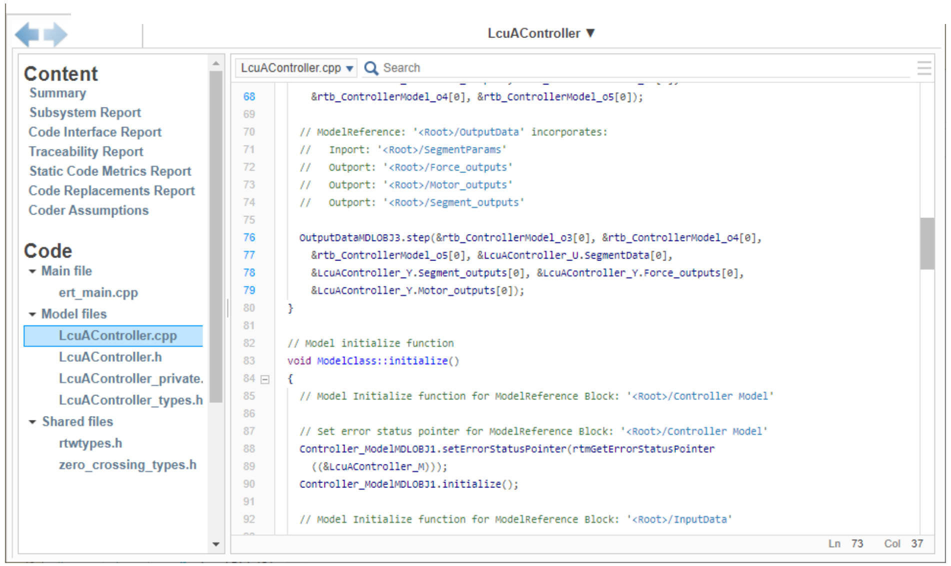


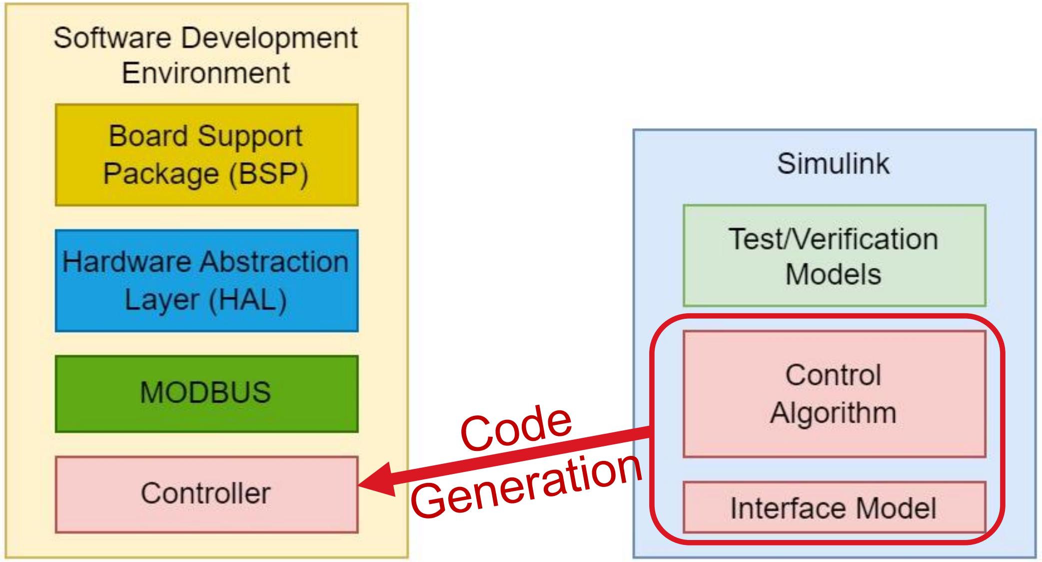


PROJECT: SKYTRON FREEDOM

Translation to model



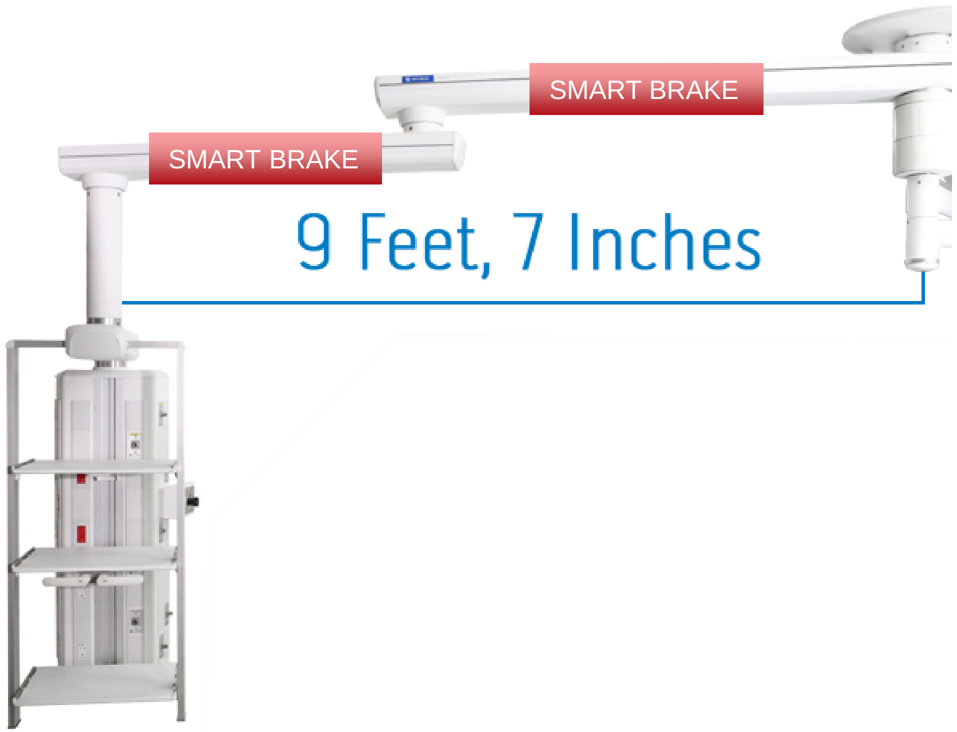


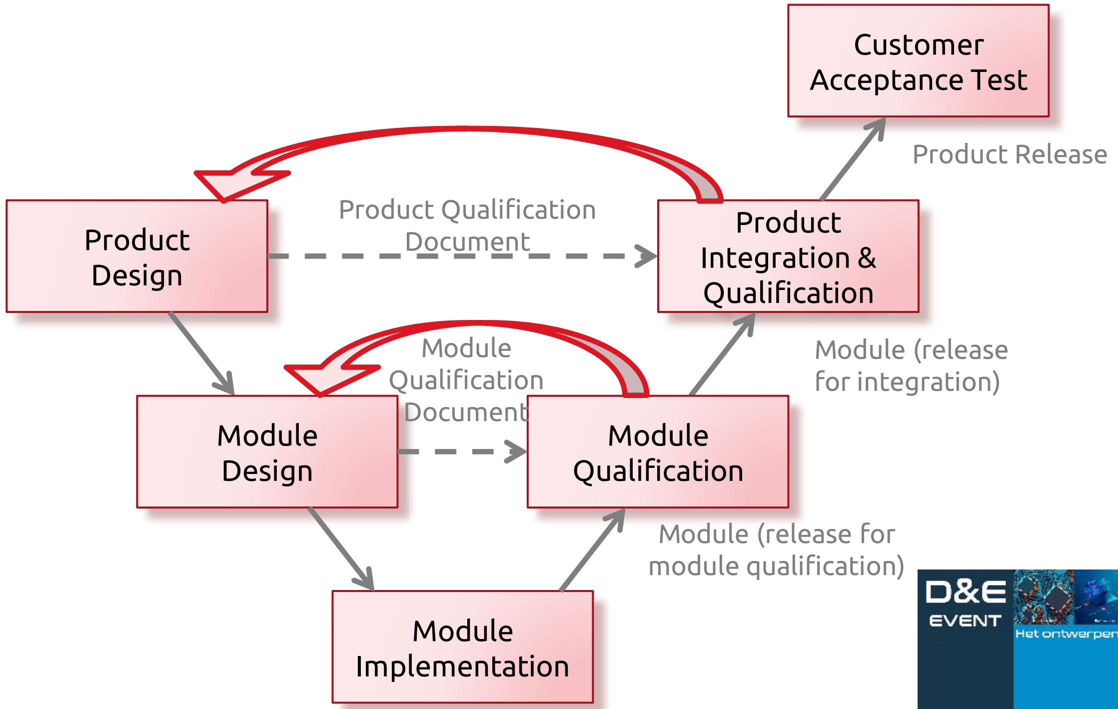


PROJECT: SKYTRON FREEDOM

Integration

- Comparison between model and mechanical system
  - Optimize system and model
- Rapid design iterations to achieve the “*Excellent User Experience*”



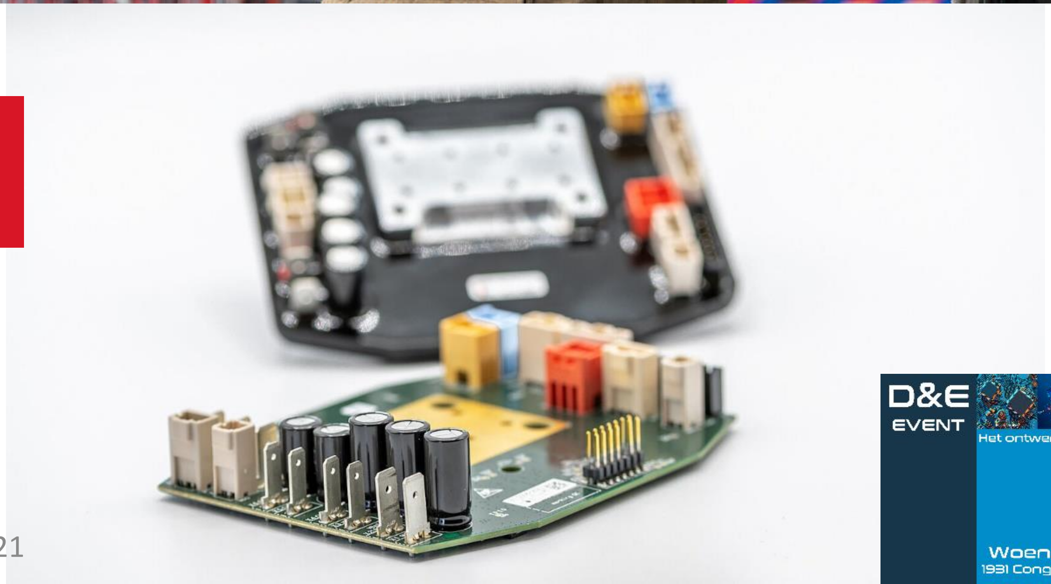


KEY TAKEAWAYS

	Project	Customer Challenge	Strategy	Results
Co - development		*- System is mechanically sub-optimal.* *- Ambiguous requirements*	*- Use models to verify understanding of requirements.* *- Use MDD as a framework, design methodology and a common language.*	*- Reduced development costs and time-to-market* *- Autogenerated 17k+ lines of source code in 4 minutes.* *- Shortened design iterations: day(s) instead of weeks.*

Racing Car by Solar Team Twente, picture © Solar Team Twente

Project: Sensorless Motor Control



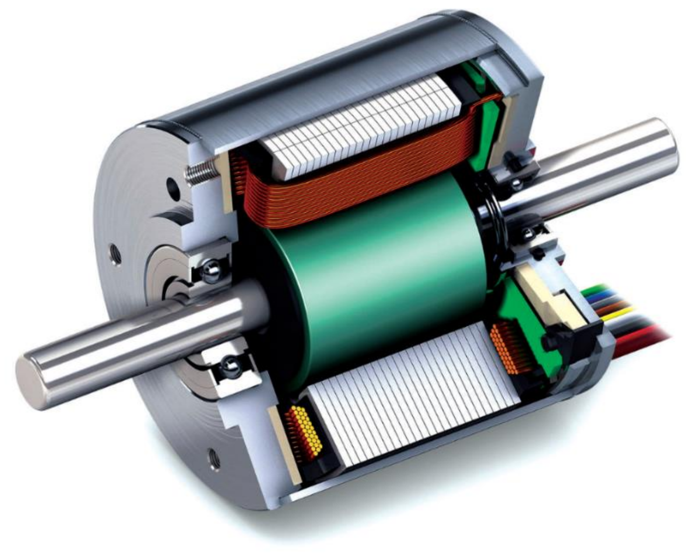
PROJECT: SENSORLESS MOTOR CONTROL

The challenge

- Develop, evaluate and optimize high performance sensorless motor control solutions.

- Feasibility studies:
  - Electrical/Mechanical system
  - Execution timing (PIL)

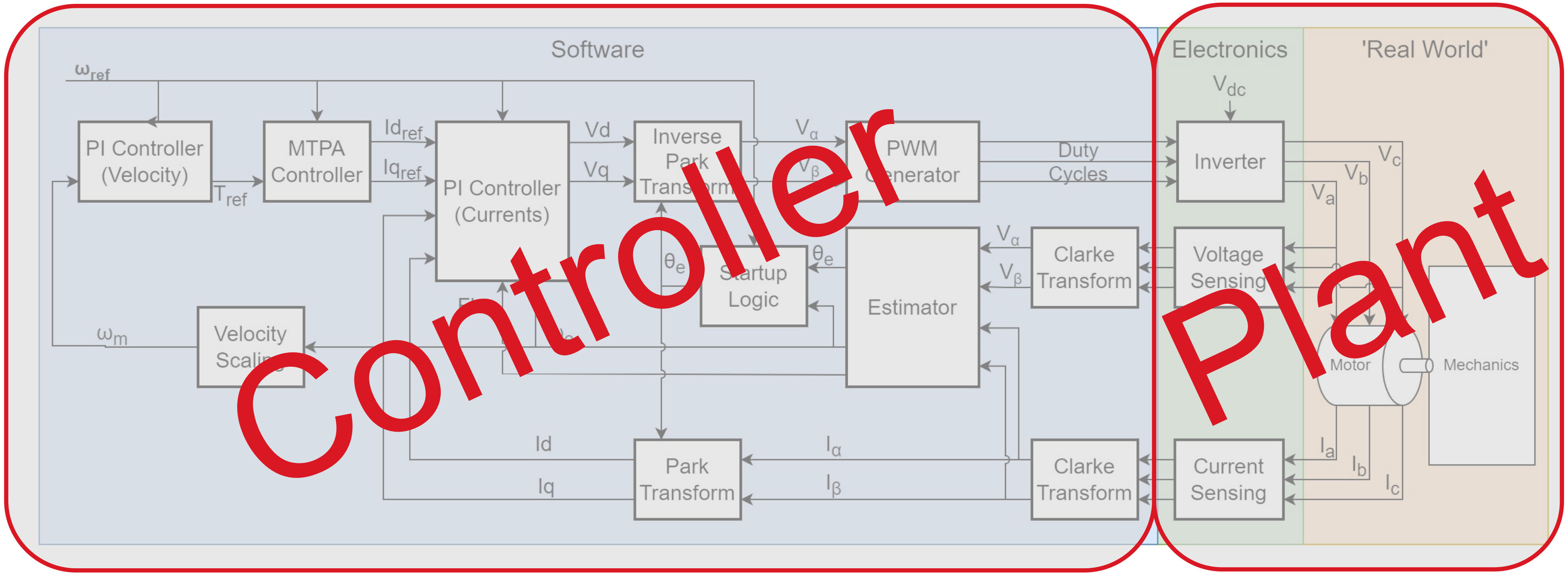
- Make control algorithm target independent.



PROJECT: SENSORLESS MOTOR CONTROL

The Solution

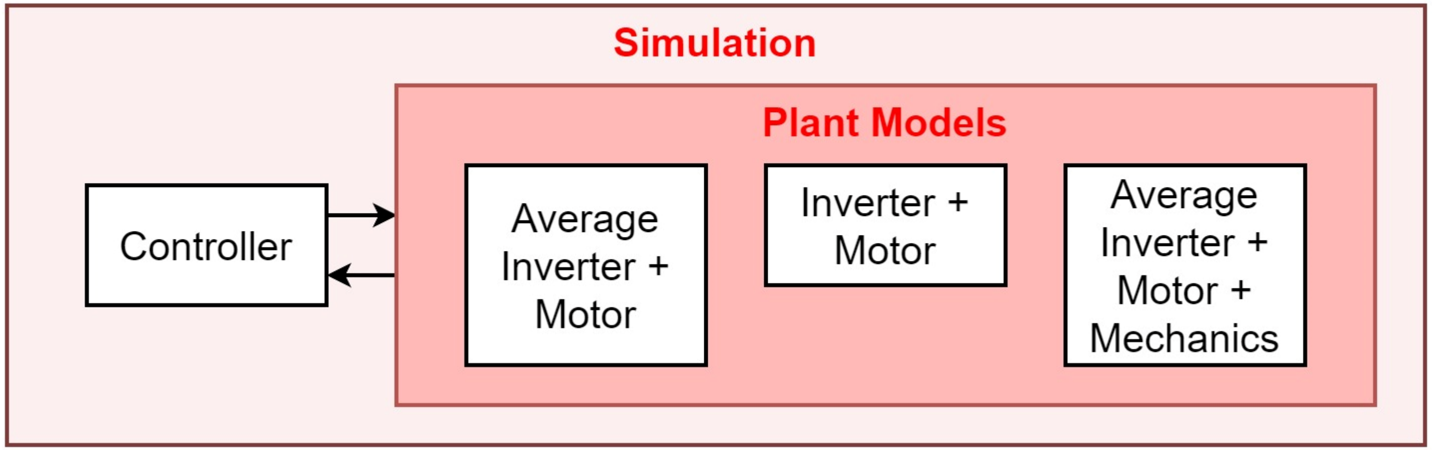
- Use Simulink to create multi domain models with clear interfaces.
  - Motor Control Blockset for Control Algorithm
  - Simscape Electrical for Motor Drive Electronics and Motor model
  - Simscape Multibody for System Mechanics



PROJECT: SENSORLESS MOTOR CONTROL

Development Strategy: Reduce development time and risk

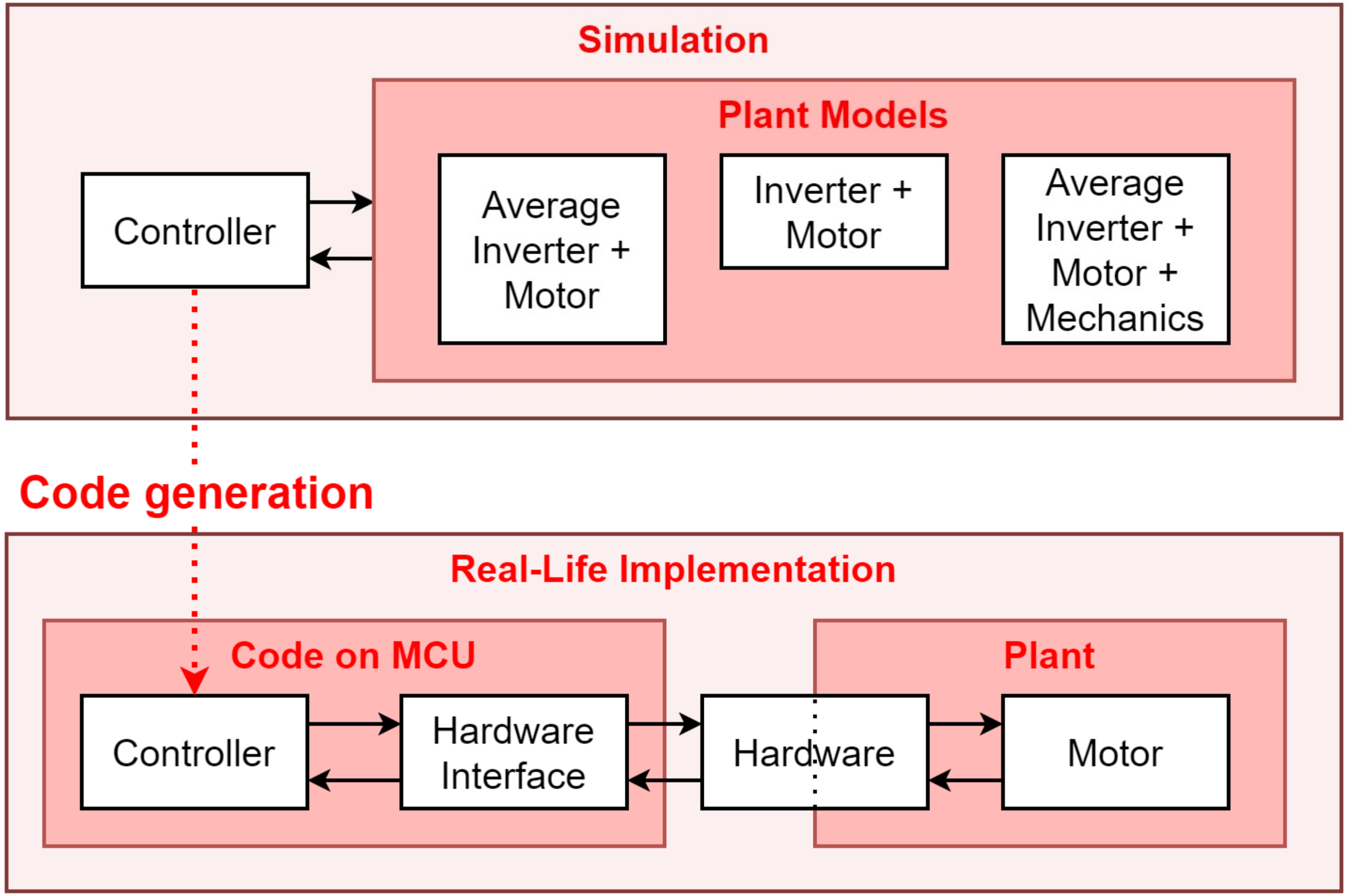
- Design and validate the controller for different operating conditions.
  - Startup behavior
  - Inverter behavior
  - Mechanical behavior



PROJECT: SENSORLESS MOTOR CONTROL

Development Strategy: Reduce development time and risk

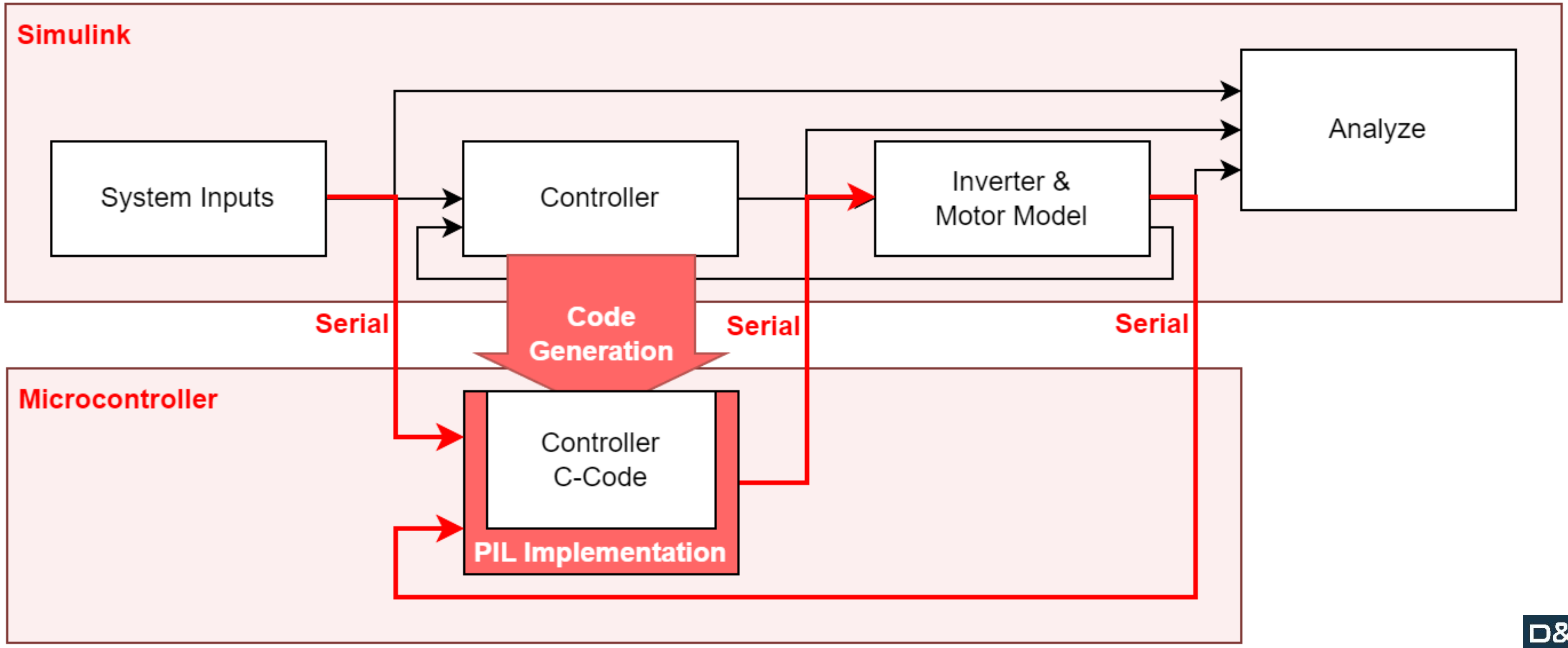
- Use Embedded Coder to generate code.



PROJECT: SENSORLESS MOTOR CONTROL

Example Feasibility study: Execution timing

- Processor in the Loop



PROJECT: SENSORLESS MOTOR CONTROL

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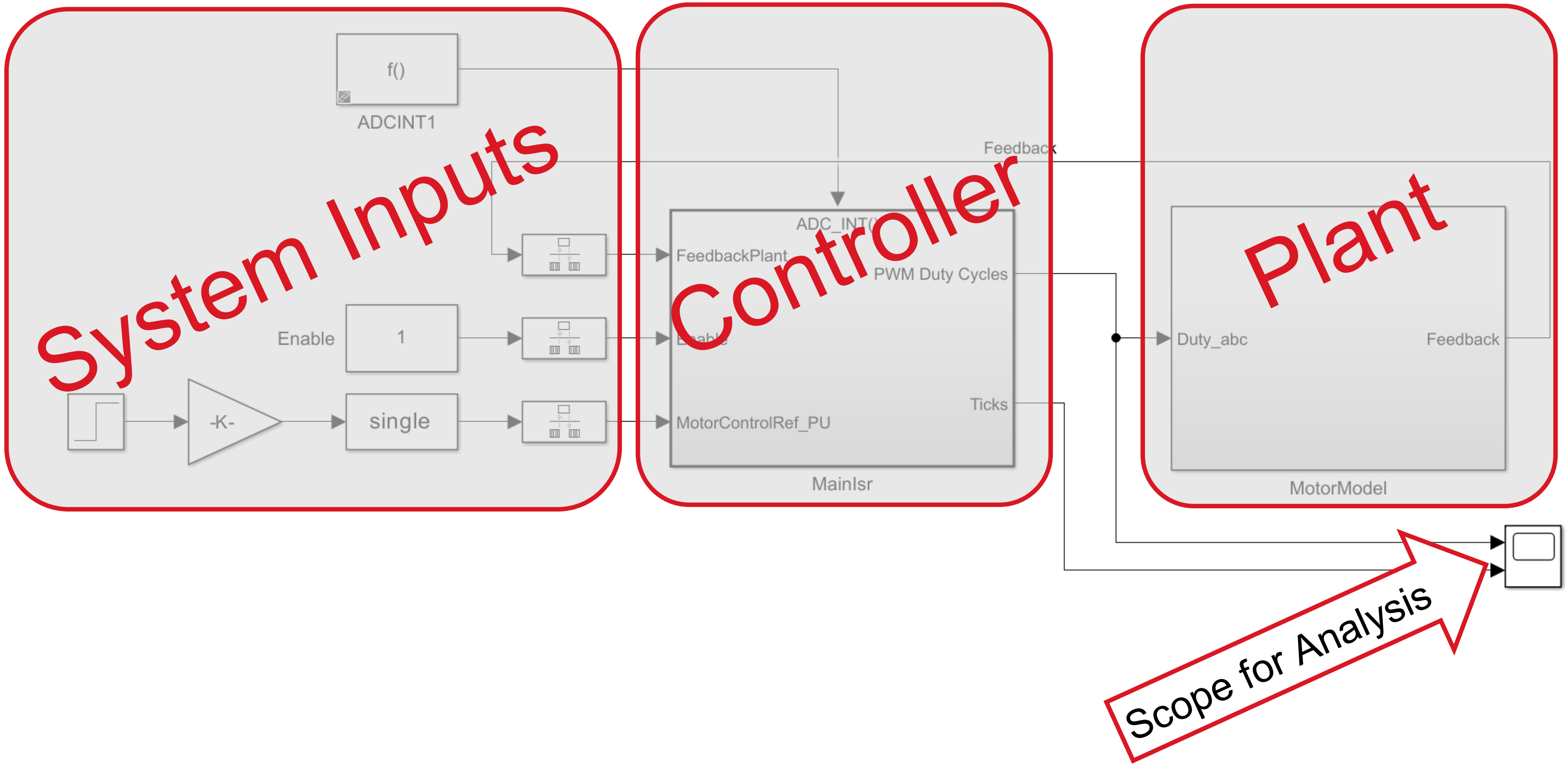

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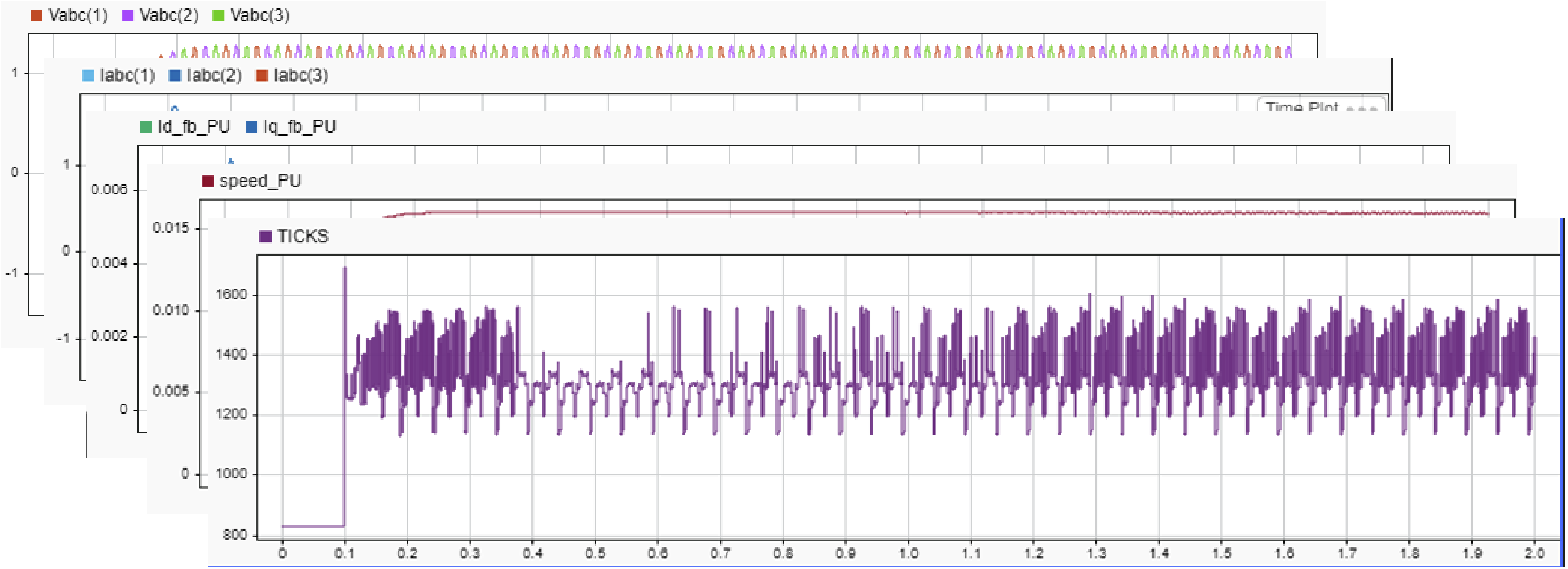
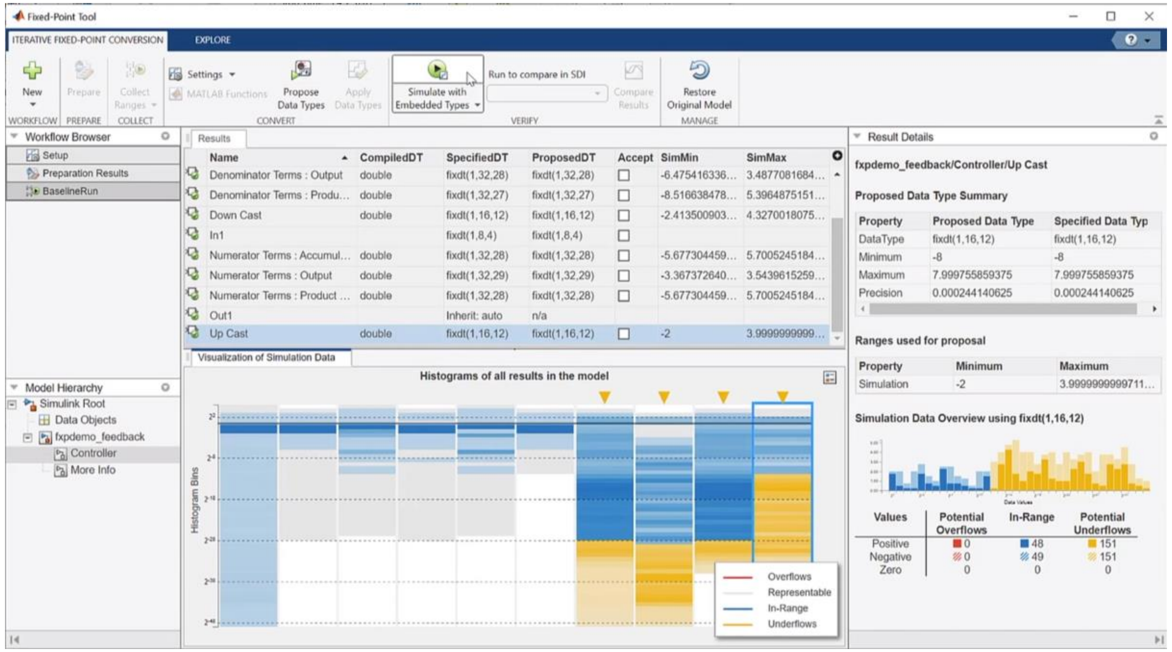


PROJECT: SENSORLESS MOTOR CONTROL

Future Plans

- Convert base datatype to fixed-point using Fixed-Point Designer Toolbox.
- Optimize computationally intensive math functions (Accuracy vs execution efficiency).



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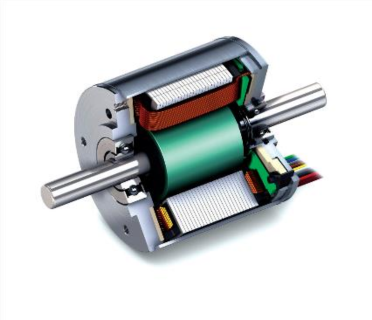
Innovation & support		*- Development of high-performance control algorithms is costly as it is target-dependent.* *- Feasibility studies of mechanical systems.*	*- Use Simulink to create multi domain models with clear interfaces.* *- Use Embedded Coder to generate target independent code.*	*- Met code execution time requirement of <30 µs.* *- Answered feasibility questions in weeks instead of months.* *- Achieved better software quality / decreased errors.*

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3T IS WHERE TECHNOLOGY AND QUALITY MEET.

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High-precision applications

Working in Harsh Environments

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Business Development
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More about 3T

D&E EVENT

Het ontwerpen van innovatieve elektronica

Woensdag 20 maart 2024
1931 Congrescentrum 's-Hertogenbosch