ELECTRIC VEHICLES INTERNATIONAL
CONFERENCE & SHOW

Powerful Advanced N-Level Digital Architecture
for models of electrified vehicles and their components

Workshop PANDA

Functional and structural representation under Simcenter Amesim

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Siemens Industry Software

SIEMENS
Ingenuity for life

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Outline

1. **Simcenter Amesim**
   - Mechatronic systems - examples
   - Electric vehicle models

2. **Functional vs Structural representation**
   - Simcenter Amesim – Signal&Control - Functional library
   - Matlab-Simulink vs. Simcenter Amesim equivalence
   - Simcenter Amesim – Structural libraries
   - Spring - Mass - Damper system
   - Simple hydraulic line and orifice

3. **EV simulation under Simcenter Amesim**
   - EV under study
   - EMR vs. structural representation
   - Simulation results

« Simcenter Amesim »

Simcenter Amesim

Model-based system testing

Industry specific

- Vehicle integration
- Vehicle electrification
- ADAS and autonomous vehicle
- Powertrain controls
- Engine design
- Aftertreatment
- Transmission
- HVAC
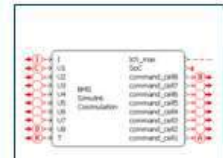- Engine thermal management
- Vehicle dynamics
- Powertrain subsystems

Pre-design

Systems sizing and integration

Performance balancing

Controls validation
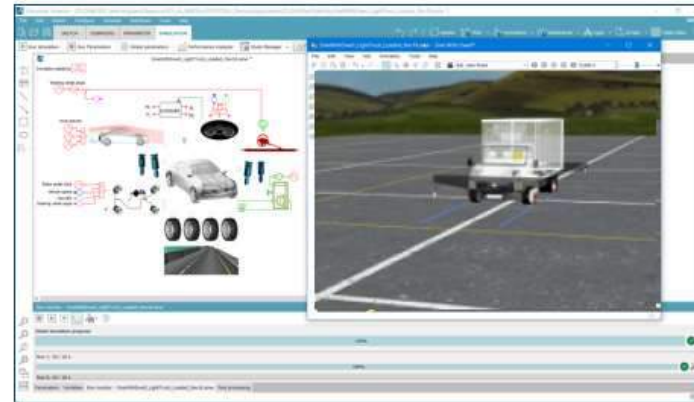
Scalable simulation

Connecting "mechanical" – "controls"

Model reduction for real-time

Co-simulation

Open and customizable
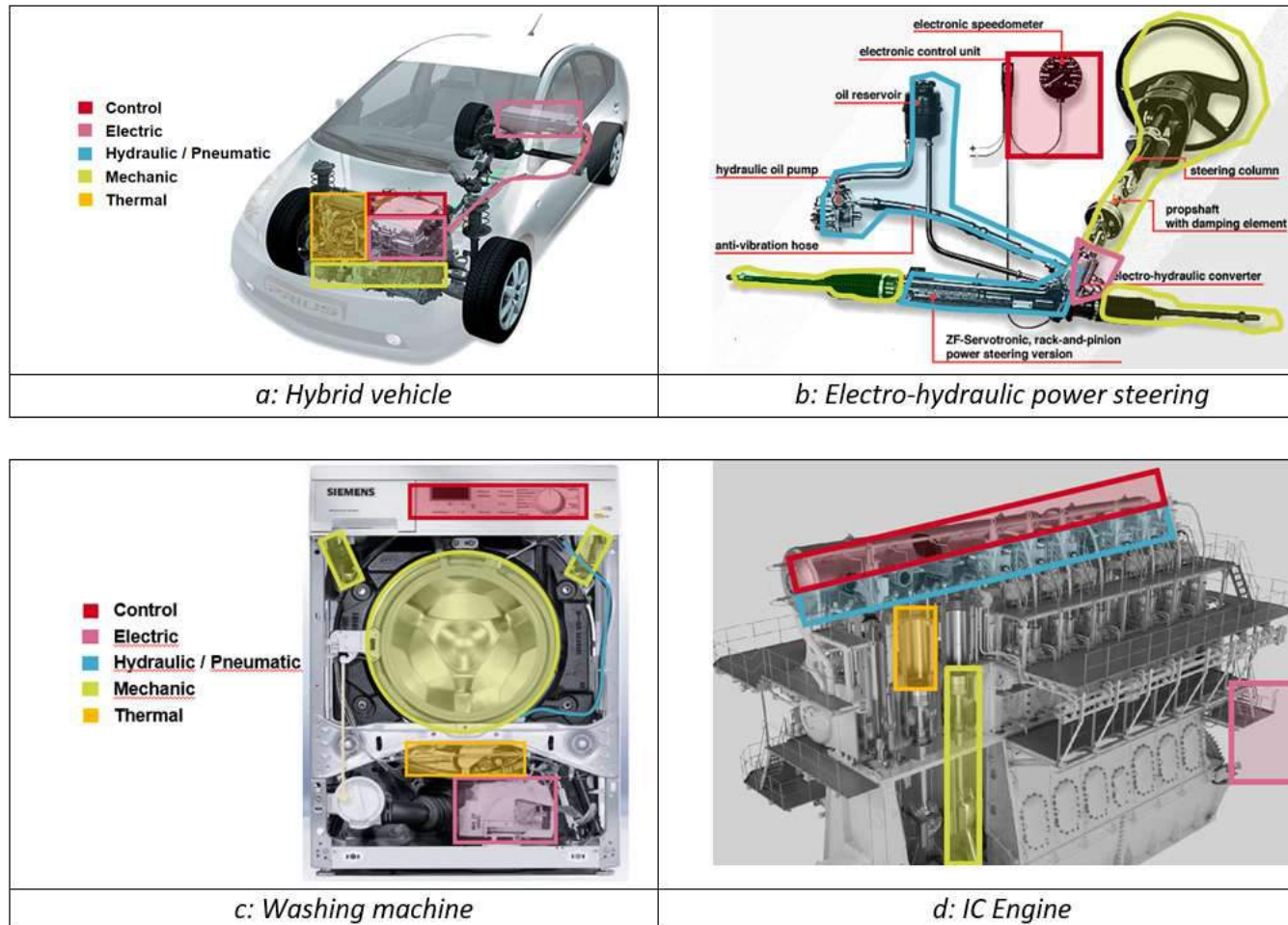
>48 libraries

>6,500 multi-physics models
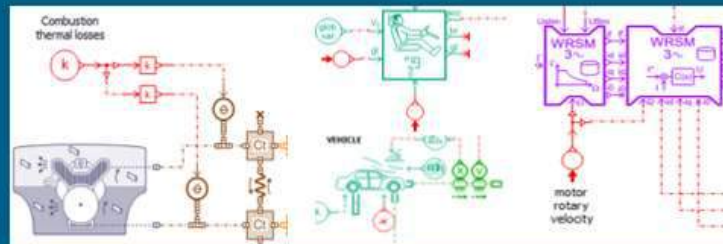
Hydraulics
Pneumatics
Thermal
Electrical
Mechanical
Signals

System architecture management

Simcenter Amesim mechatronic systems

Legend (a & c):
- Control
- Electric
- Hydraulic / Pneumatic
- Mechanic
- Thermal

a: Hybrid vehicle

b: Electro-hydraulic power steering

Labels in b: electronic speedometer, electronic control unit, oil reservoir, hydraulic oil pump, anti-vibration hose, steering column, propshaft with damping element, electro-hydraulic converter, ZF-Servotronic, rack-and-pinion power steering version

c: Washing machine

d: IC Engine

Simcenter Amesim - Electric vehicle models
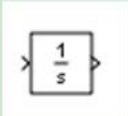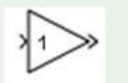
«Functional vs Structural representation »

 03/10/2019

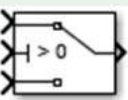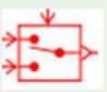# Simcenter Amesim – Signal&Control - Functional library
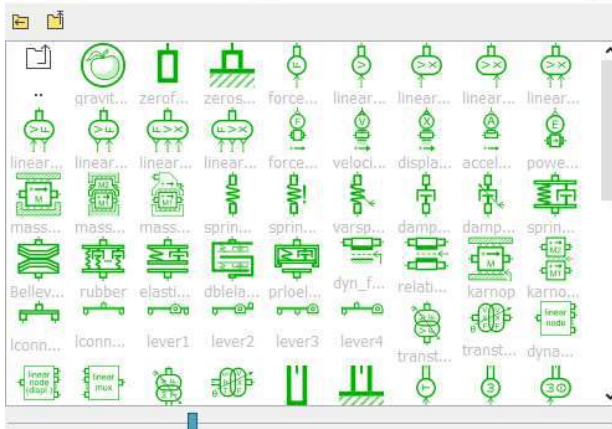
Matlab-Simulink vs. Simcenter Amesim equivalence

	Matlab-Simulink	Simcenter Amesim
Integrator		
PID Controller		
Saturation		
Gain		
Mux		
Switch		

03/10/2019

Simcenter Amesim – Structural libraries

> 48 Libraries

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Spring - Mass - Damper system

Input: Force   Output: velocity

Mass = 1 kg

Spring stiffness = 100 000 N/m

Damper rating = 1000 N/(m/s)
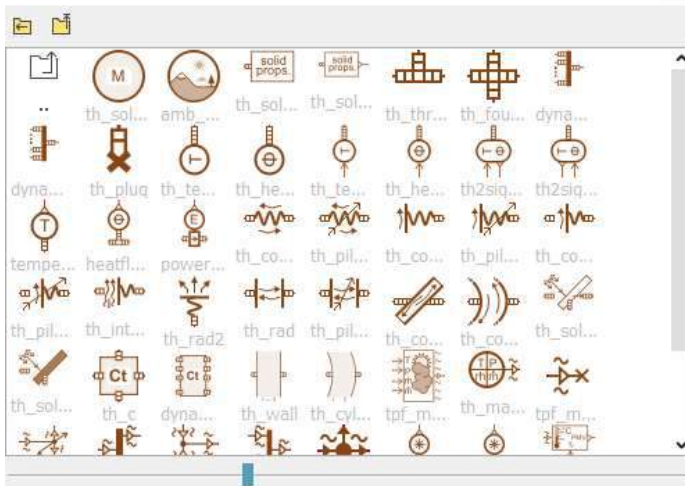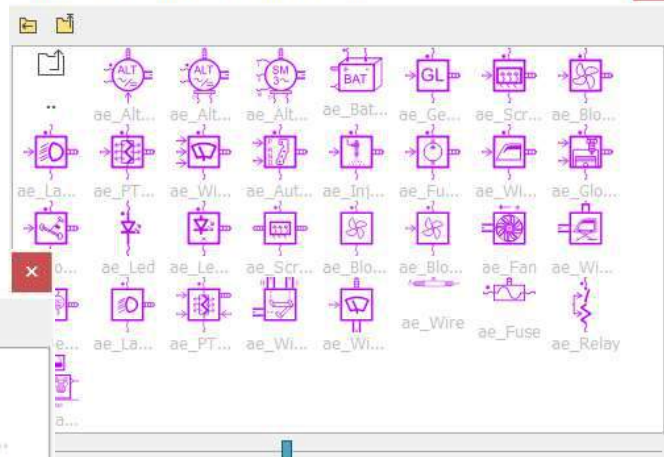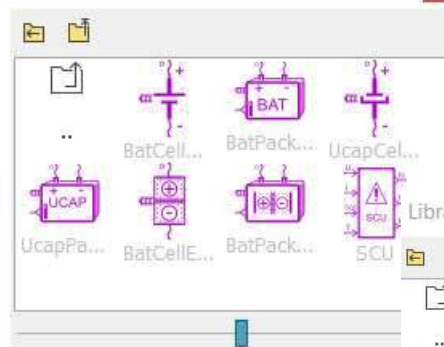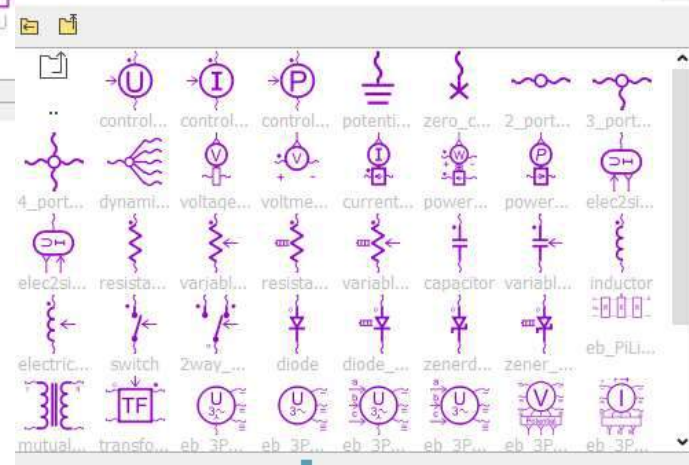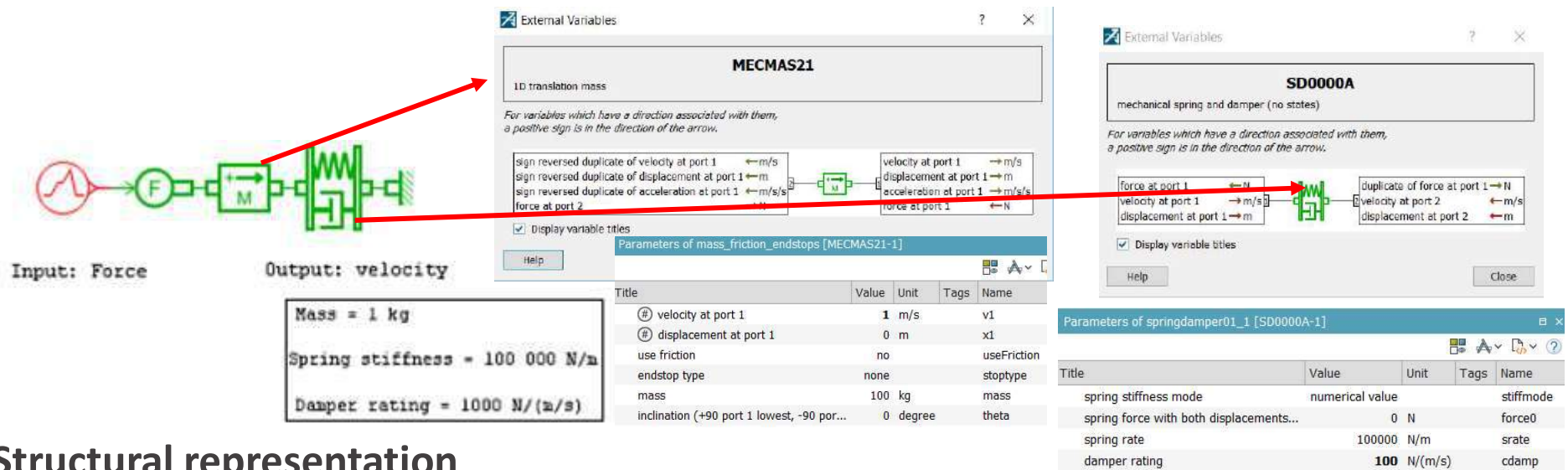
Structural representation

Functional representation

Spring stiffness = 100 000 N/m

Damping coeff = 1000 N/(m/s)

dV/dt

F   V   x

gain = 1/Mass   V
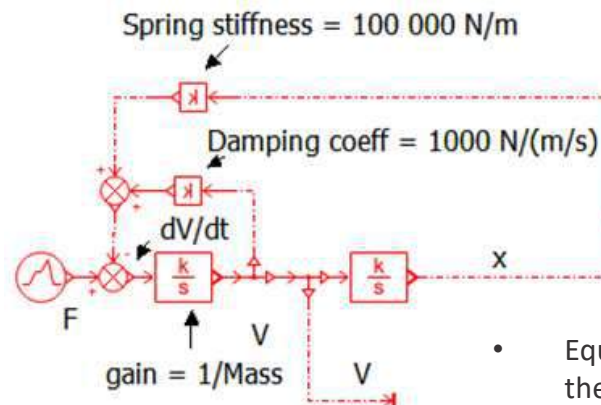
- Equivalent model build based on the mathematical equations

Simple hydraulic line and orifice

Structural representation

Model Line: C,I,C (Volume, Inertia, Volume)   Restriction   Circuit

Functional representation

«EV simulation under Simcenter Amesim »

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EV under study

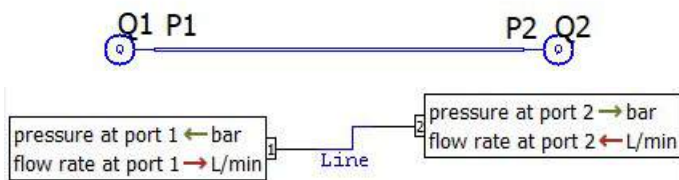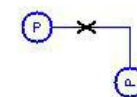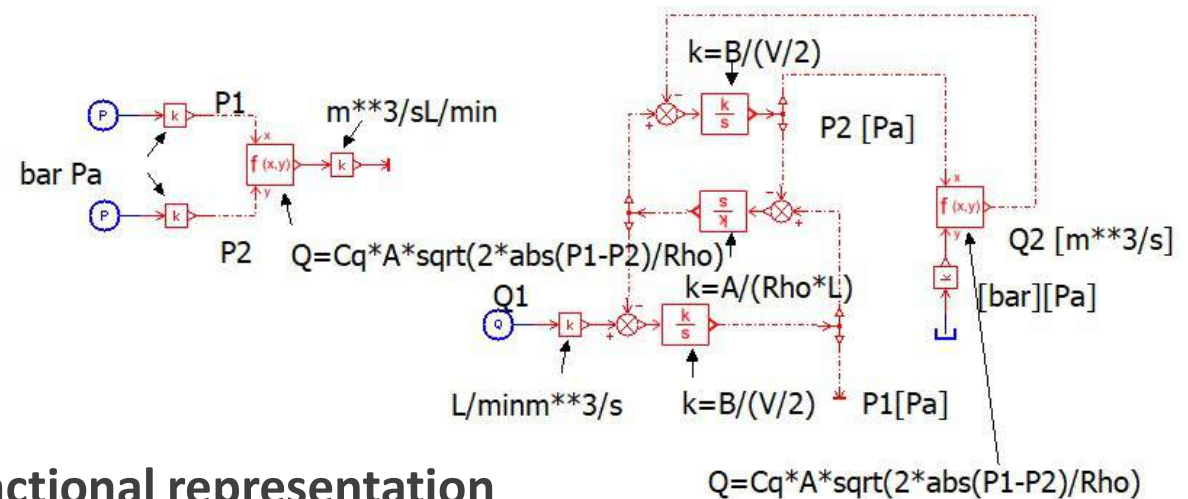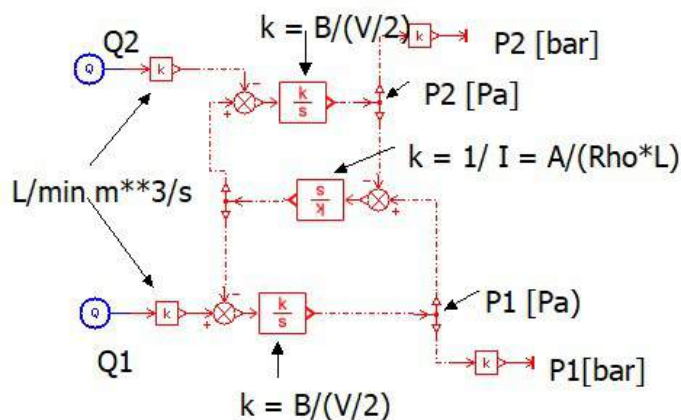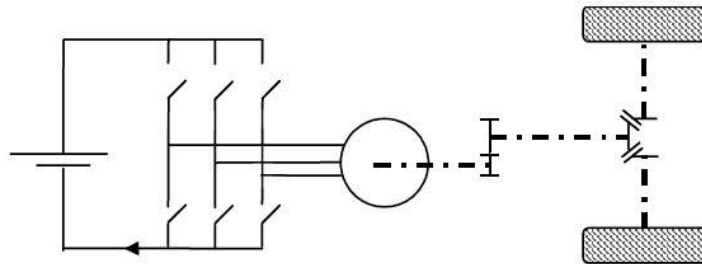- Battery - modelled by a simple source of D.C. voltage;
- PMSM - replaced by a DC machine;
- The Chopper - considered with a constant efficiency;
- Mechanical transmission - composed of a gearbox, a mechanical differential and one equivalent wheel;
- The chassis - represented with an equivalent mass.
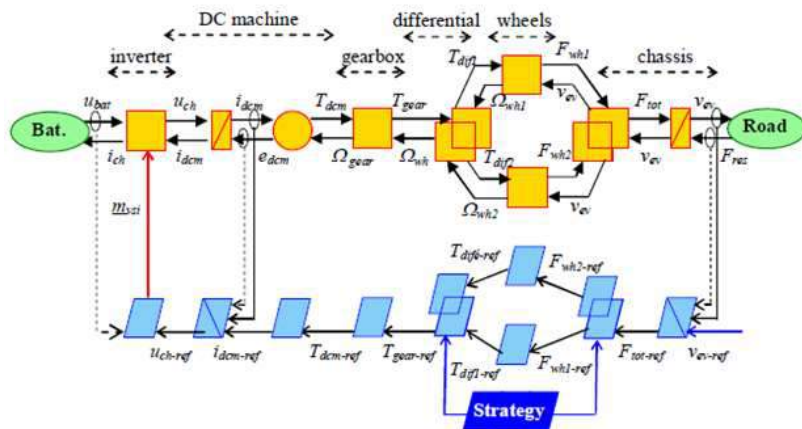
Global Parameter Setup - EV_19.ame
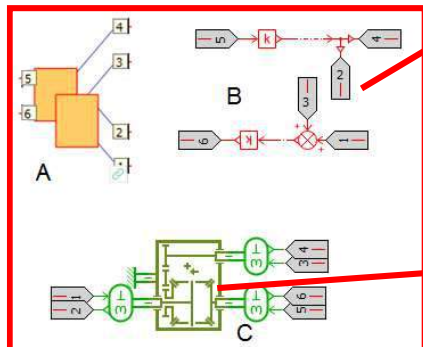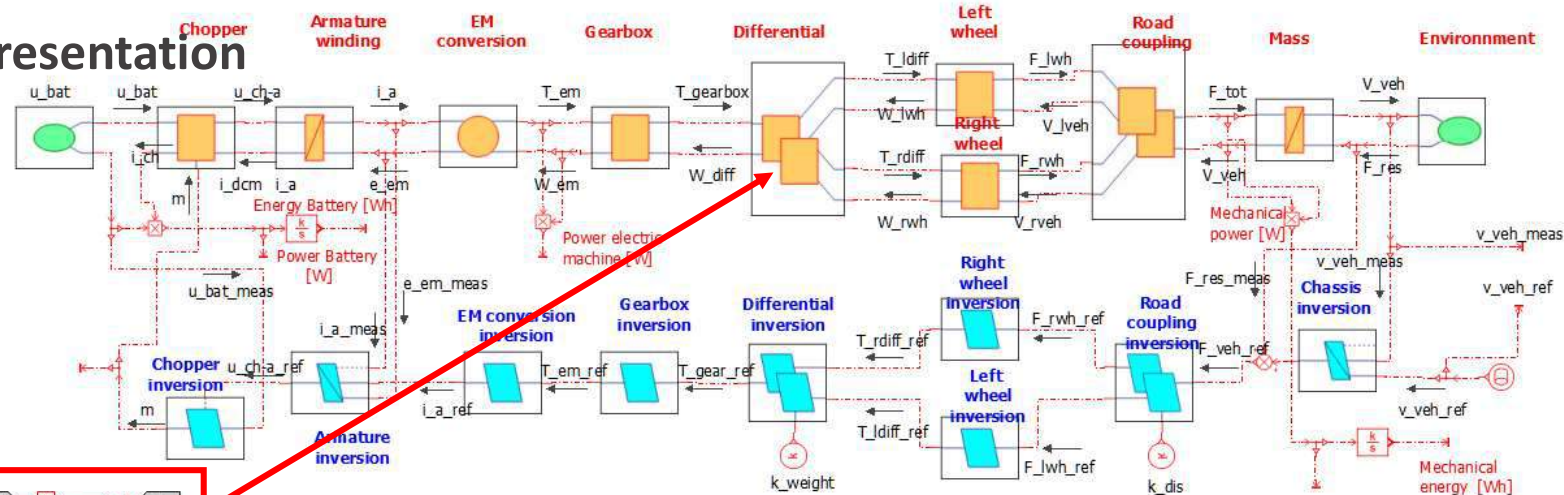
Right click to set global parameters: Search: _____ ✓ ⊗   More >

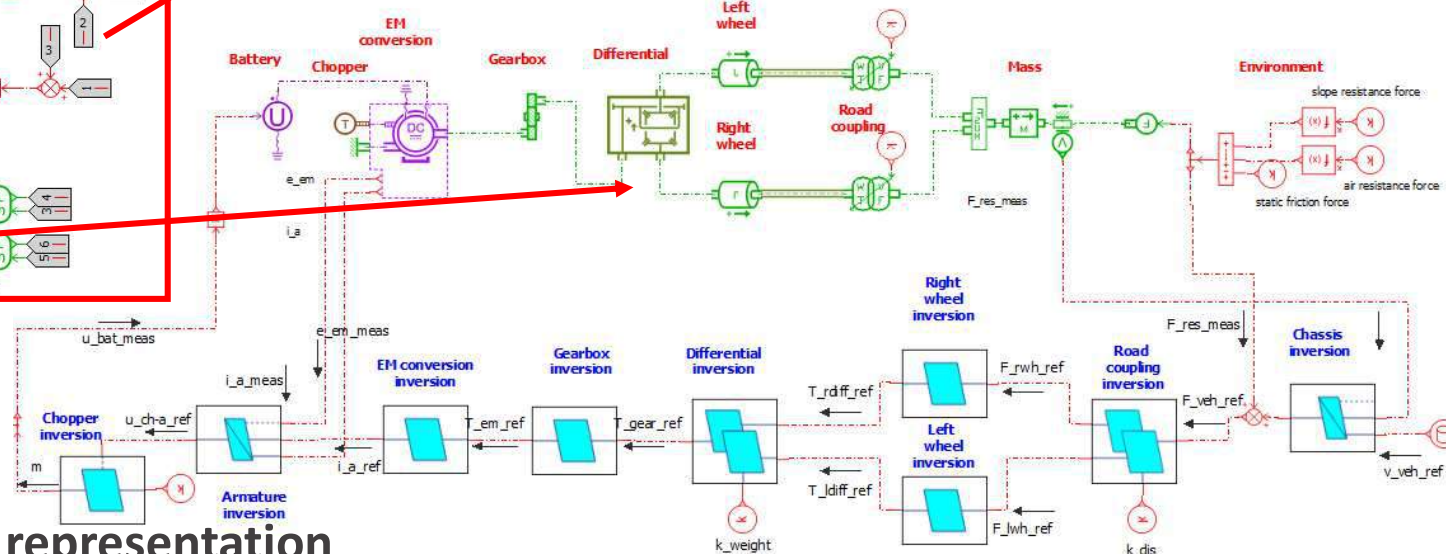| Name	Title	Value	Unit
BATpV_batt	battery tension	400	V
EMpU_arm_nom	DC nominal tensi...	400	V
EMpI_arm_nom	DC nominal curr...	162	A
EMpN_nom	nominal speed	2840	rpm
EMpN_max	max speed	6000	rpm
EMpW_nom	nominal angular ...	3.14/30*EMpN_...	rad/sec
EMpP_nom	DC nominal power	65000	W
EMpDamp	viscous friction	0.1	Nm*sec/rad
EMpJ	equivalent inerti...	4.8	kg*m^2
EMpR_arm	DC resistance	0.35	Ohm
EMpL_arm	DC inductance	0.0065	H
EMpK_em	emf constant	(EMpU_arm_no...	V*sec/rad
EMpK_tq	torque constant	EMpK_em	Nm/A
EMpK_arm	Gain of the arma...	1/EMpR_arm	null
EMpT_arm	Time constant of...	EMpL_arm/EMpR...	null
CHp_eff	Chopper efficiency	0.95	null
MTpGear_eff	Gearbox efficiency	0.8	null
MTpK_gear	Gearbox ratio	5	null
MTpD_wheel	wheel diameter	0.52	m
MTpR_wheel	wheel radius	MTpD_wheel/2	m
MTpJ_wheel	wheel inertia	4.3	kg.m^2
CHApM_eq	Equivalent mass	1600	kg
CHApK_eq	Velocity gain	1/CHApM_eq	null
RDpwheelbase	wheelbase	2.4	m
RDpw_ev	EV width	1.6	m
RDpg	gravity	9.81	m/s^2
RDpA	frontal area	2	m^2
RDpCx	Drag coefficient	0.35	null
RDpro	Density of the air	1.223	kg/m^3

Help   OK   Cancel   Apply

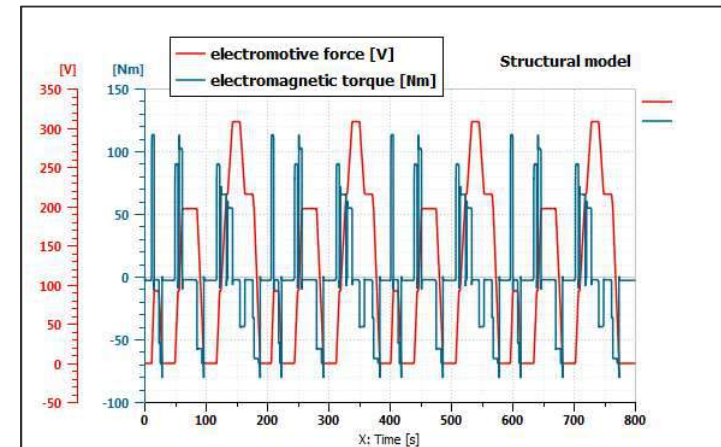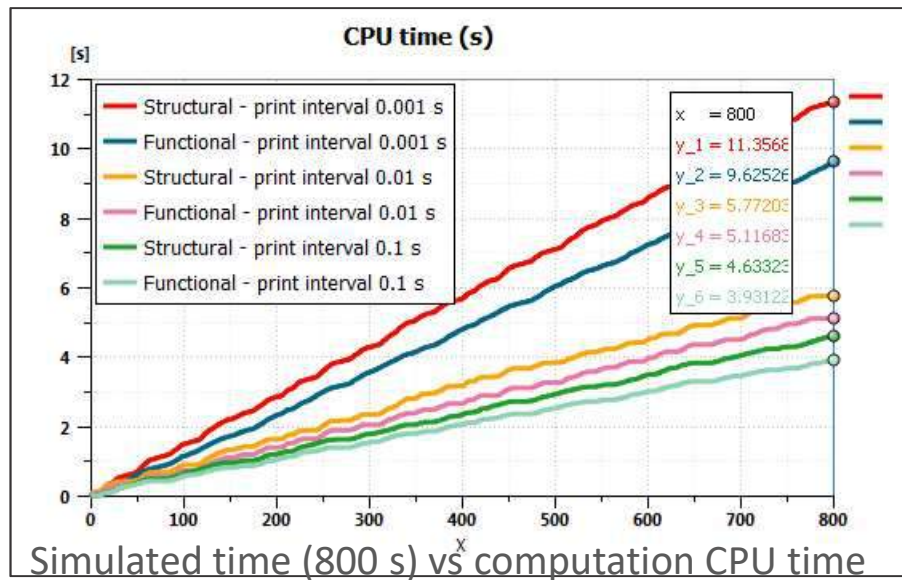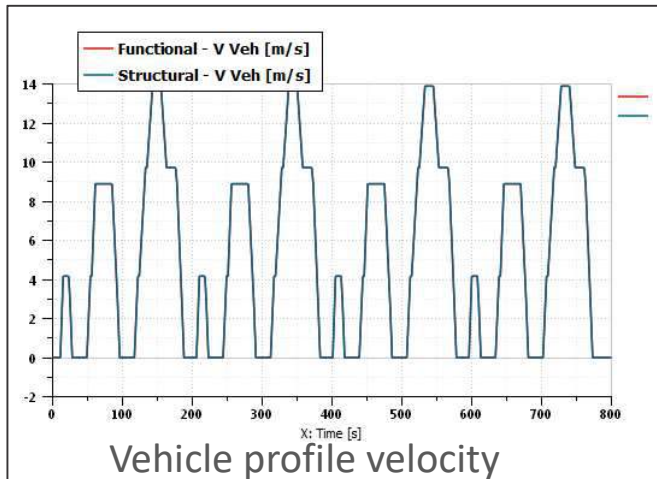# EMR vs. structural representation
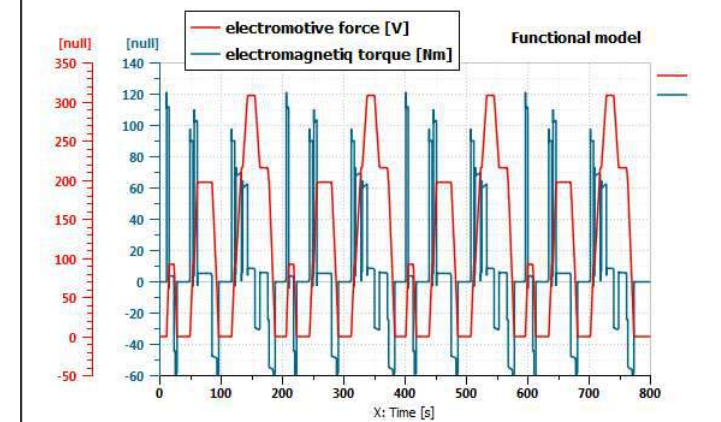
EMR representation

Structural representation

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Simulation results

Vehicle profile velocity

Simulated time (800 s) vs computation CPU time

Electrical vs mechanical performance

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End of presentation

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