«EMR-based simulation using Simcenter Amesim»

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SIEMENS

- Outline -

1. Simcenter Amesim software
2. EMR library into Simcenter Amesim
3. Structural vs. Functional representation
4. PANDA EMR simulations

« Simcenter Amesim »

- Simcenter Amesim -

Model-based system testing

Industry specific

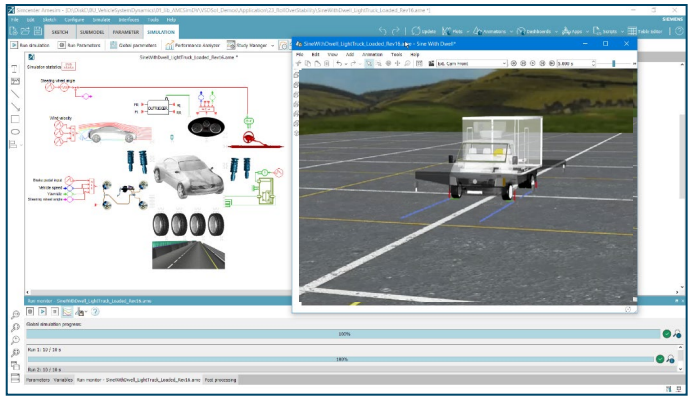
- Vehicle integration
- Vehicle electrification
- ADAS and autonomous vehicle
- Powertrain controls
- Engine design
- Aftertreatment
- Transmission
- HVAC
- Engine thermal management
- Vehicle dynamics
- Powertrain subsystems

Pre-design

Systems sizing and integration

Performance balancing

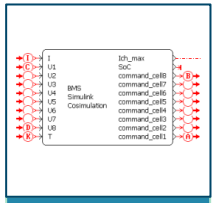
Controls validation



Scalable simulation

Connecting "mechanical" – "controls"

Model reduction for real-time

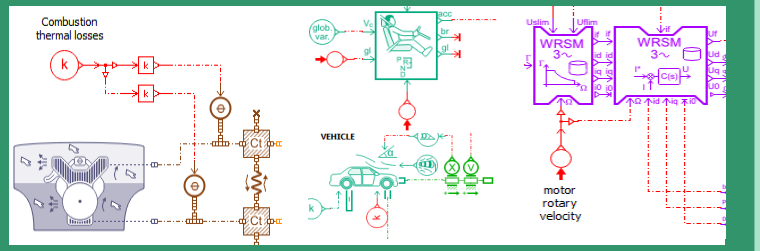


Co-simulation

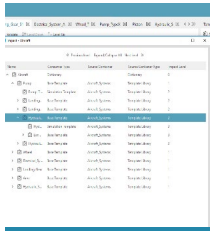
Open and customizable

>48 libraries

>6,500 multi-physics models

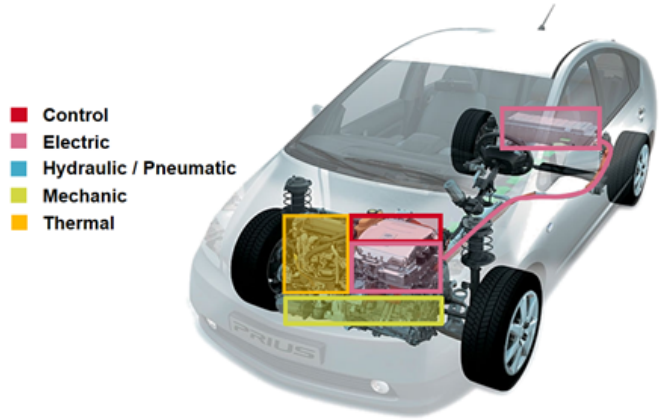


Hydraulics
Pneumatics
Thermal
Electrical
Mechanical
Signals

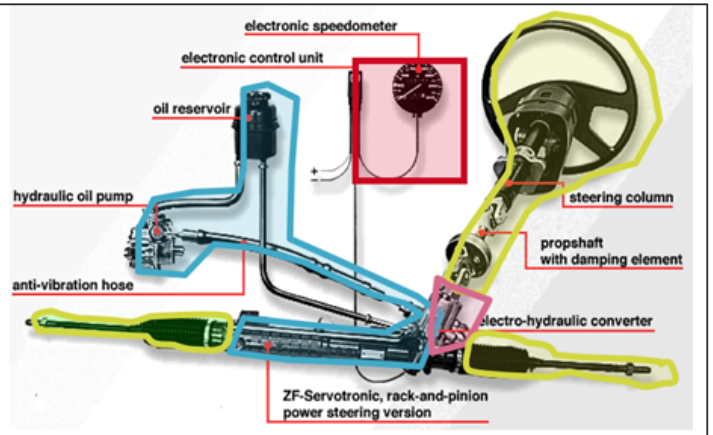


System architecture management

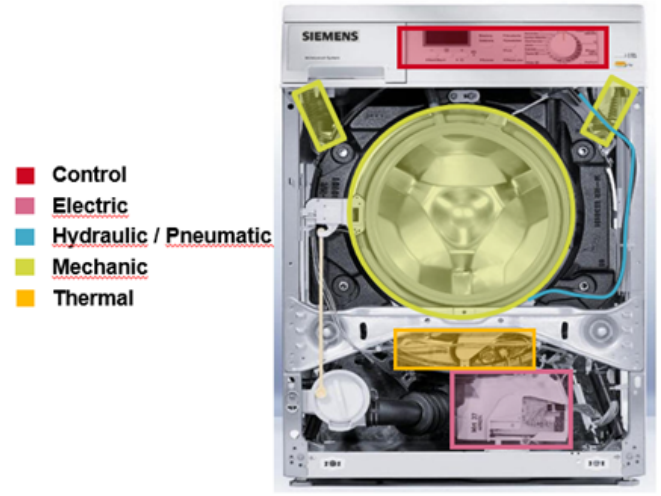
- Simcenter Amesim mechatronic systems -



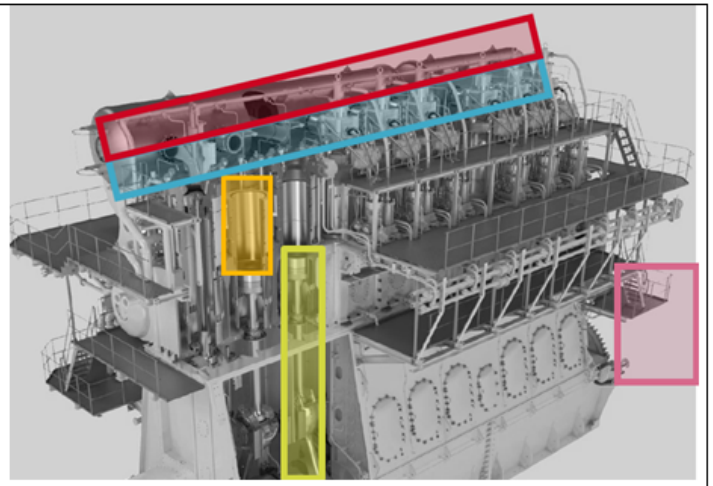
a: Hybrid vehicle



b: Electro-hydraulic power steering



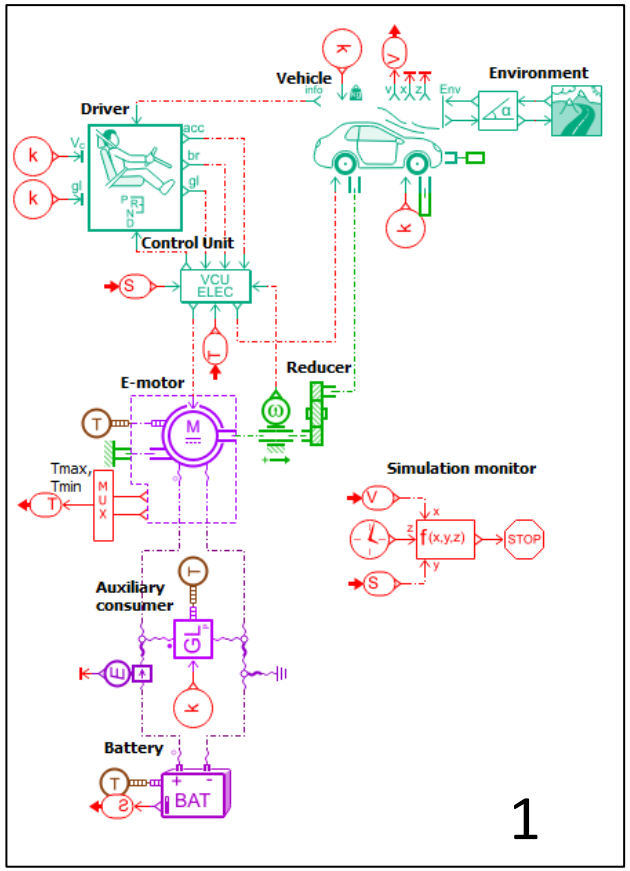
c: Washing machine



d: IC Engine

EMR-based simulation using Simcenter Amesim

Example of Simecenter Amesim



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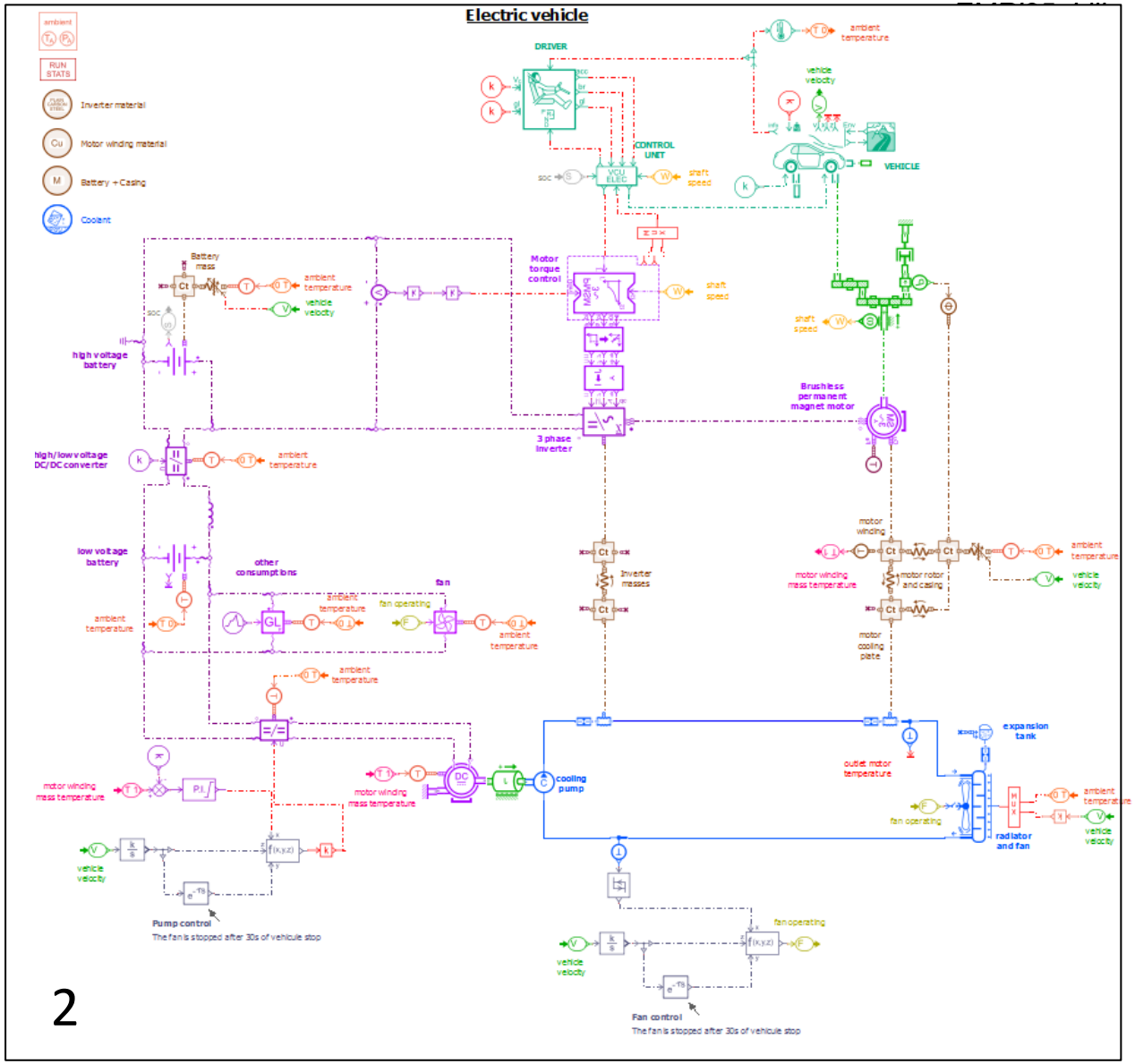

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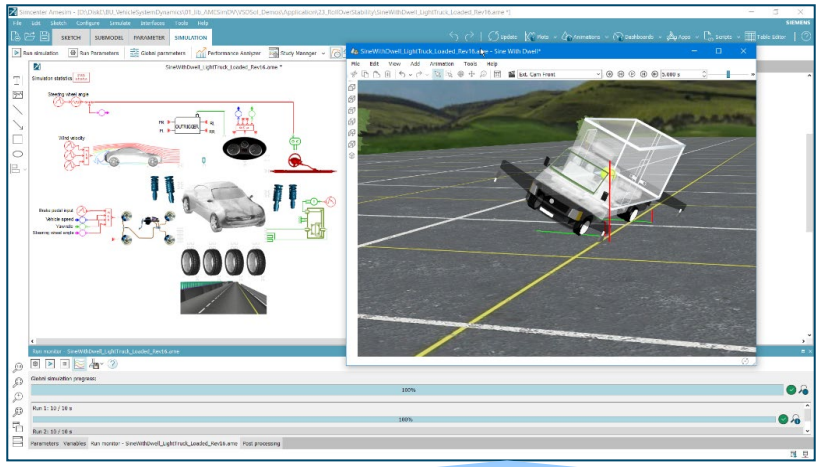
«EMR library into Simcenter Amesim»

EMR-based simulation using Simcenter Amesim

- Simcenter Amesim - New EMR library-



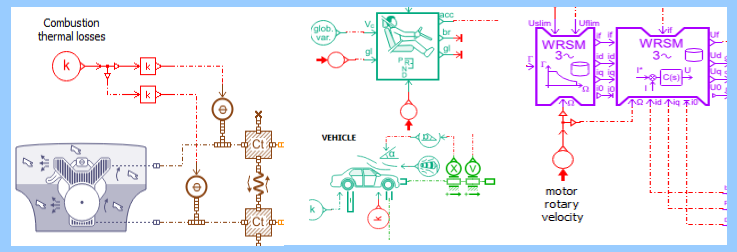
Model-based system testing

Pre-design

Systems sizing & integration

Performance balancing

Controls validation



48 libraries (6500 models)

- Hydraulics
- Pneumatics
- Thermal
- Electrical
- Mechanical
- Signals, etc.

Advanced industrial Multiphysics simulation package

based on **structural libraries for models** and a functional library for control

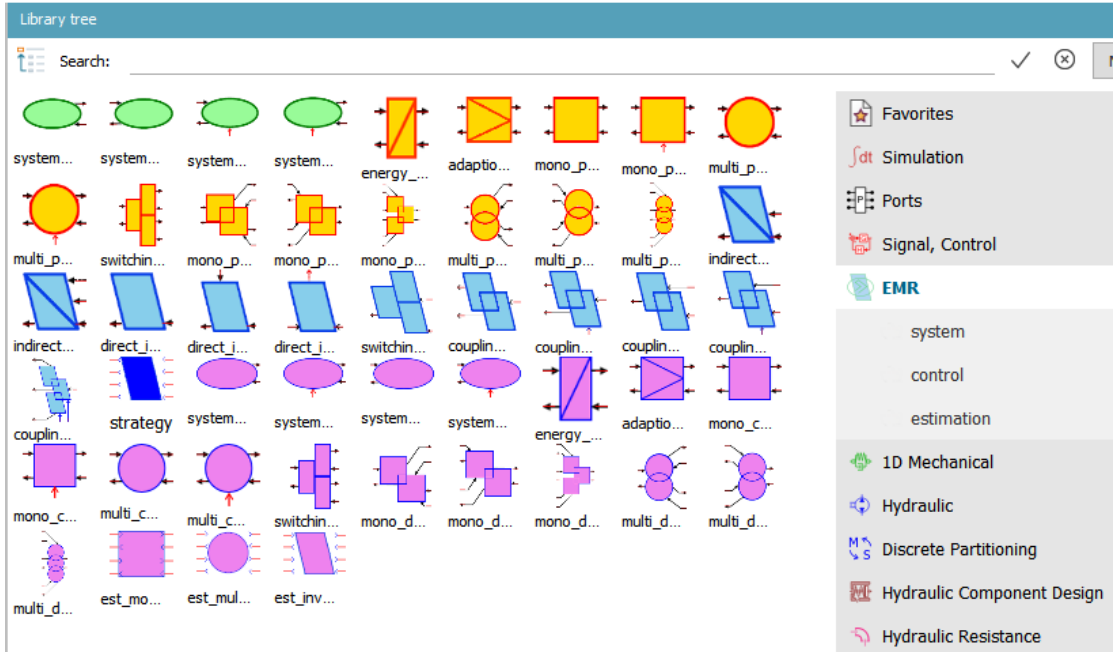
landa

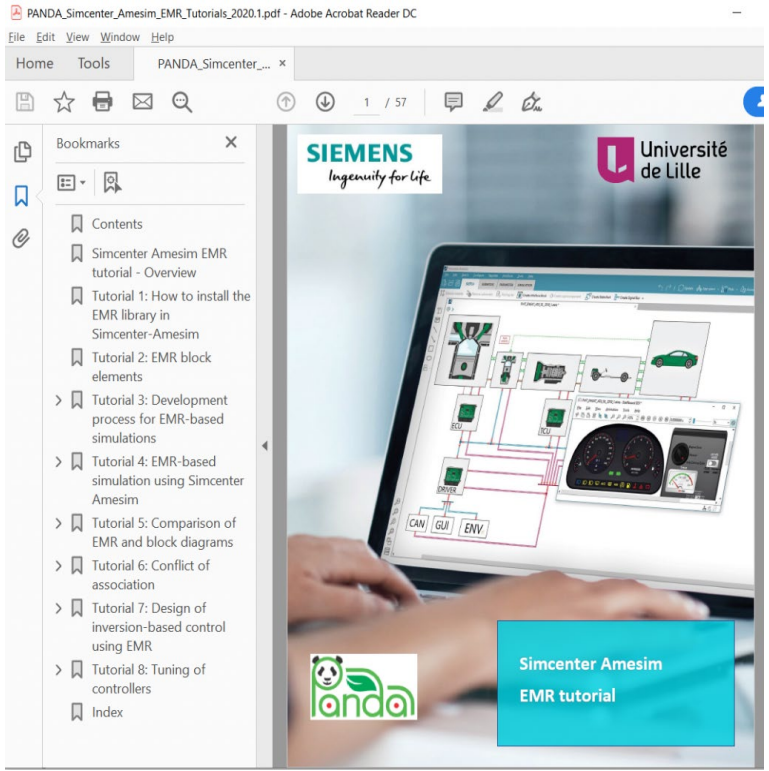
new **EMR-based functional library** for models & control

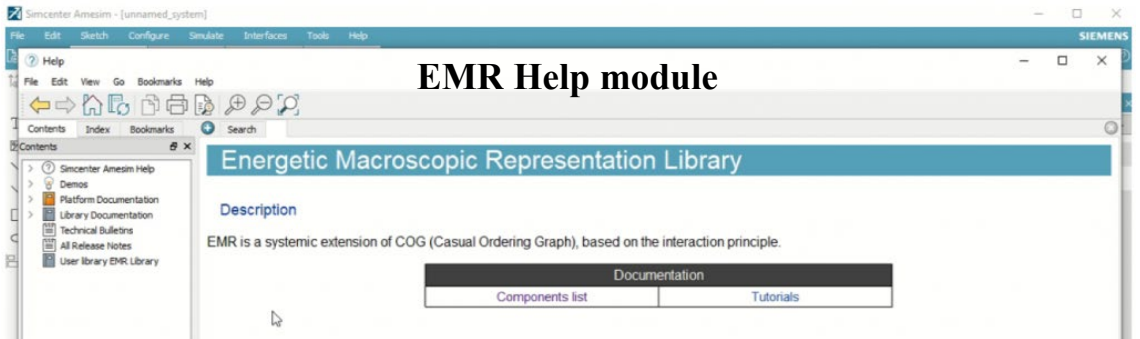
Simcenter Amesim EMR library

New and dedicated **EMR library** where all components defined by EMR theory are included

Help module with the description of each EMR element and new developed EMR tutorials included

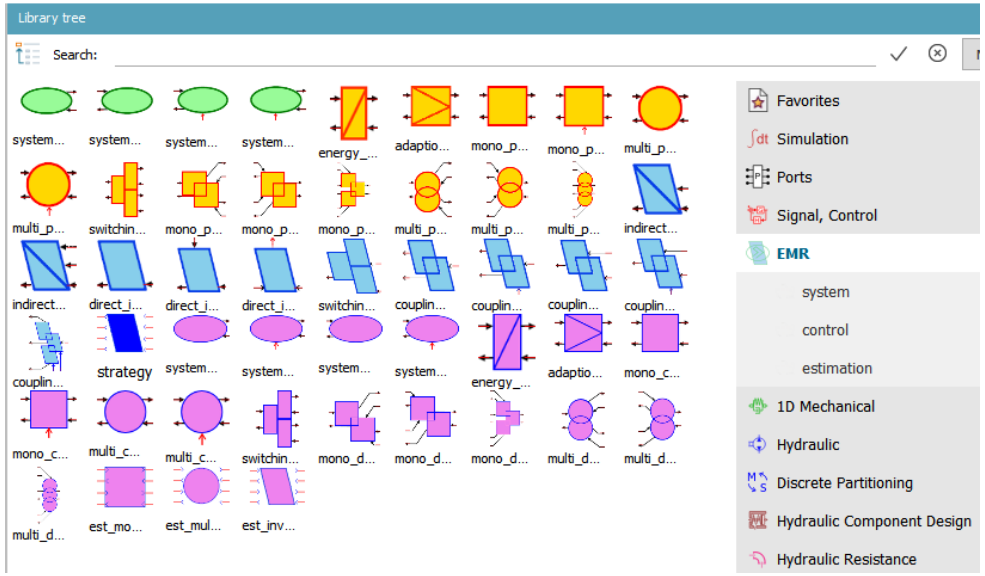




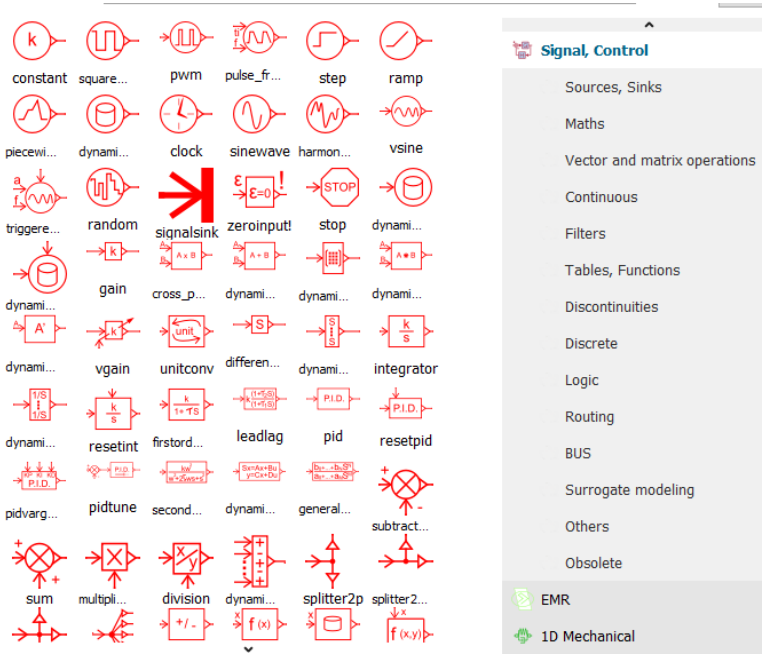


EMR simulations in Simcenter Amesim

New EMR library



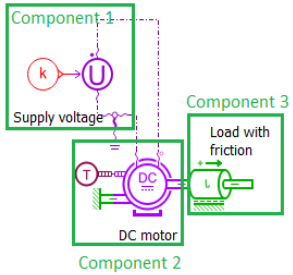
Signal & Control library



EMR simulations in Simcenter Amesim

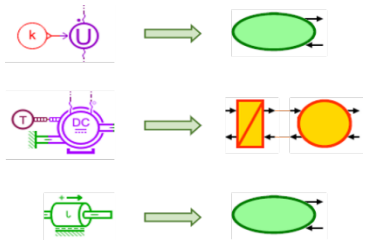
Development process for EMR simulations into Simcenter Amesim

Step 1.
Definition of the different subsystems to be considered



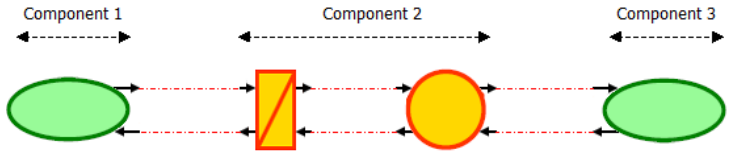
System level choice

Step 2.
Definition of the equivalent EMR elements



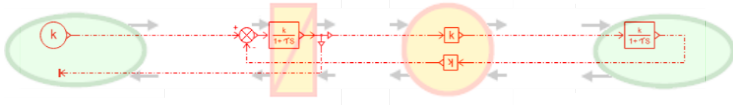
Component models vs. EMR elements

Step 3.
Interconnection of the EMR elements while resolving the conflict of association



EMR diagram

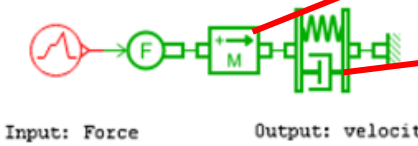
Step 4.
Integration of the model equation in the EMR element using the Signal and Control library



Equation model

«Structural vs. Functional representation »

Structural vs. functional



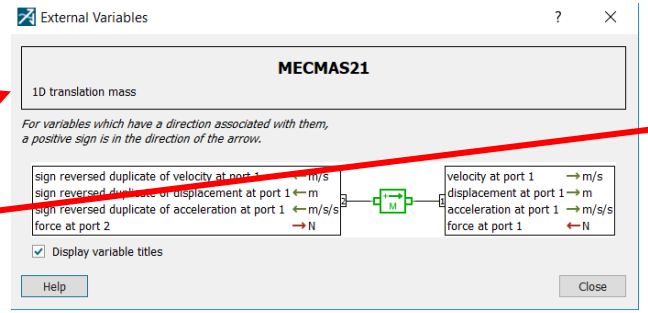
Input: Force

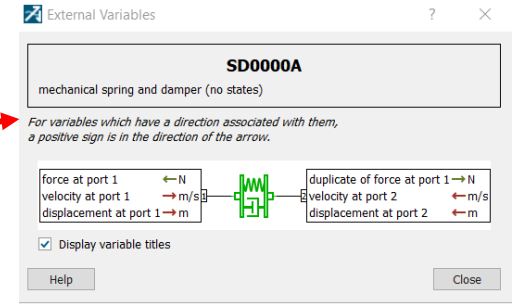
Output: velocity

Mass = 1 kg

Spring stiffness = 100 000 N/m

Damper rating = 1000 N/(m/s)





Parameters of mass_friction_endstops [MECMAS21-1]

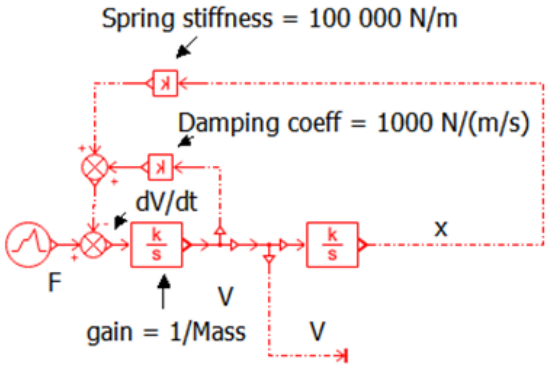
Title	Value	Unit	Tags	Name
velocity at port 1	1	m/s		v1
displacement at port 1	0	m		x1
use friction	no			useFriction
endstop type	none			stoptype
mass	100	kg		mass
inclination (+90 port 1 lowest, -90 por...	0	degree		theta

Parameters of springdamper01_1 [SD0000A-1]

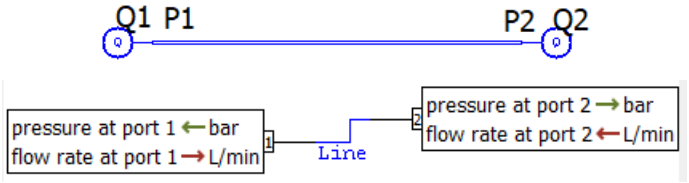
Title	Value	Unit	Tags	Name
spring stiffness mode	numerical value			stiffmode
spring force with both displacements...	0	N		force0
spring rate	100000	N/m		srate
damper rating	100	N/(m/s)		cdamp

Structural representation

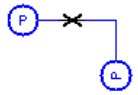
Functional representation



Structural representation

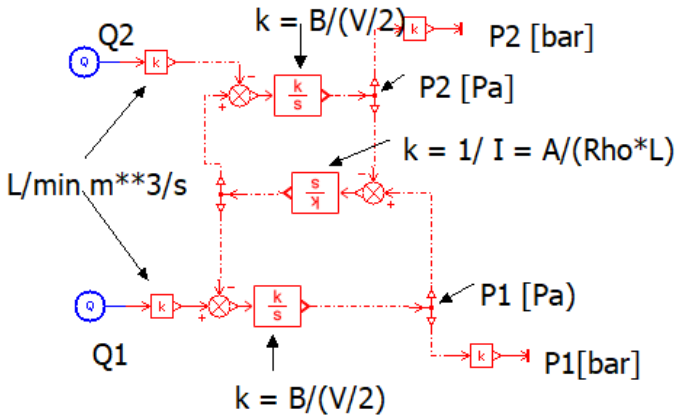


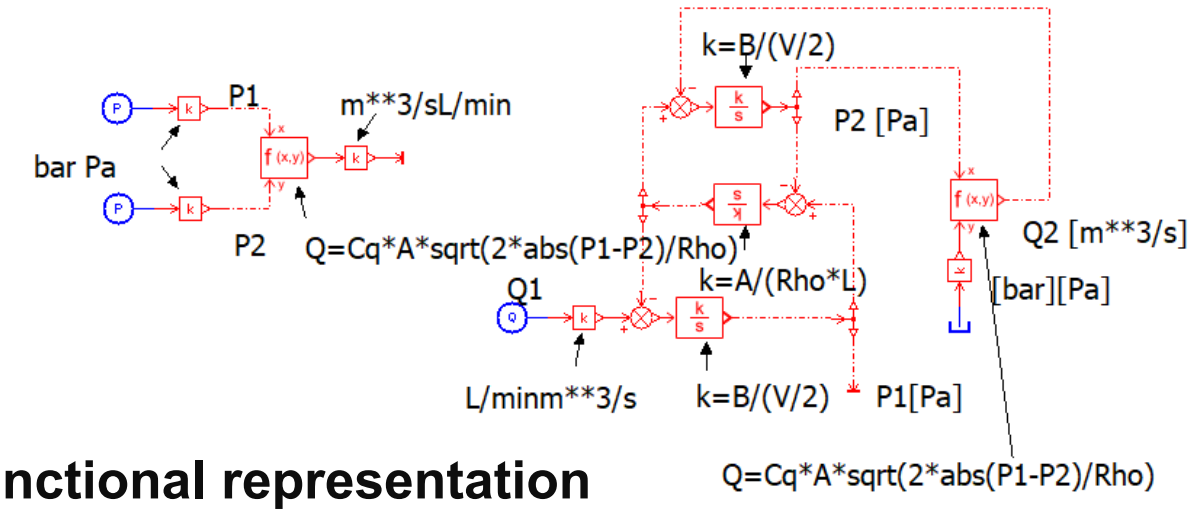
Model Line: C,I,C (Volume, Inertia, Volume)



Restriction

Circuit





Functional representation

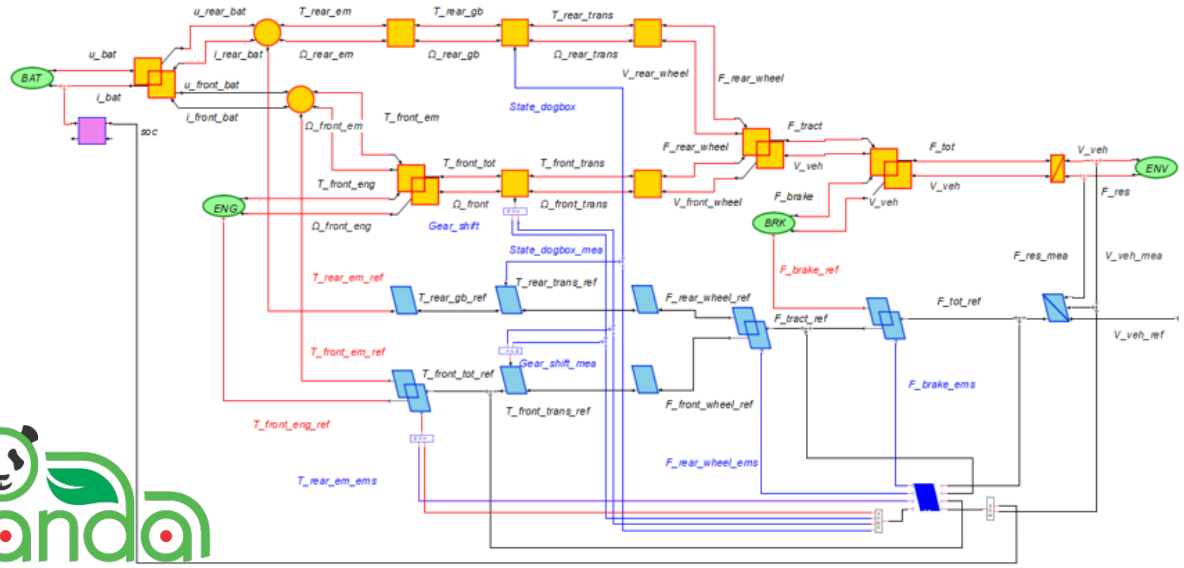
« PANDA EMR simulation»

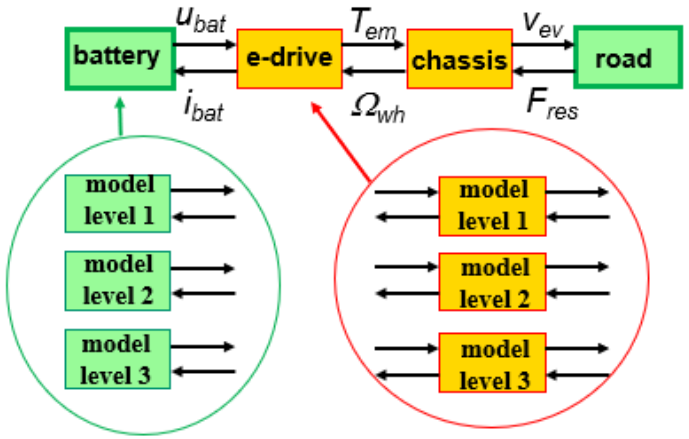
Powerful Advanced N-Level Digital Architecture
for models of electrified vehicles and their components

Vehicle EMR models

PANDA Simcenter Amesim EMR n-level vehicle models based on:

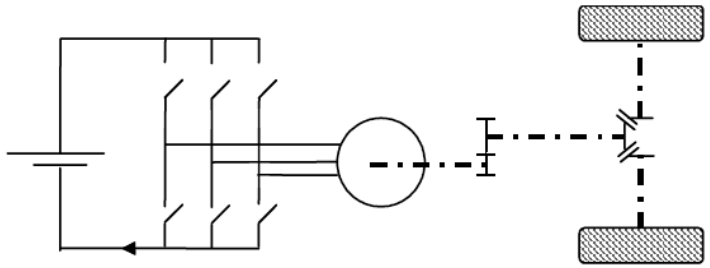
Renault Zoe (BEV) Mobypost (FCV) Valeo Demo Car (P-HEV)



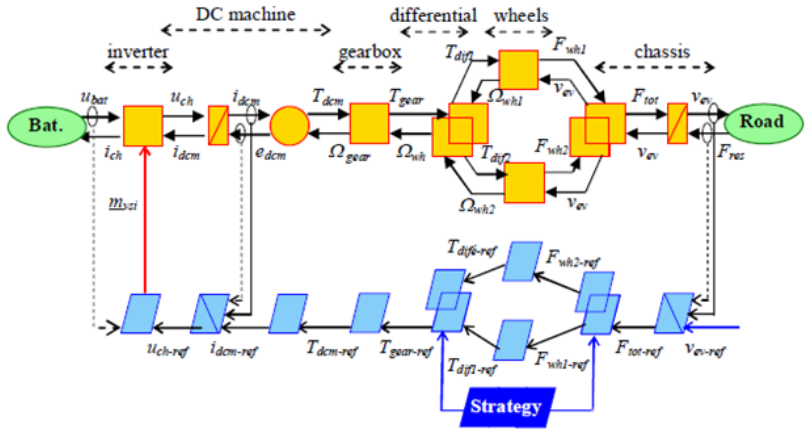


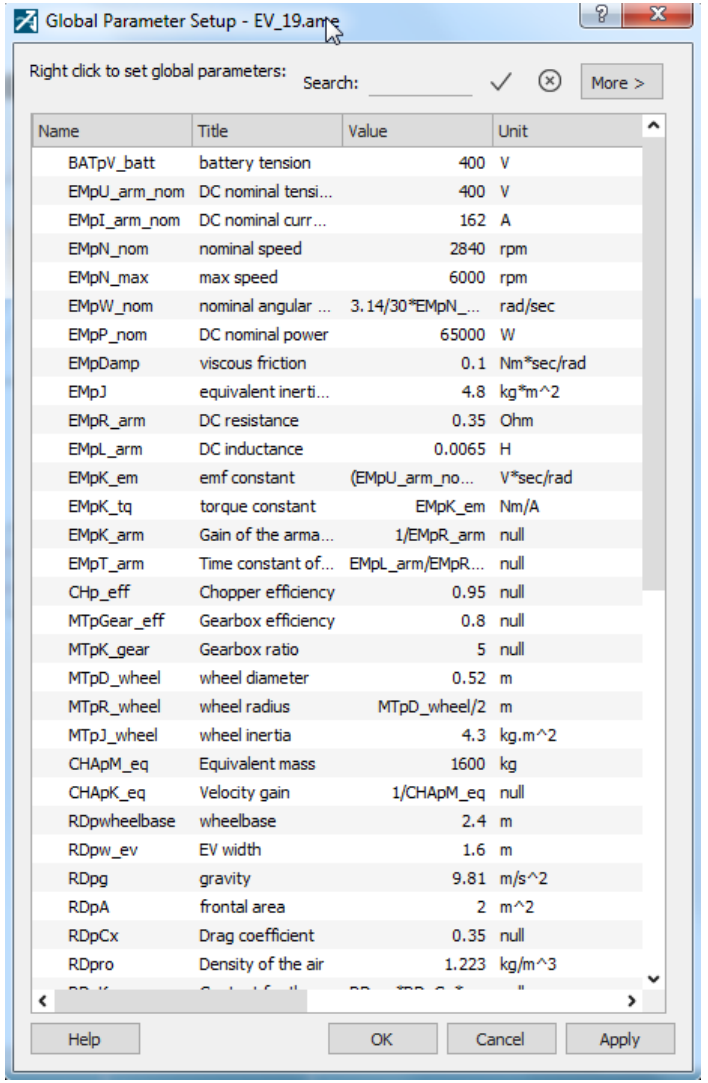
Powerful Advanced N-Level Digital Architecture
for models of electrified vehicles and their components

https://project-panda.eu/virtual-testing/



- 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.

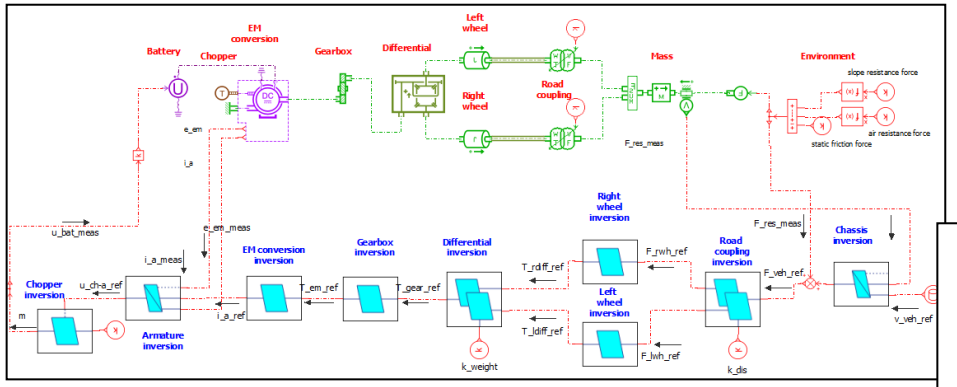




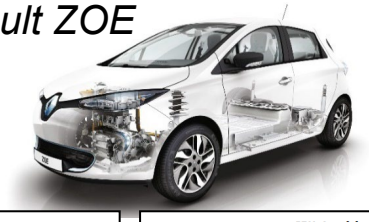
Name	Title	Value	Unit
BATpV_batt	battery tension	400	V
EMpU_arm_nom	DC nominal tensi...	400	V
EMpI_arm_nom	DC nominal curr...	162	A
EMpN_nom	nominal speed	2840	rpm
EMpN_max	max speed	6000	rpm
EMpW_nom	nominal angular ...	3.14/30*EMpN_...	rad/sec
EMpP_nom	DC nominal power	65000	W
EMpDamp	viscous friction	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

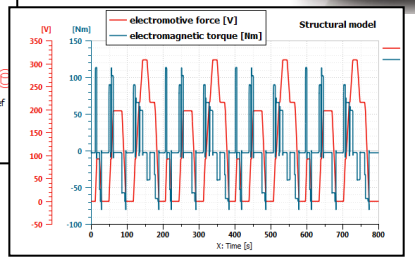
Results using a functional library

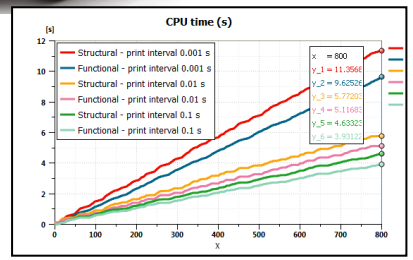
Classical Simcenter Amesim structural library

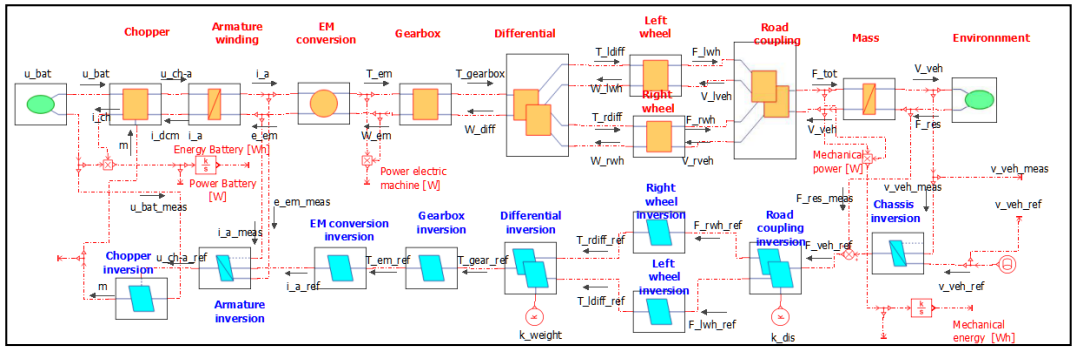


Simulation of Renault ZOE









- same model / control
- same accuracy
- -15% of computation time with the functional library

New EMR-based (functional) library in Simcenter Amesim

« BIOGRAPHIES AND REFERENCES »

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Thanks for your attention !

- References -

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