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Professional Edition

Efficiency Analysis of Mobile Applications Using Machine-Based Simulation

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Agenda

- Introduction
- Concepts and Definitions
  - Simulation Scope
  - Proposed Hybrid Model Approach
  - Upstream vs Downstream Concepts
  - Machine Knowledge Management System
- Application Examples
  - Excavator Machine Modeling
  - Hydrostatic Transmission Efficiency Analysis
- Conclusion

Introduction

OEM & System Integrator Objectives

- Increase performance & efficiency
- Reduce time-to-market
- Limited time in early prototyping

Simulation as a solution

- Validate components and system behavior

Simulation project efforts and difficulties…

- High level of effort and time required for component modeling (traditional method)
- Realistic system model is challenging (specialist, missing information, time consuming, …)
- Difficulties to adapt & reuse simulation models

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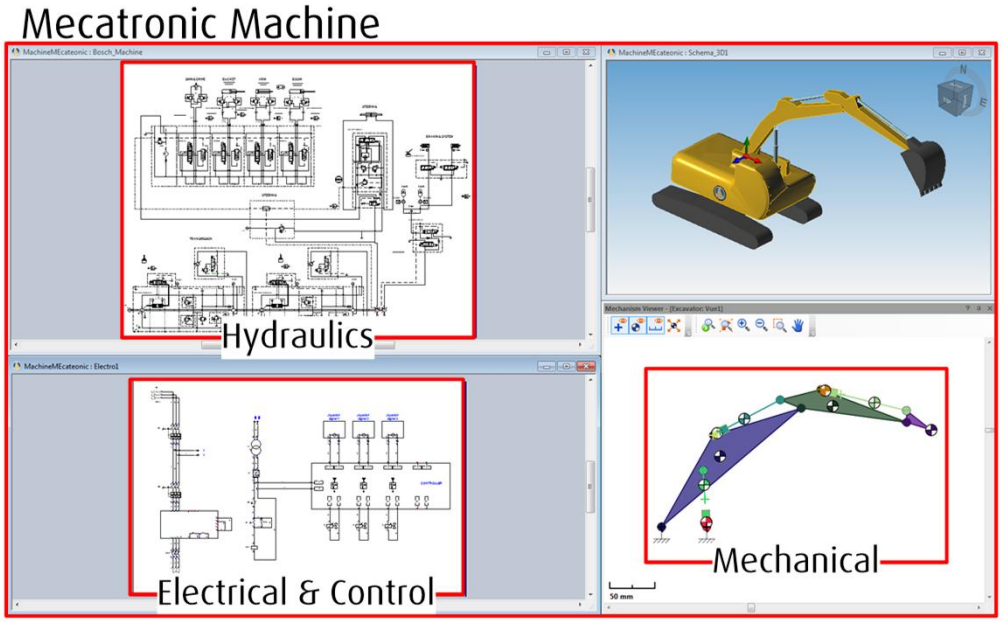
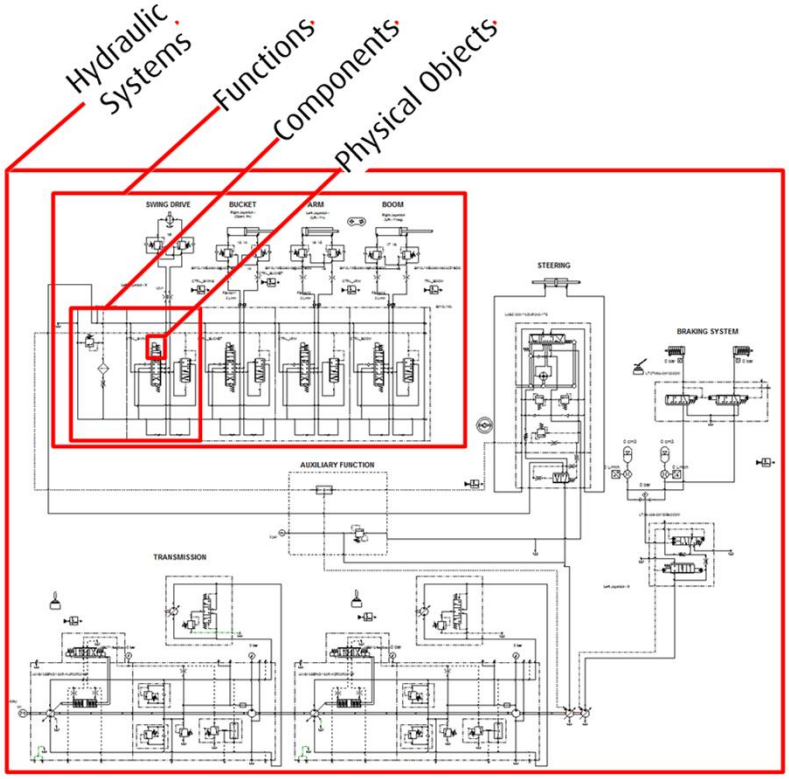
Concepts and Definitions

Simulation Scope

- Complete Machine/Systems
- Function & Components





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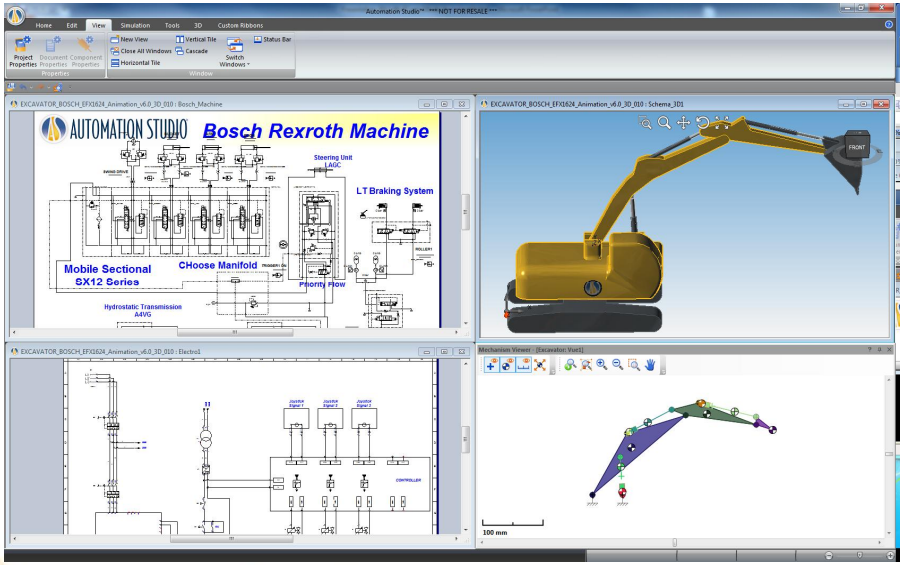
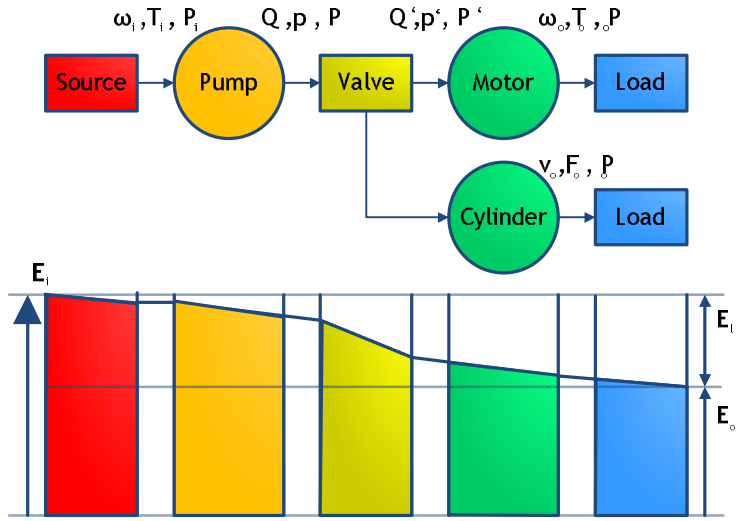
Concepts and Definitions

Machine Knowledge Management System

- Complete simulation model, enhanced with 3D visualization that reproduces the real functional behavior of the system
- Complete Virtual Machine with multi-technology
- System Environment Creation





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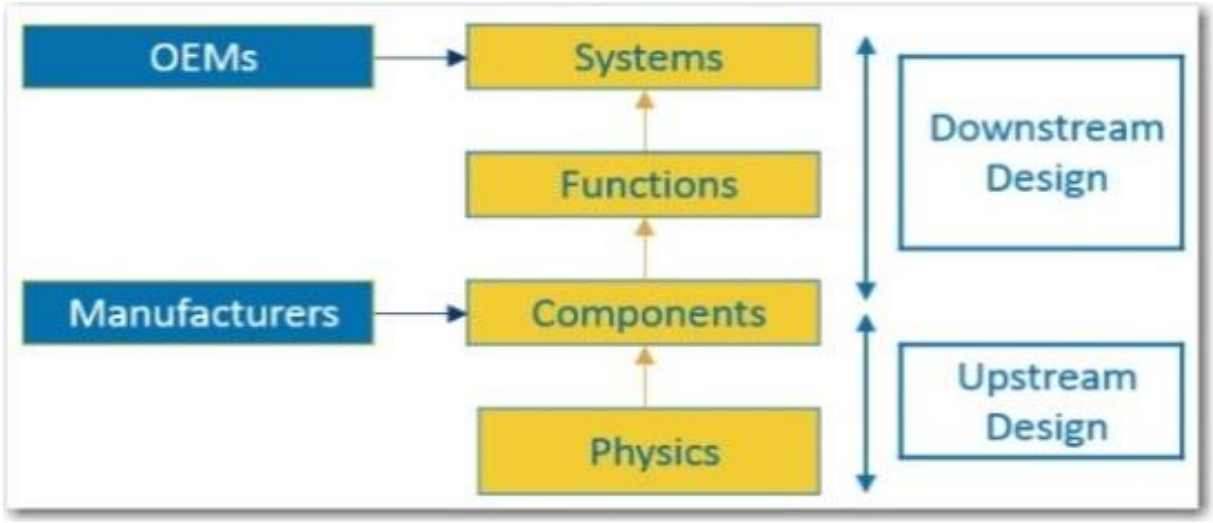
Concepts and Definitions

Proposed Hybrid Approach

- Different levels of simulation possible
- Upstream: component model based on fundamental equations
- Downstream: uses data-mapping (input-output tables, graphical representations of components' behaviour, characteristic curves)



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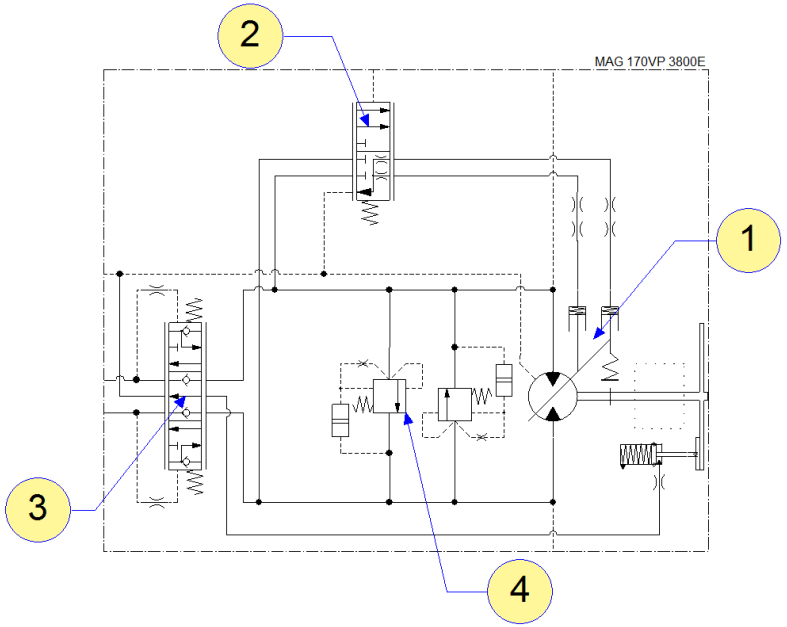
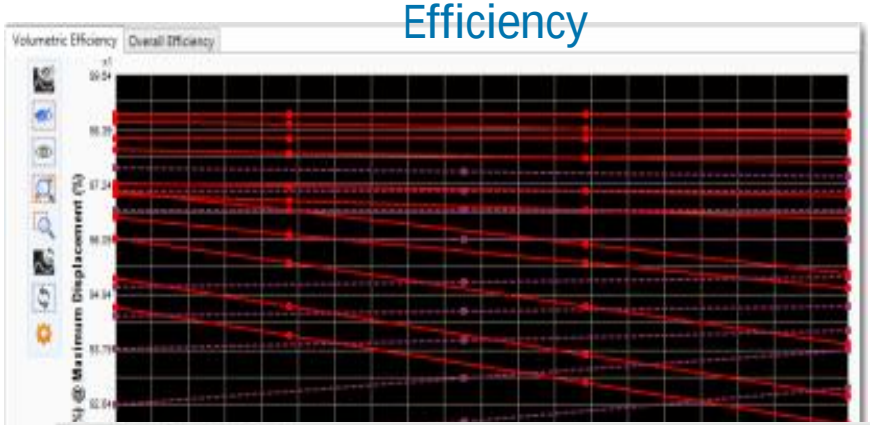
Component Model Examples

Hydraulic Motor Model (KYB MAG)

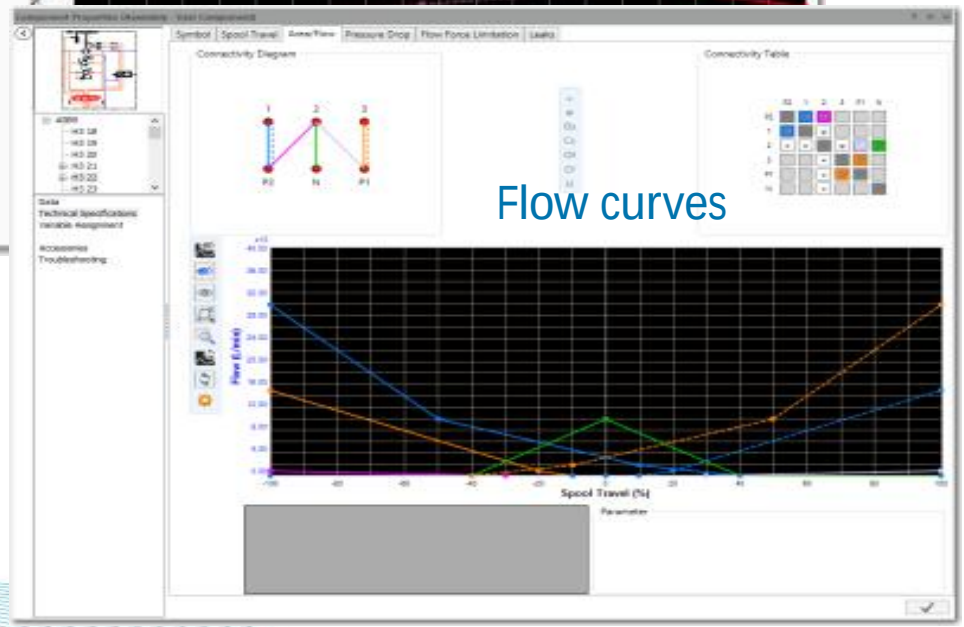
1. Piston rotary group
2. Displacement control valve
3. Double counterbalance valve
4. Shockless crossover relief valves



Efficiency



Flow curves



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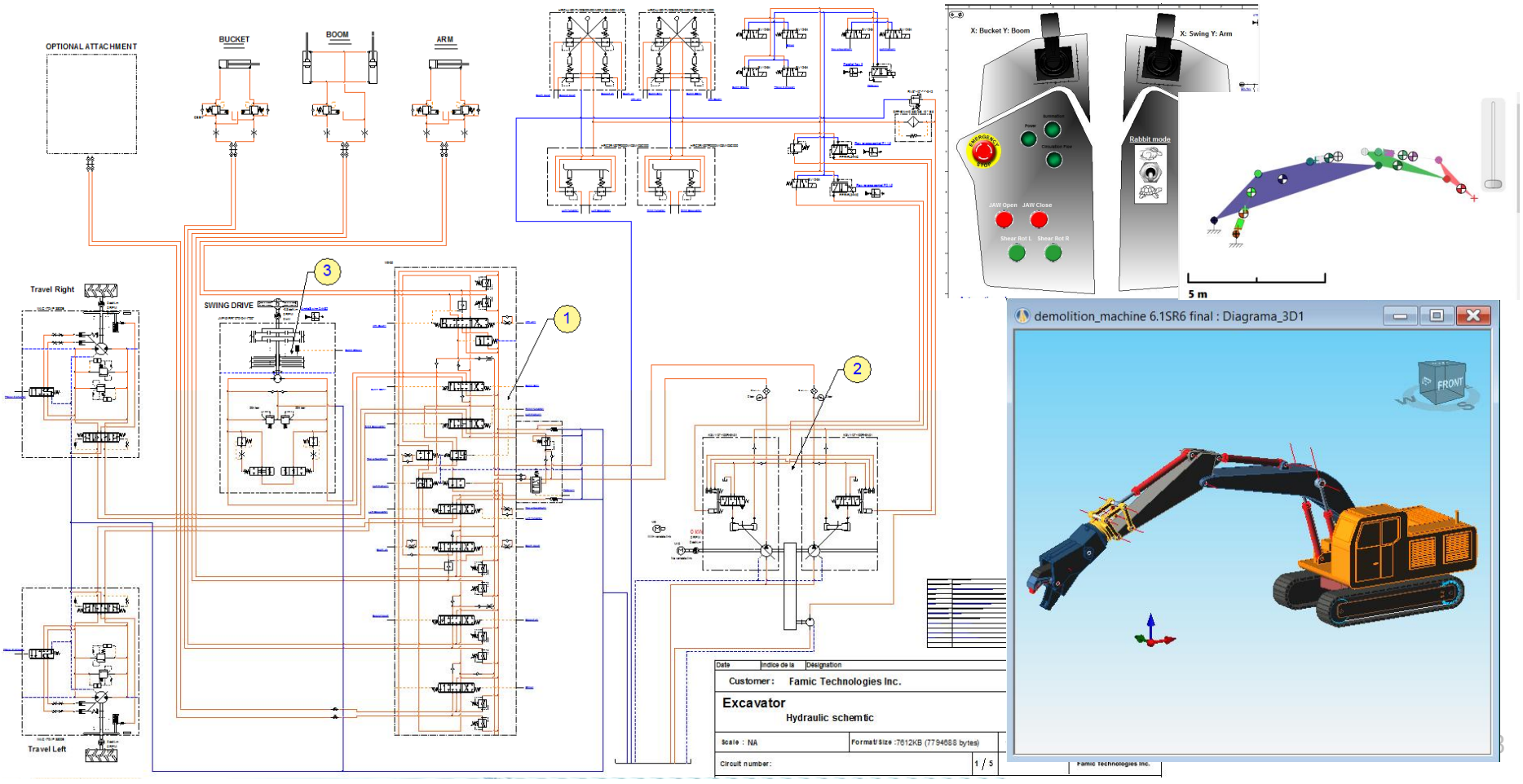
Excavator modeling example

- Interactive simulation (first functional analysis, overall expected behaviour...)
- Individual components models: possible to be modified and improved



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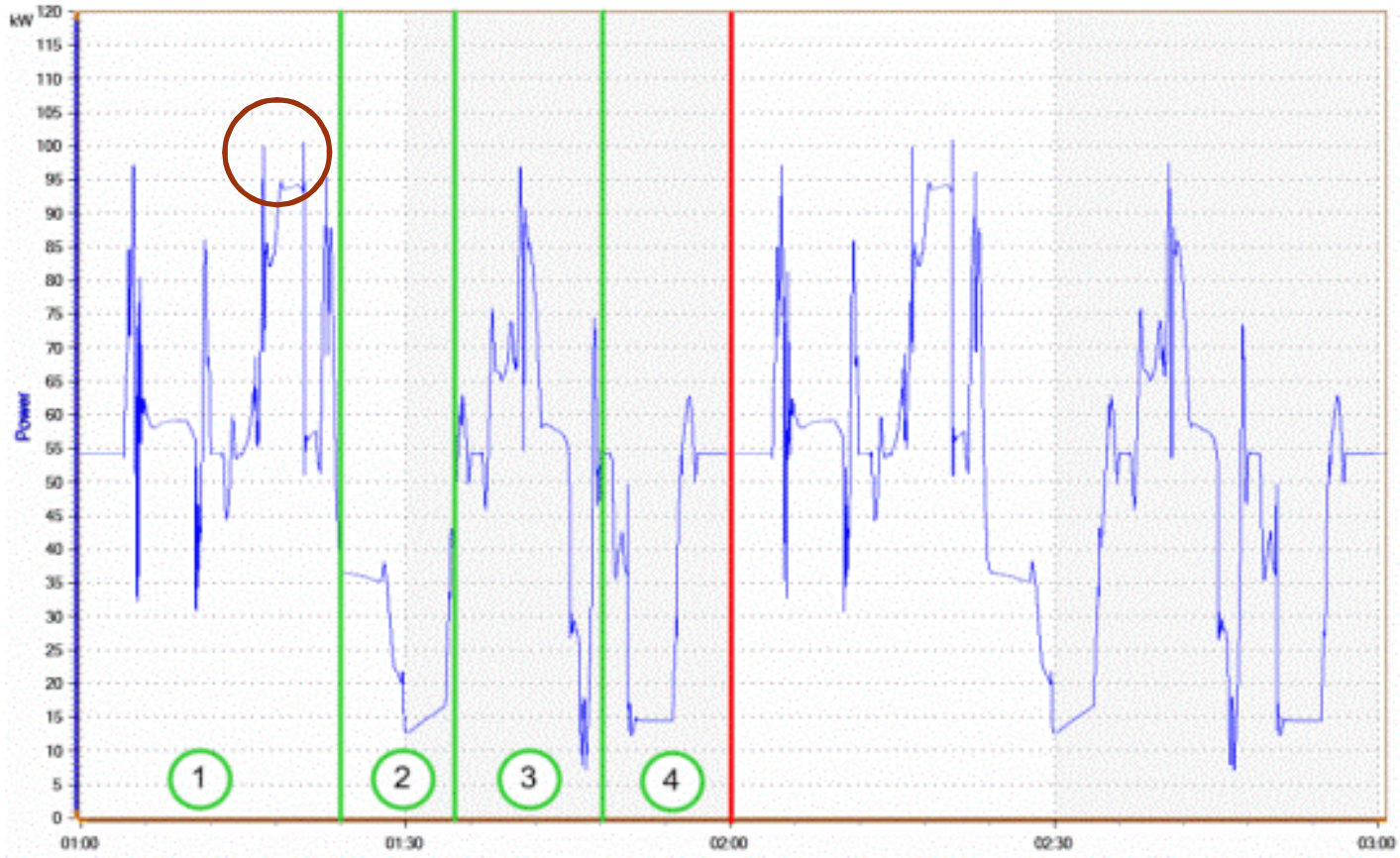
Excavator modeling example

Machine Working Cycle (Bucket Option) – Power at Pump Shaft

1. Arm extension and digging function 2. Swing function
3. Unloading bucket 4. Swing back to initial position



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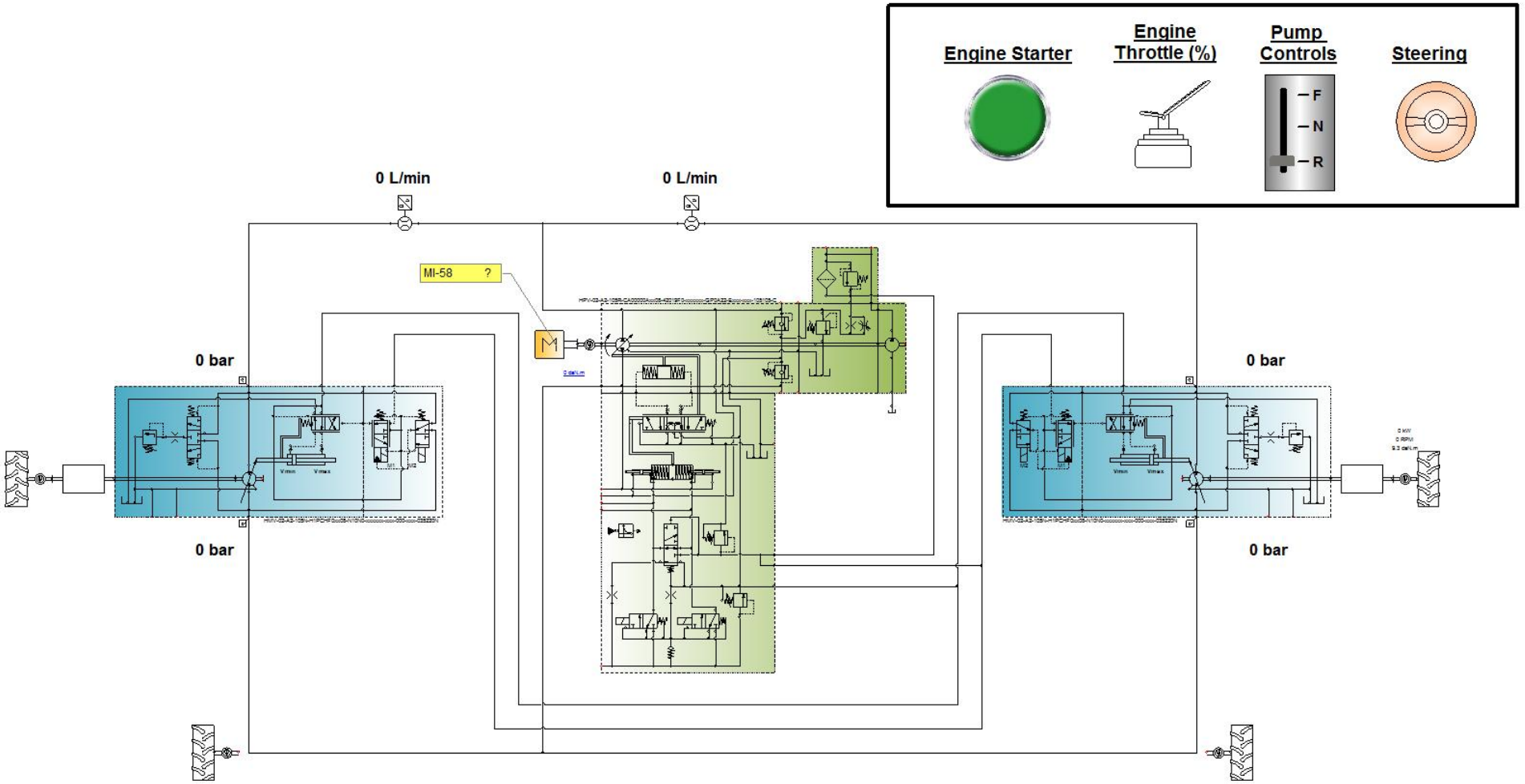
Hydrostatic Transmission Efficiency Analysis

Circuit with Pump HPV-02 and HMV-02 (Linde Hydraulics)



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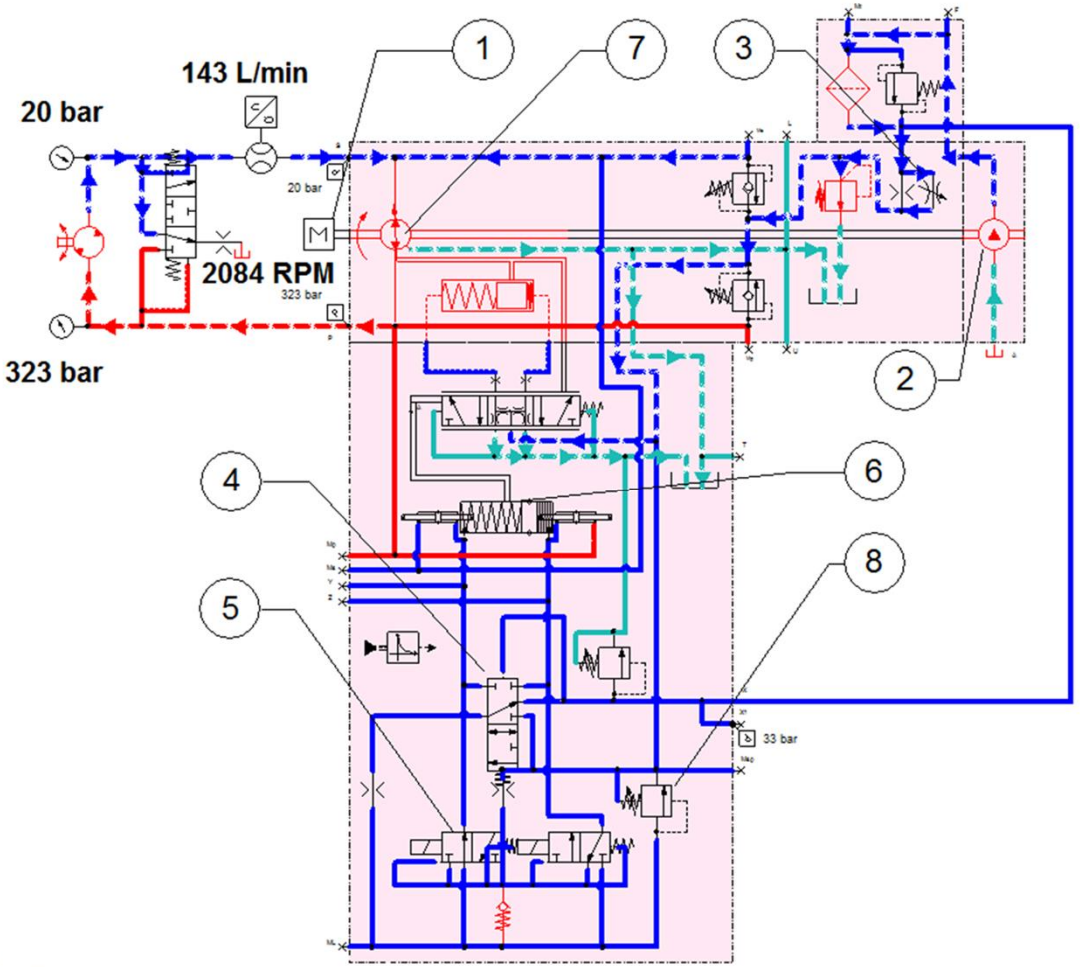
Hydrostatic Transmission Efficiency Analysis

Manufacturer component tested first independently.



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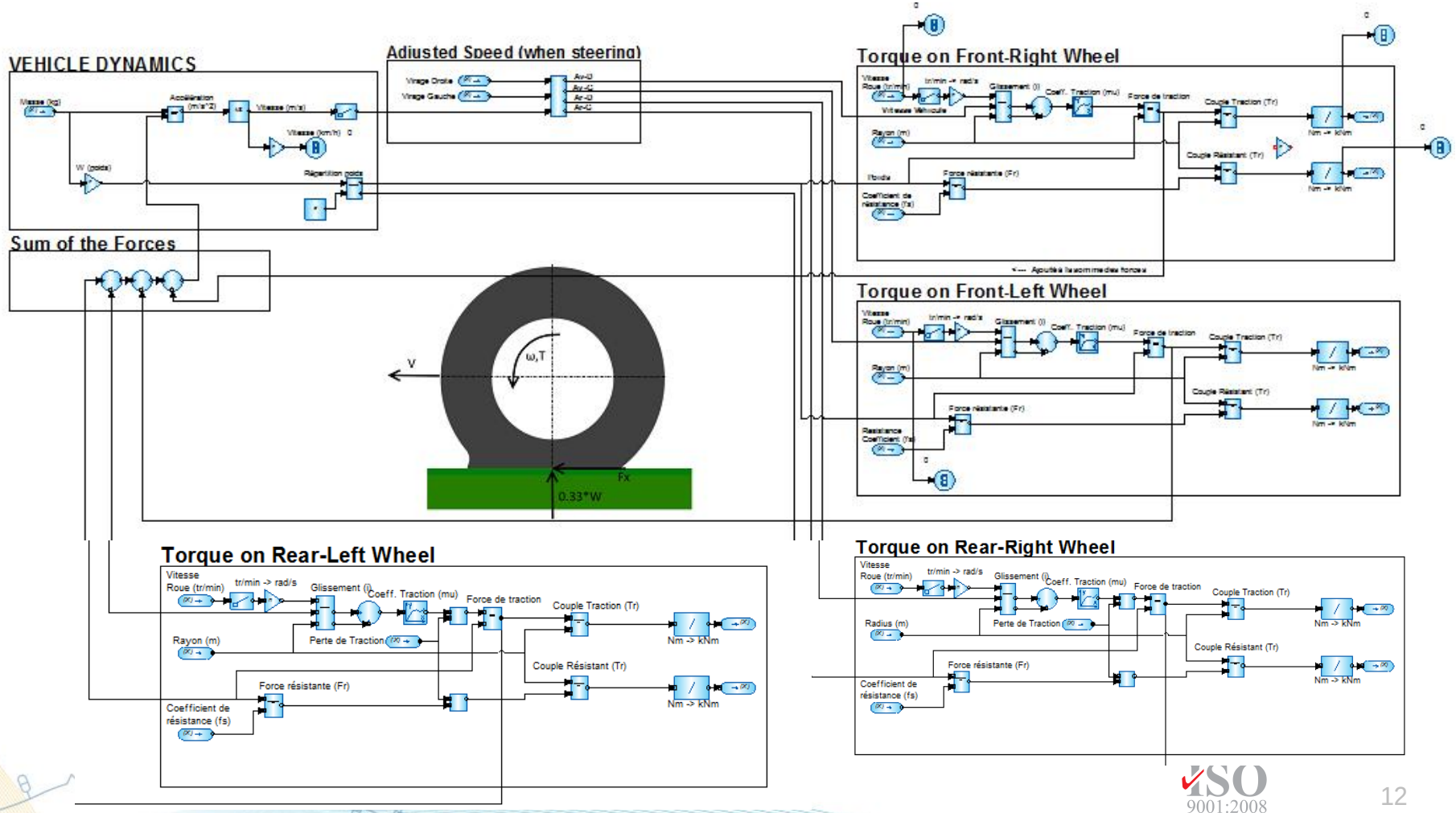
Technological Models

Vehicle dynamic model



Technological Models

Some of the ground vehicle equations involved:

Vehicle Acceleration:

$$m\ddot{x} = F_{Fr} + F_{Rr} - R_{Fr} - R_{Rr}$$

Wheel Acceleration:

$$J\dot{\omega} = r(F_x - R_r) + \tau_{tr}$$

Longitudinal force transmitted:

$$F_x = \mu * W$$

$$R_r = f_s * W$$

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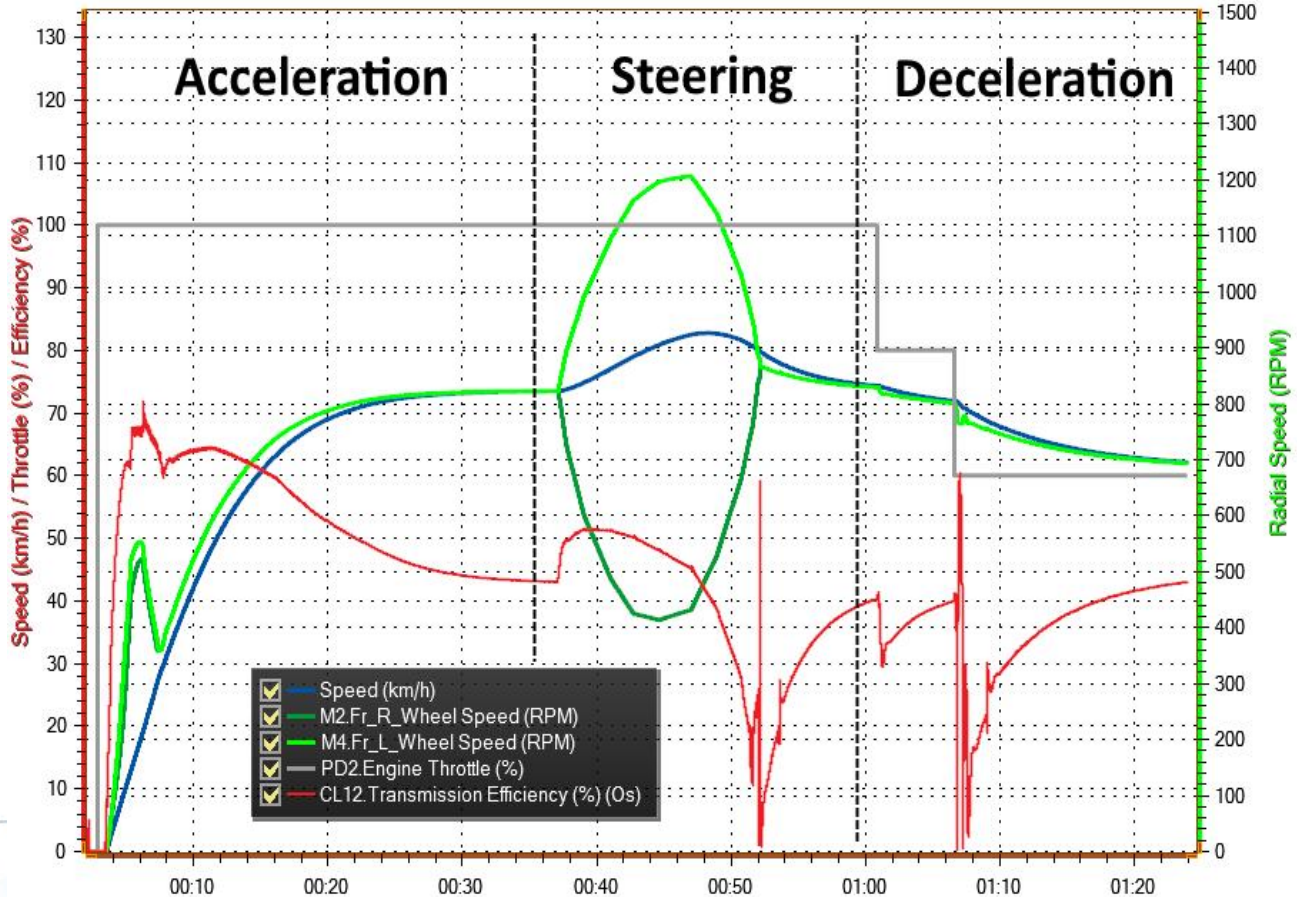
Efficiency Analysis Models

Transmission efficiency at different driving conditions



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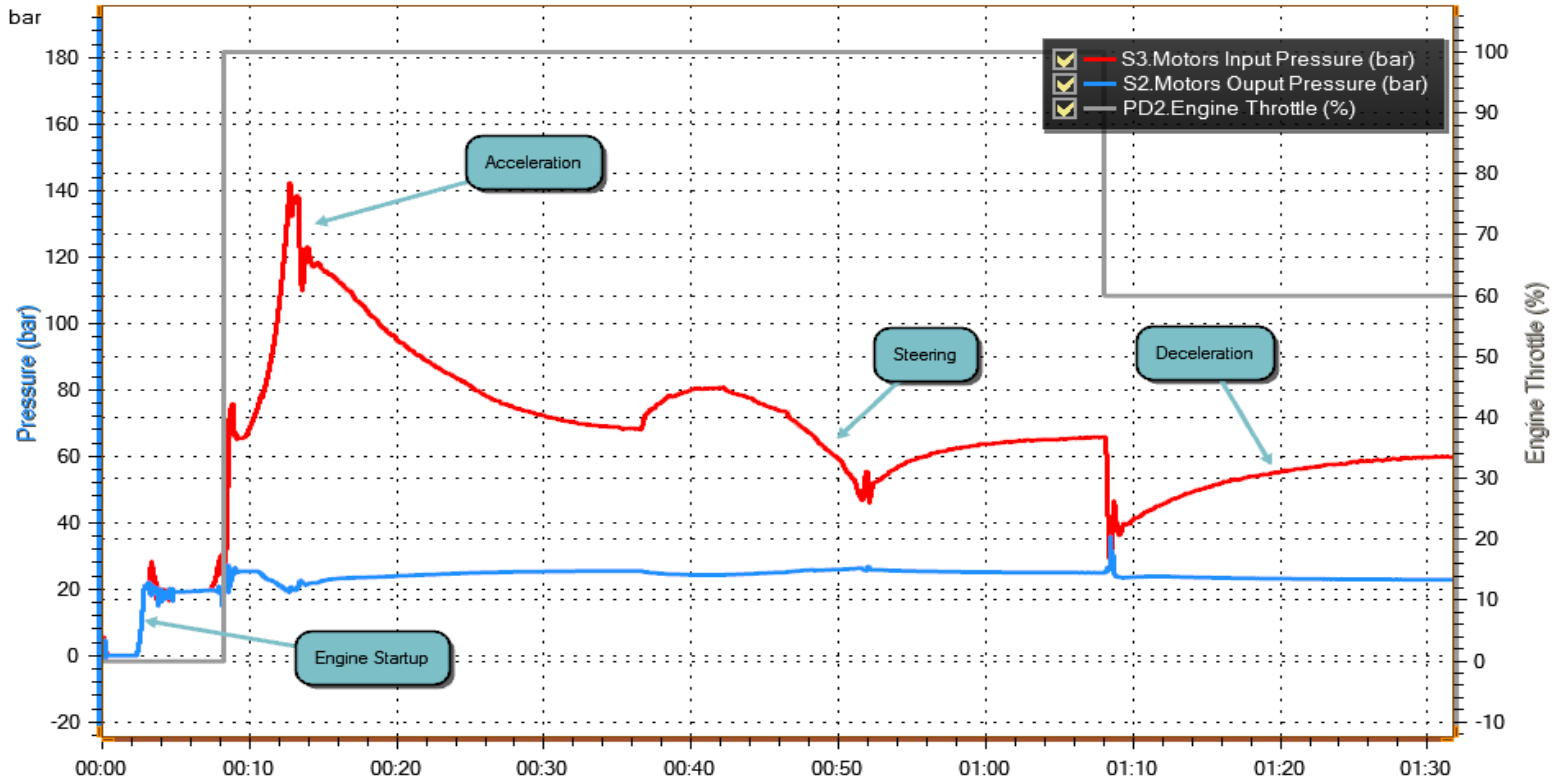
Efficiency Analysis Models

Pressure at motors input and output

Maximum pressure (vehicle engine at full throttle) and pressure while the vehicle is steering and decelerating.



Benefits

Novel Simulation Approach

- Makes the user's focus away from the challenges
- It combines:
  - the benefits of advanced mathematical and physical representations
  - common-knowledge representation of component behaviors like input-output tables, or graphical representation, etc.
- Reusable for different phase of the production cycle.

Conclusion

Hybrid modeling approach facilitates the multi technology and multi level integration

- Applicable for any type of systems
  - The new trend of electrification of hydraulic system…
- Analyze new systems architectures & optimize production cycles
  - System Performance & Efficiency
  - Control & Stability
  - Etc.
- Building complex systems using Manufacturers' E-catalogs
  - Note: Many manufacturers have already started to follow that trend by offering virtual models of their components

Conclusion

To spread and standardize the use of virtual systems

- A common modular language of modeling must be used.

The hybrid model approach that we introduced constitutes a significant step in this direction…

Danke!

Thank You!

Question?