Full-Vehicle simulation for control system development and testing

1.-TECNALIA

2.-TRENDS - MODEL BASED DEVELOPMENT

3.-DYNACAR®: FULL VEHICLE MODEL

4.- APPLICATIONS

TECNALIA

-

Global player for the applied research

TECNALIA

- Private applied research center, with headquarters in the north of Spain, other locations: France, Serbia, China, Mexico
- The largest private non-profit Research Organization in the south of Europe (fourth in Europe)
- Staff of 1400 researchers working for more than 4000 customers

- Active partner of the European automotive research associations EARPA and ERTRAC EARPA: European Automotive Research Partners Association / ERTRAC: The European Road Transport Research Advisory Council

Trends

-

Model based development

Trends on automotive industry

- Time to market and development cycle:
  - 10 years in 1990, 5 years in 2013, ¿in 2025?
- Increase vehicle complexity:
  - ADAS, Passive Safety …
  - EV, Consumer Electronics/Infotainment,

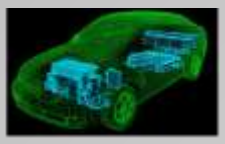
- Electronics as the fastest growing automotive commodity from aprox. 20% in 2003 to aprox. 40% in 2015

In 10 years from 100.000 to 100.000.000 code lines

ADAS: Advanced Driver Assistance Systems

Trends on automotive industry

Three main trends to consider on future vehicle ECU design:



•Vehicle Electrification and component complexity
→ Increased number of ECU´s

•Functional Safety under ISO26262
→ Increased development effort

•ADAS systems and Automation:
→ Increased complexity and safety

ADAS: Advanced Driver Assistance Systems

Model based development and testing

to shift activities into earlier phases of the development process

- integration of simulation, optimization and validation at earlier development phases of vehicles to prevent cost intense problems in later development phases.

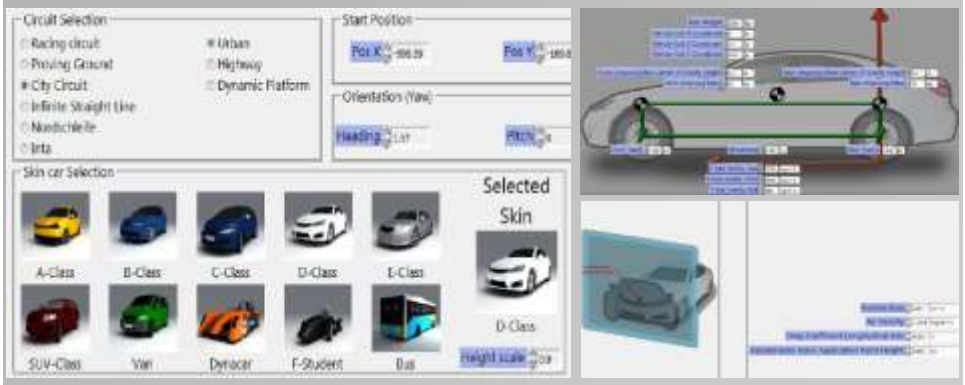
- part of time consuming tasks like drive ability, durability testing etc. can be shifted from vehicle prototype into component test bench in order to get more knowledge with less time effort at earlier project phases

DYNACAR®

Flexible, real time simulation environment for the design, development and validation of complete vehicle components and systems

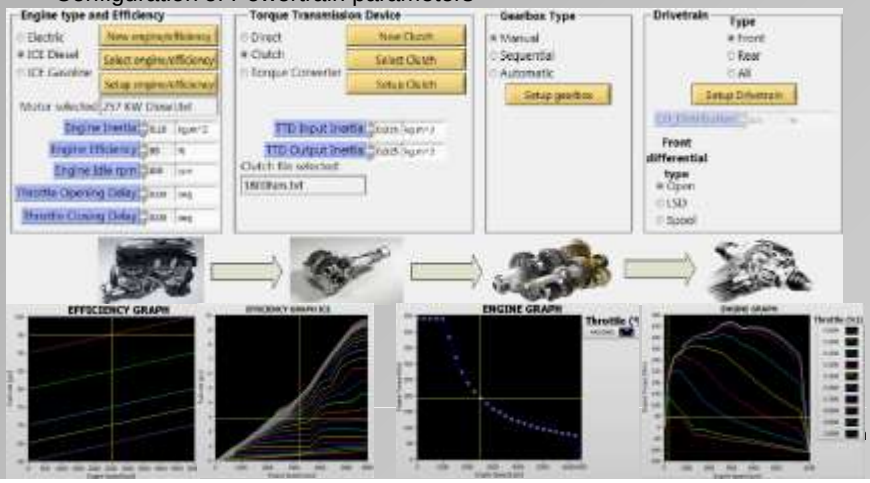
DYNACAR® - Vehicle model and track

Vehicle parameters, skin, sprung mass, aerodynamic, and circuit configuration



DYNACAR® - Vehicle model

Configuration of Powertrain parameters



DYNACAR® - Vehicle model

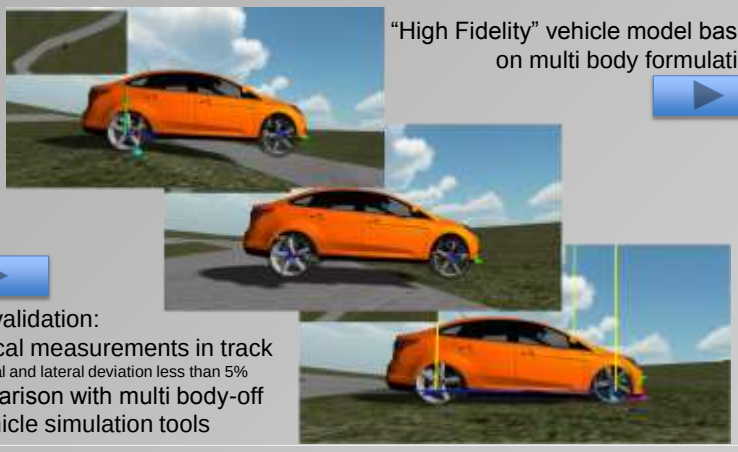
Configuration of other parameters: Wheel, Break, Tire, Suspension, Steering

DYNACAR®

- Full plant model is generated
  - ESS ECU (with battery and DC-BUS models)
  - Inverter ECU (with motor model)
  - Throttle ECU
  - EBS/ESP ECU (with e-braking control model)
  - Body ECU
  - VCU

- Plant models read data from vehicle model using virtual sensors

DYNACAR® - Full Vehicle Model



"High Fidelity" vehicle model based on multi body formulation

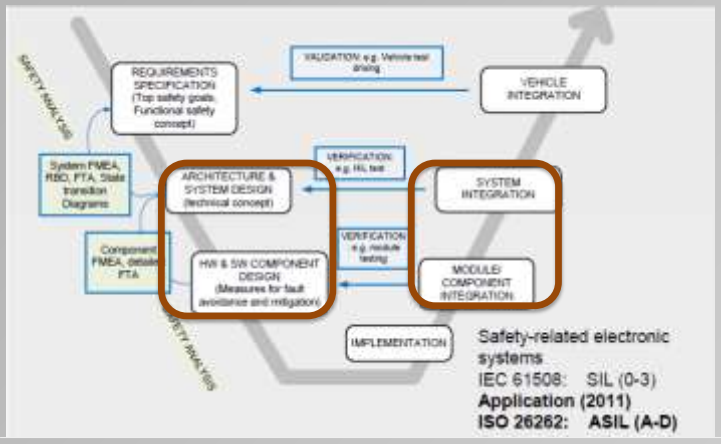
Model validation:

- Physical measurements in track

Longitudinal and lateral deviation less than 5%

- Comparison with multi body-off line vehicle simulation tools

DYNACAR® - Model based development and testing



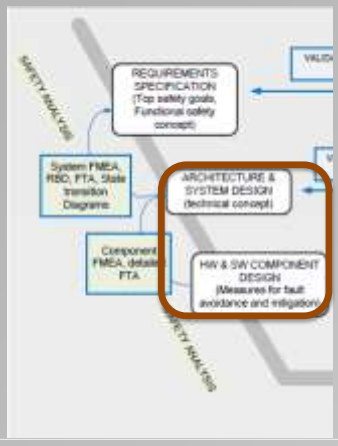
Safety-related electronic systems

IEC 61508: SIL (0-3)

Application (2011)

ISO 26262: ASIL (A-D)

DYNACAR® - Model based development and testing



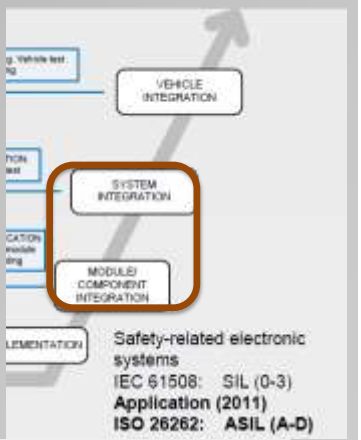
DYNACAR® can be used in the development of electric, hybrid and ICE powered vehicles for the following purposes:

- Quick vehicle performance assessment
- Power Train and Drive Train system and subsystem specification definition
- Power Train and Drive Train control strategies design and development (SW / Model in the Loop)
- Human in the loop assessments as driving Simulator

DYNACAR® - Model based development and testing

DYNACAR® can be used in the validation of electric, hybrid and ICE vehicles systems for the following purposes:

- Hardware in the loop of power train and drivetrain controllers
- Engine / transmission in the loop and electric drive in the loop
- Model based test of Energy Storage systems
- "Third party" real time model integration through Veristand 2011 from National Instruments
- Combined Human & Power/Drive train in the loop



Applications

Application #1: Development of optimum shifting strategy of a 2 speed EV gearbox control ECU

Design and HiL test of control algorithms under ISO26262

- Shift strategy definition for maximum efficiency (up to 8% saving)
- Gear change sequence optimization for seamless torque (driveability)
- Integration with other virtual ECU´s (ESP, ESS, Navigation)

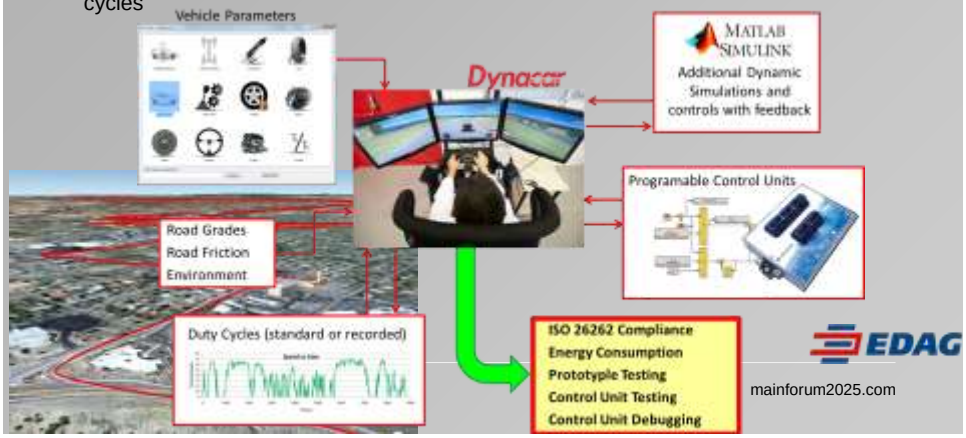
Application #1: Development of optimum shifting strategy of a 2 speed EV gearbox control ECU

Testing of ECU SW against full powertrain / calibration

Application #2: Model Based Design and Testing of an EV

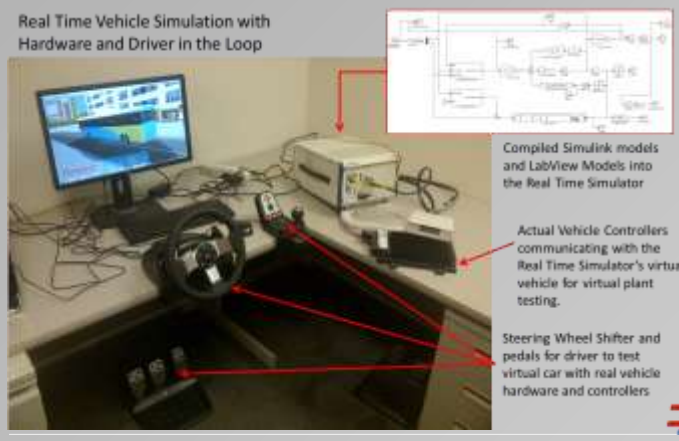
Objective: ***Optimum sizing of power train components*** and ***ECU testing***

Approach: DYNACAR® electric vehicle model using simulink powertrain models, with duty cycles



Application #2: Model Based Design and Testing of an EV

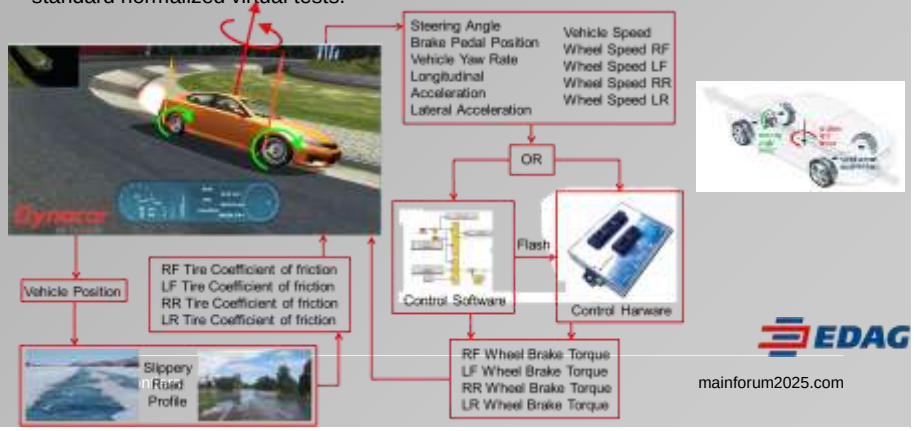
Real Time Vehicle Simulation with Hardware and Driver in the Loop



Application #3: Development and testing of ESC controller

Objective: ***Design and test of Electronic Stability Control for new vehicle***

Approach: Vehicle model in DYNACAR® with custom EDAG ESC Simulink model on standard normalized virtual tests.



Application #4: Control Development for AGV

Objective: Concept development of autonomous vehicle for Personal Rapid Transit (PRT) at Technology Park

Project: A Personal Rapid Transit (PRT) based on existing vehicles oriented to cooperate within the overall public transport system, and giving users a mobility solution for the “last mile”

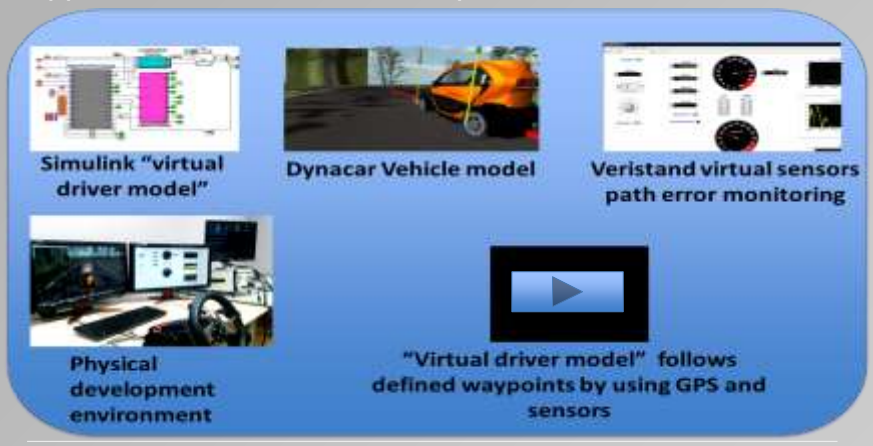
Prototype vehicle is fully “drive by wire”

Application #4: Control Development for AGV

Approach: Design and test of ECU for a fully autonomous road vehicle

- **Step1 -** Simulation environment: Vehicle model in DYNACAR®, SW in the loop using Simulink “virtual driver” model & real time testing of controller
- **Step 2 –** Real environment: Implement control on vehicle and test of simple use cases
- **Step 3 –** Correlation/Validation: Adjust the model and validate it

Application #4: Control Development for AGV



DYNACAR® Users

DYNACAR® Users

OEM´s for short volume series: Buses, trucks and new electric vehicles. For vehicle conceptualization, ECU development and testing

Tier 1-2 and Powertrain and Drivetrain designers: Powertrain and drivetrain module manufacturers, motor in wheel designers, electric & hybrid management and ECU developers. For component conceptualization, ECU development and testing.

Universities, technology centres and engineering services: For fast and flexible research and development activities on power train, electrification and vehicle conceptualization.

pablo.martinez@tecnalia.com

Manager Business Development NAFTA
TECNALIA Industry & Transport

MF2025

Automotive Frontiers.