Continental Engineering Services
Developing the technology for future mobility

www.conti-engineering.com
Agenda

› Continental Engineering Services at a glance
› Project: Agility tuning based on a virtual benchmark study
   › Overview
   › Report
      › Model parametrization
      › System integration
      › Simulation study
   › Outcome
› Further CarMaker use cases at CES
Overview
Continental Engineering Services at a glance

Service Portfolio

Consulting
› Process Consulting
› Software Consulting
› Technology and Topology Consulting

Development
› Software Engineering
› Hardware Engineering
› Mechanical Design

Production
› Technology Consulting
› Additive Manufacturing
› Samples & Components
› Small-Series Manufacture

Integration
› E/E-Architecture
› Vehicle Integration
› Software Integration
› Calibration
› Validation & Homologation
› Vehicle Acoustics

Profile

We are…
› an engineering and technology provider.
› an one stop shop – from the idea to the product.
› a gateway to high volume automotive products.
› more than 1,500 experienced engineers & specialists.
› developers of the technology for future mobility.

Areas of Expertise

Markets

Customers
## Project overview
Starting point, subjects of investigation and goals

### Starting point
- Customer type: OEM
- Development of a vehicle model
  - Basic parameters provided
  - No control system decision
  - No powertrain layout decision
- Vehicle dynamics goal: Customer selected benchmark vehicle
  - Static and dynamic measurements provided

### Subjects of investigation
- Vehicle dynamics study
  - Steering
  - Handling
  - Maneuverability
- What active control systems can provide the desired behavior?
- Which Powertrain configuration is needed?
- Where are the benefits and disadvantages of certain control systems and powertrain configurations?

### Goals
- Vehicle model parametrization
  - Benchmark vehicle
  - Customer vehicle
- Control system integration
  - Torque Vectoring
  - Rear Wheel Steering
  - Combinations
- Vehicle dynamics investigation
  - Maneuver definition
  - Evaluation of results
  - Recommendation
Benchmark vehicle model
Parametrization and validation

Parametrization

› Model generation with basic parameters from measurements
  › Masses, dimensions
› Conversion of kinematic measurements using KnC Data Converter from IPG
› Adjustments to real measurements
  › CoG, Inertias, etc.
› Model ready to be validated

* No data from project
Benchmark vehicle model
Parametrization and validation

Static validation

› Validation to quasi-static measurements
› Comparison of steering wheel angle to lateral acceleration

› Quasi-static vehicle dynamics validated for the use case
  › missing dynamic validation

![Graph showing comparison of steering wheel angle change in degrees vs lateral acceleration in g between Testdrive and CarMaker Simulation.](image-url)
Benchmark vehicle model
Parametrization and validation

Dynamic validation

› Steer Step maneuver used to adjust damping characteristics
› Sinus Steer maneuver for validation

› Benchmark vehicle model validated for use in simulations study
Customer vehicle model
Parametrization and control system integration

Parametrisation

› Model generation with basic parameters
  › Masses, inertias, dimensions
  › Vehicle larger than benchmark vehicle
› 3 different powertrain layouts

Control system integration

› Control systems integrated using CarMaker for Simulink
› Torque vectoring control based on Continental DTV
› Prototype rear wheel steer control with fixed ratio and active control
Customer vehicle model
Parametrization and control system integration

Control system integration

› Yaw rate reference generator
  › Tunable to desired dynamics
› Different yaw control systems
  › Torque vectoring
  › Active rear wheel steering
› Fixed ratio rear wheel steering
› Customer vehicle model ready for use in simulations study
Simulation Study
Maneuver and metrics

Steering characteristics

› Investigation of yaw gain characteristics
› No technology
  › characteristics shifted
› Rear wheel steering
  › less agile, but characteristics similar
› Torque vectoring
  › Matching desired behaviour

› Control systems are capable of influencing vehicle characteristics
**Simulation Study**

**Maneuver and metrics**

**Agility**

- Steering response in steer step maneuver
- Not technology
  - Less agile
- Rear wheel steering
  - Improvement of agility, but overshooting
- Torque vectoring
  - Tunable by control parameters
- Agility is tunable by control systems
Simulation Study
Maneuver and metrics

Maneuverability

› Specific customer needs
› Does the vehicle get around a specific corner? → Tractrix
  › Benchmark vehicle → yes
  › No technology → no
  › Rear wheel steering → yes

› Rear wheel steering is capable of improving maneuverability
Project Outcome
Summary, Evaluation and Recommendation

Summary
› Parametrization of 4 vehicle models
› Integration of two control systems with 5 variants and combinations
› Test series with ~60 Maneuvres
› Automatic visualization and evaluation of ~ 1000 simulation results

Evaluation
› Simulation study is capable of investigating impact of control systems to vehicle dynamics
› Control systems can influence the vehicle behavior to the desired characteristics

Recommendation
› Recommendation of a combination of Rear Wheel Steering and Torque Vectoring
  › All systems are capable to achieve vehicle dynamics goals
  › Rear wheel steer influences maneuverability
  › Combination of Torque Vectoring and Rear Wheel Steering due to safety and energy considerations
### Simulation Services offered at CES

**Team Virtual Vehicle Test**

#### As shown in the project
- Model parametrization and validation
- System integration
  - Continental components
  - Prototype control systems
- Test design and evaluation
  - Maneuver definition
  - Test series configuration
  - Automated Evaluation

#### Further activities
- Test Systems
  - HiL
  - ViL
- SiL and MiL development environments
- Testing
  - Development support
  - Requirement based for releases
Thank you