



Vehicle Dynamics Expo 2011

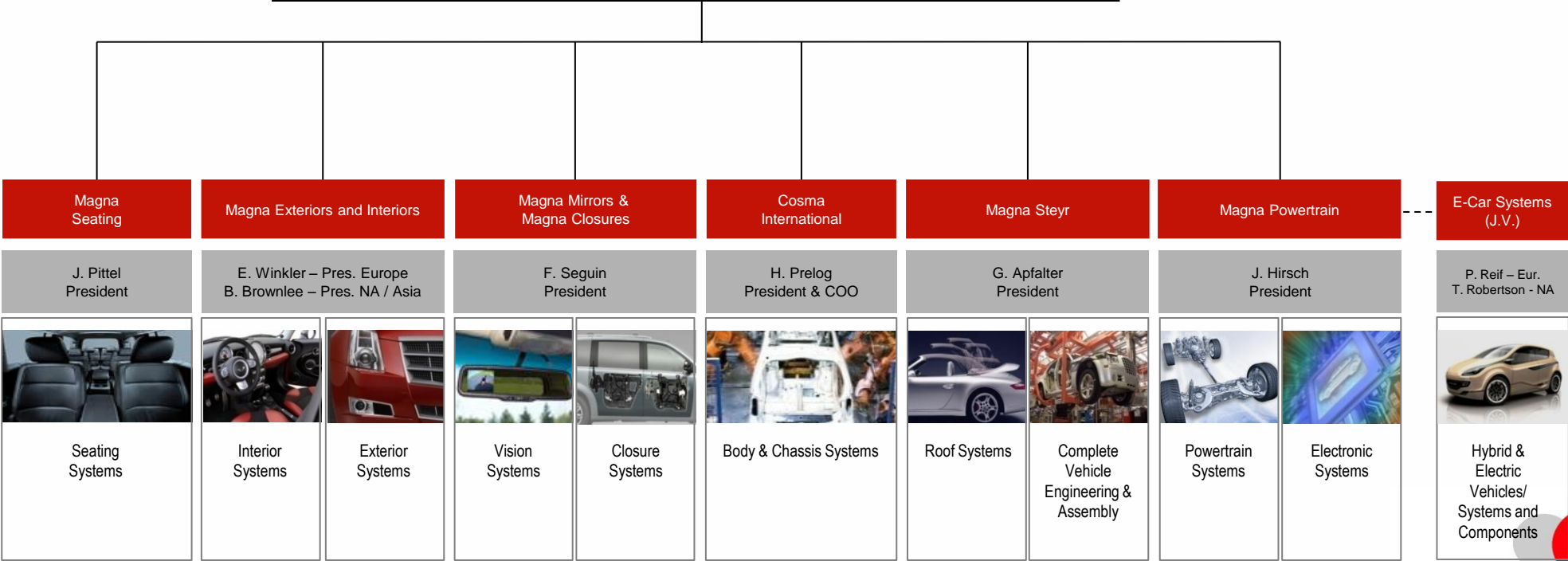
Vehicle dynamics control: An integrated approach

Daniel Lindvai-Soos, Walter Rosinger

Management Structure



Frank Stronach Chairman	Don Walker CEO
Vincent Galifi CFO	Marc Neeb EVP Human Resources
Burkhard Goeschel CTO	Jeff Palmer CLO
Jim Tobin CMO and President Magna Japan, Korea	
Tom Skudutis COO Magna Interiors, Exteriors, Seating, Mirrors and Closures	
Herbert Demel EVP Magna and President Magna China, India, South/East Asia, S. America, Africa	
Guenther Apfalter President Magna Europe	
Manfred Eibeck EVP Magna Europe and President Magna Russia	



The Project House, founded on July 1, 2008 is a cooperation of Magna Steyr, Magna Powertrain and E-Car for the

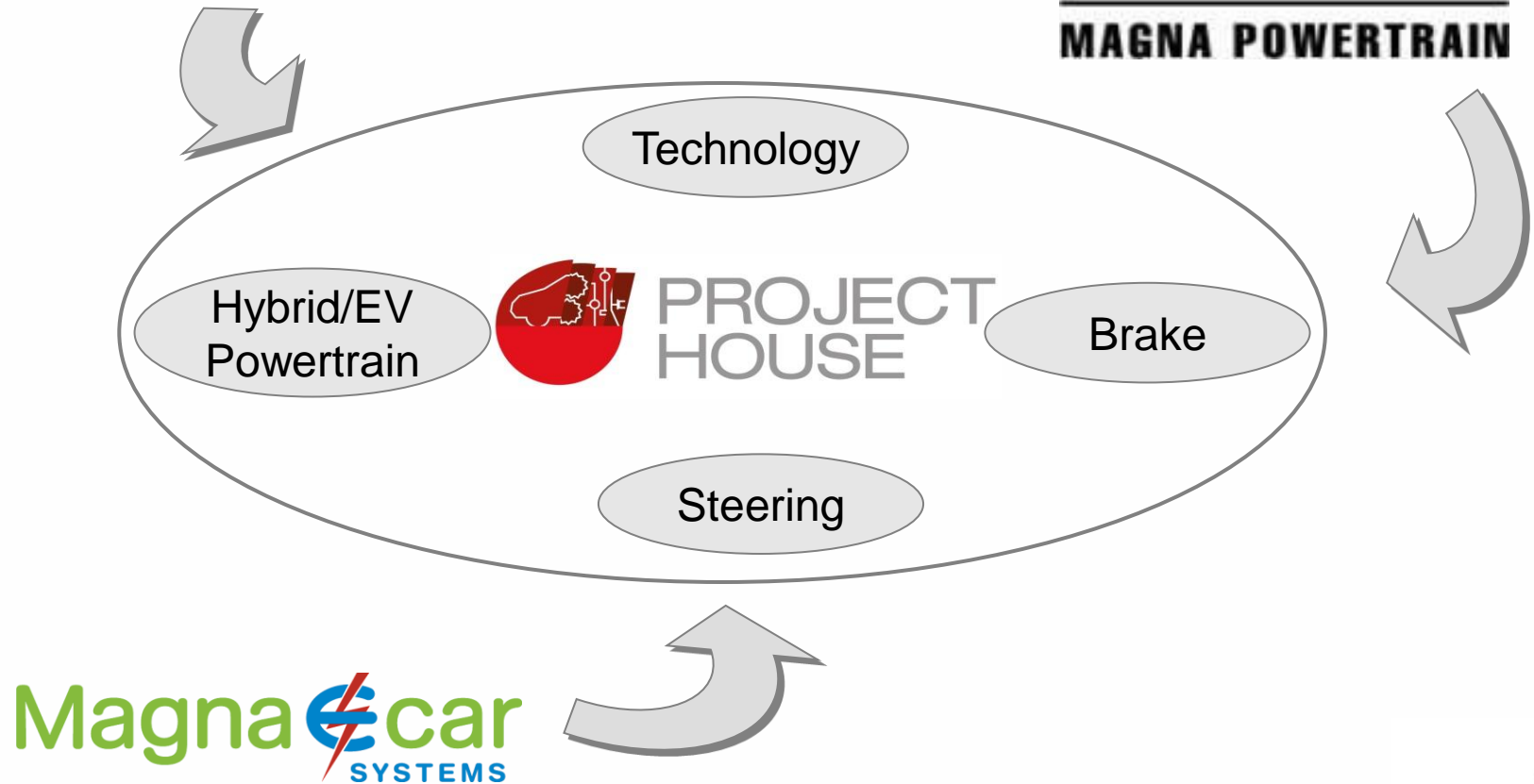
- Identification of new products for the participating groups
- Pre-development of prioritized projects (incl. business plan, product evaluation and MoB-decisions)
- Design and assembly of the first prototypes and
- Concept proof



of innovative products within defined functional areas, which need the competencies of more than one group.

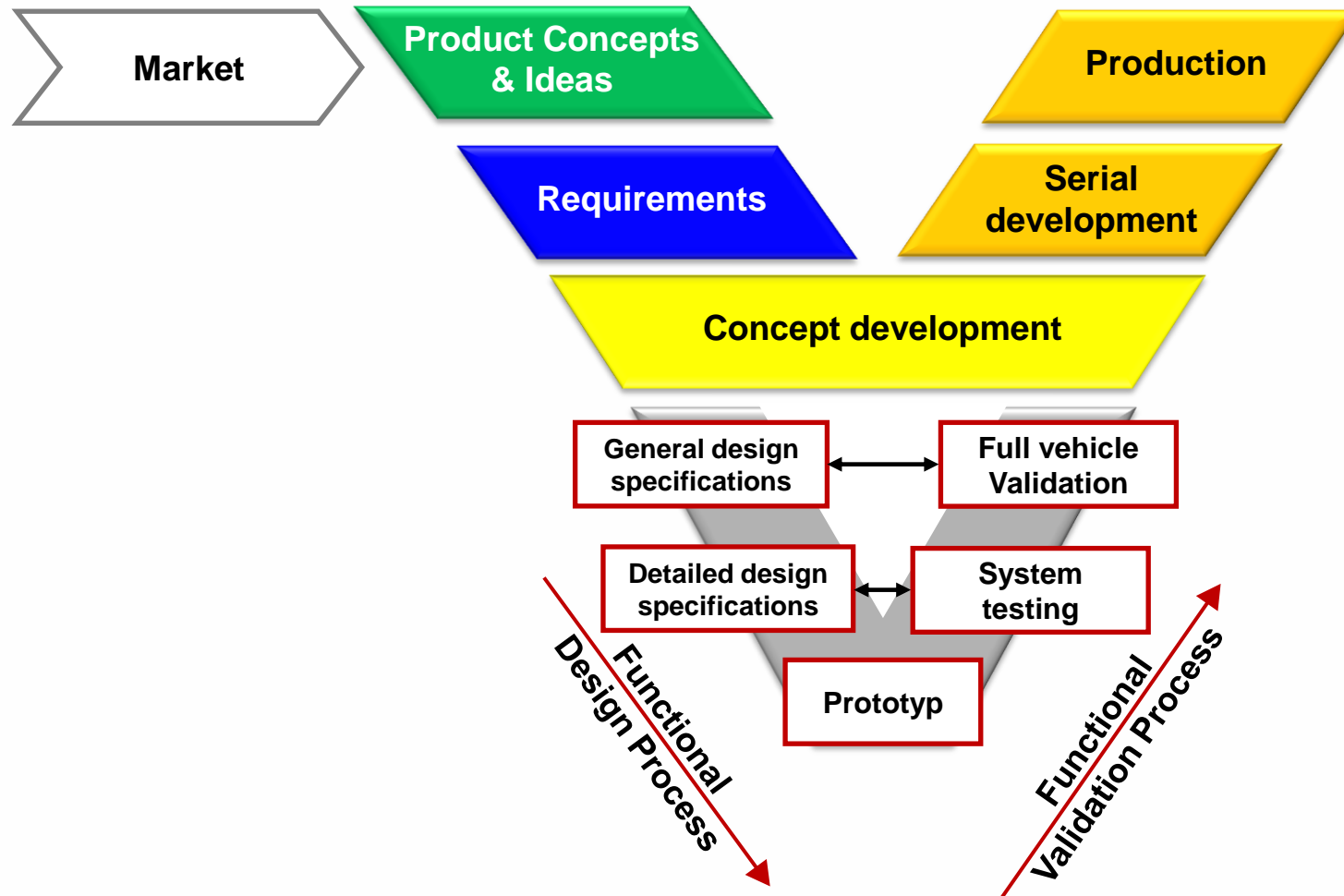
Handover of the proofed concept to the group, which will do the serial development and production of the product (product owner) - concept hand-over meeting

Project House – Functional Areas



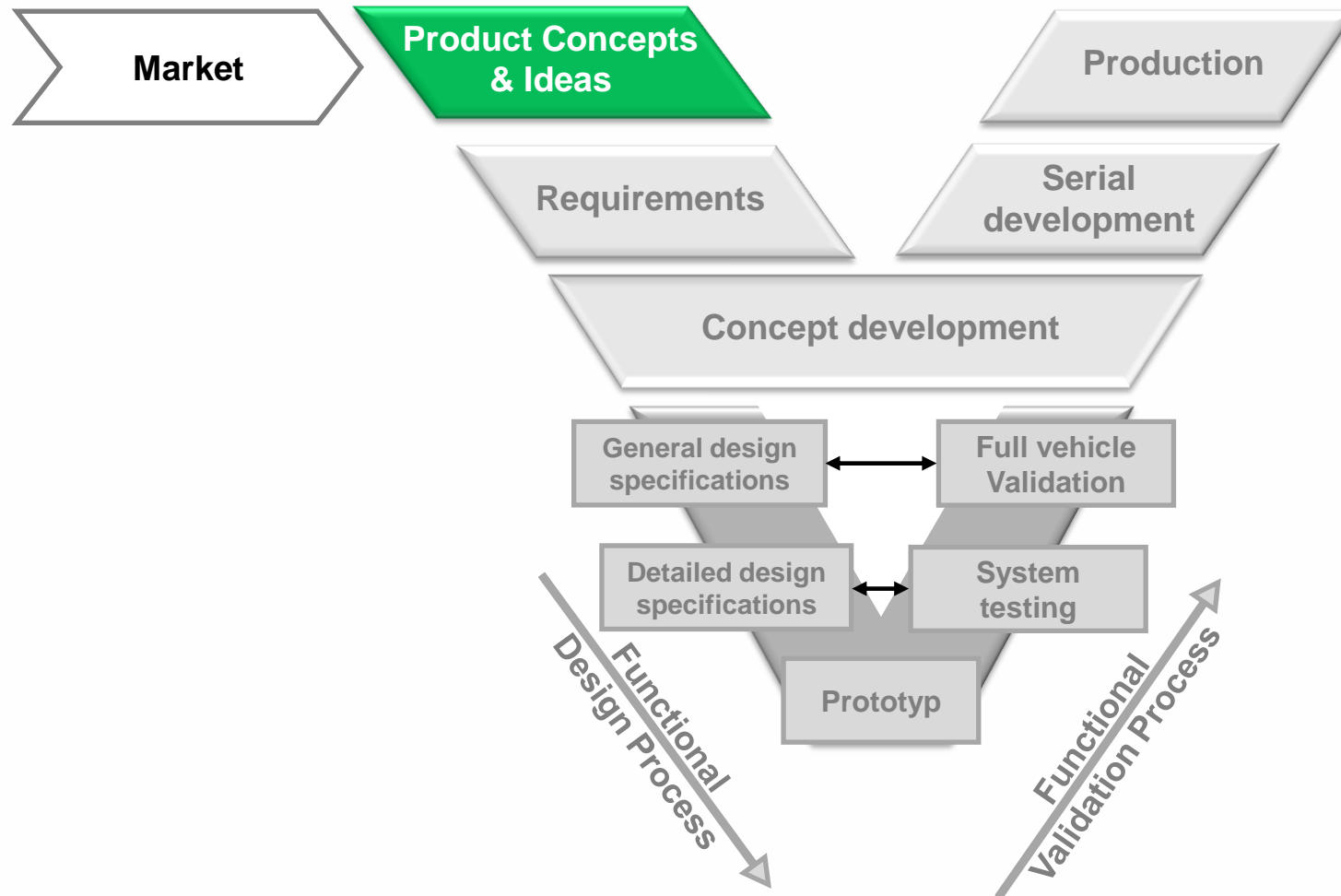
The Integrated Approach

... in the **development process** of advanced Vehicle Dynamics Control concepts



The Integrated Approach

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Market → Products?



Identifier



Translator



Innovator

Market Requirements

- Ride comfort, driving safety, handling
 - Costs
 - Environmental friendly, CO₂ Reduction
- Costumer/ Brand Philosophy
- ← legislative body

Vehicle Dynamics: Targets

- Roll angle control, yaw behavior control: over- / understeering
- Low package requirements, same parts, 12V on-board electrical system
- Less energy consumption, weight

Product Concepts

New Technologies

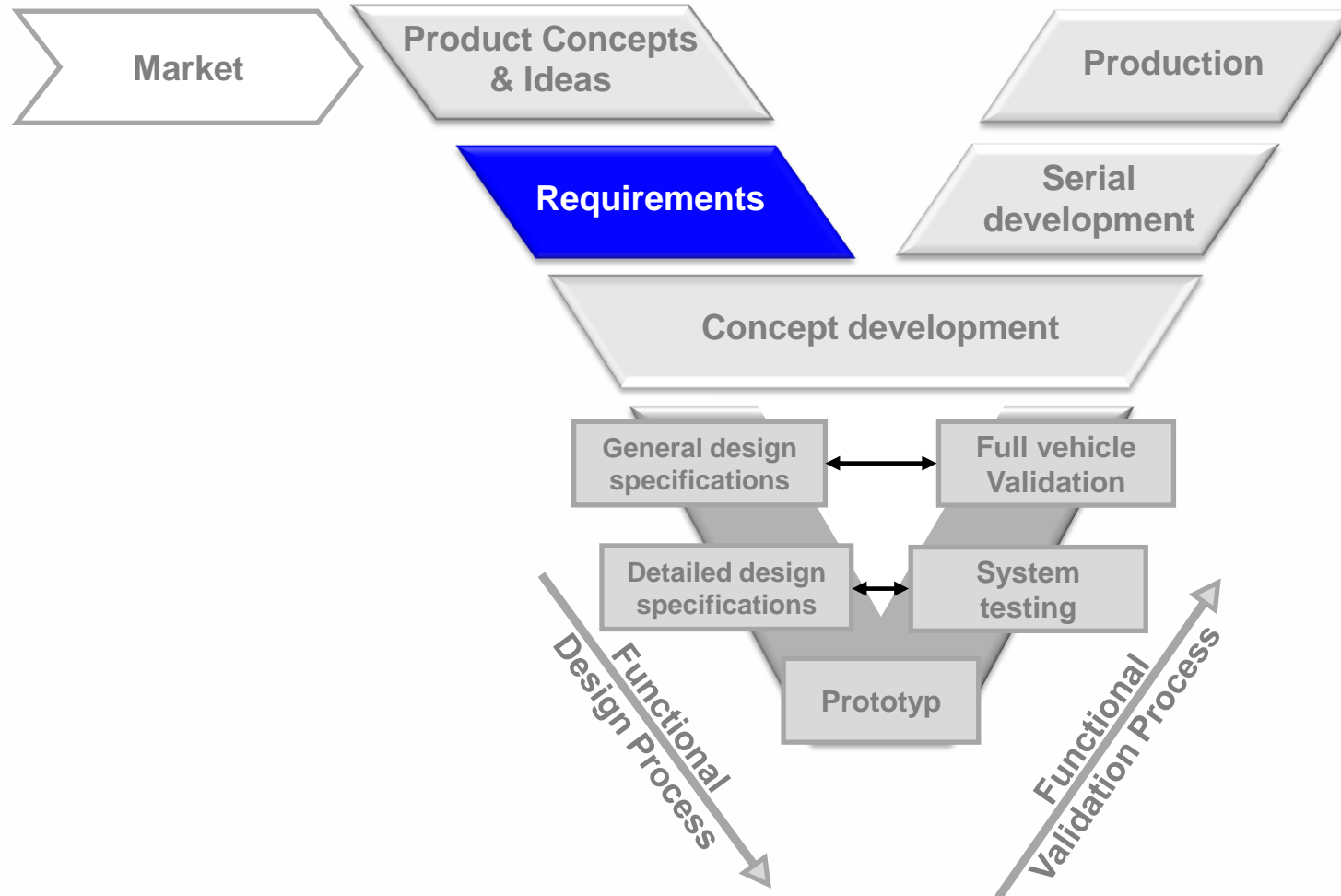
- Full active suspension control
- Anti-Roll-Stabilizer: active

electric



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too tight

best compromise

in costs, weight, technology
and functional requirements

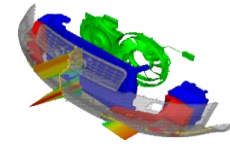
too loose

perhaps **too cheap**....



Technical
specification

← Simulation (MBS, Suspension analysis, vehicle handling /ride, load spectrum, fatigue & lifetime,....)



■ Benchmark & Experience (Reference projects, databases, ...)



■ Rig Tests (4WD Chassis Dyno, K&C, Brakes & Suspension, powertrain & chassis benches)

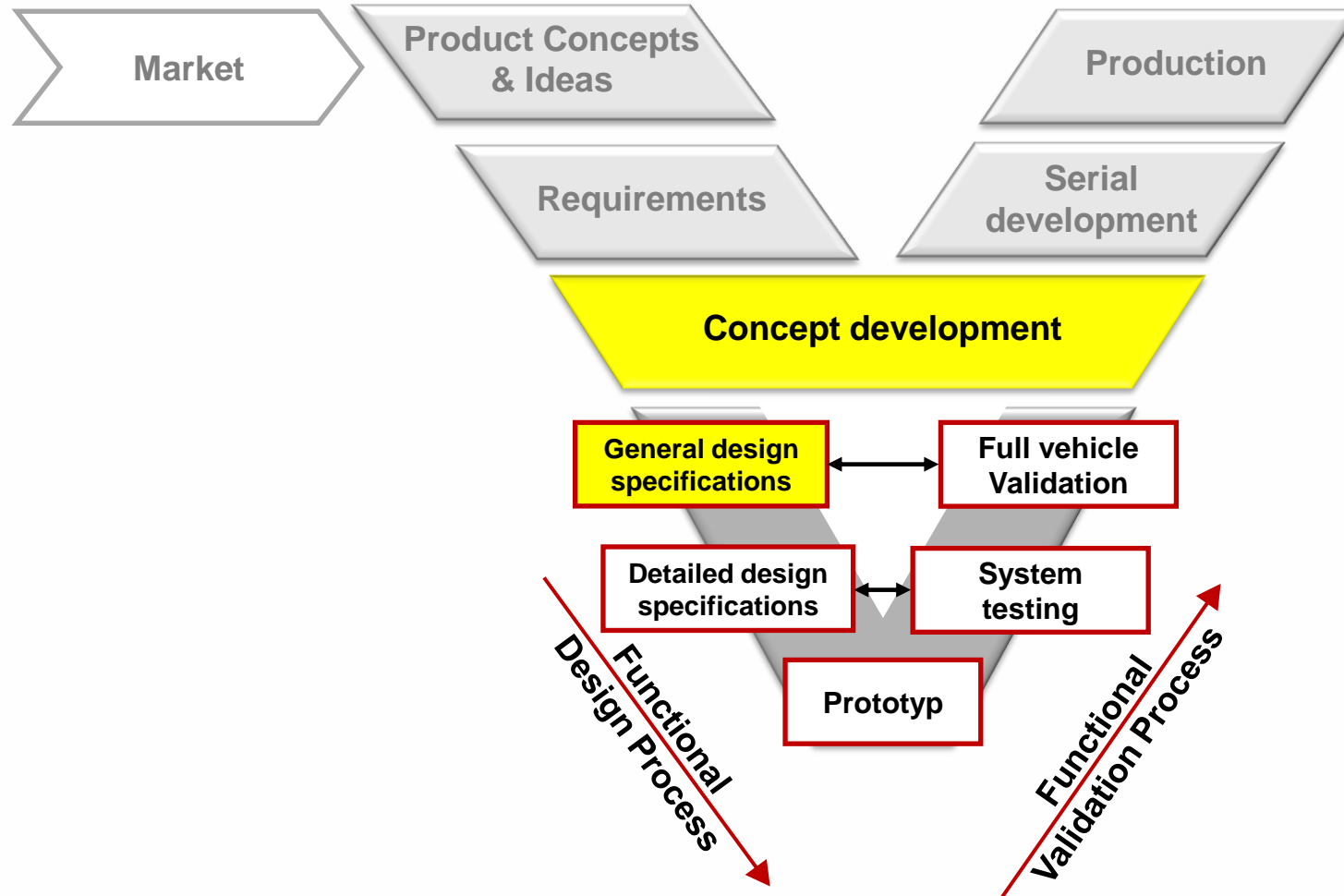


■ On Vehicle Tests (On-road, Off-road)



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General design specifications: Design

• Selection of Systems

— Analysis and evaluation of each system

- Performance/Function
- Costs
- Weight / Balance
- Integration
- Quality
- Modularity

Criteria	Weight	Criteria Weight	System Rating				
			System 1	System 2	System 3	System 4	System 5
			System 1	System 2	System 3	System 4	System 5
Performance/Function	1	1	1	1	1	1	1
Costs	1	1	1	1	1	1	1
Weight / Balance	1	1	1	1	1	1	1
Integration	1	1	1	1	1	1	1
Quality	1	1	1	1	1	1	1
Modularity	1	1	1	1	1	1	1
Total Rating			79.7%	100.0%	88.5%	100.7%	91.0%
Total Weighted Criteria			72.0%	100.0%	92.0%	98.1%	75.0%

MS Rating Matrix

Actuator-Setup



ESP Electronic Stability Program
AFS Active Front Steering
RWS Rear Wheel Steering
ARS Active Roll Stabilization

General design specifications: Design

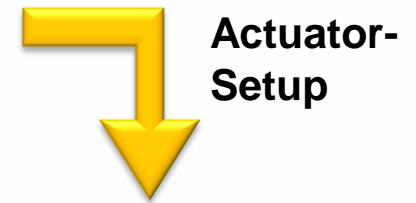
• Selection of Systems

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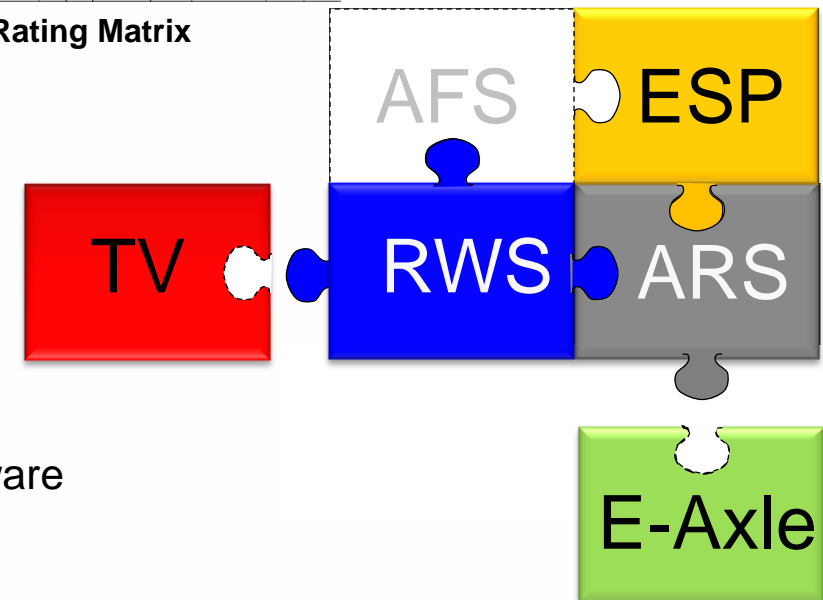
	Criteria	Weight	Value	System Rating				
				System 1	System 2	System 3	System 4	System 5
				Rating	Rating	Rating	Rating	Rating
Weight	Weight	10%	100	100	100	100	100	100
Cost	Cost	20%	200	200	200	200	200	200
Performance	Performance	30%	300	300	300	300	300	300
Integration	Integration	10%	100	100	100	100	100	100
Quality	Quality	10%	100	100	100	100	100	100
Modularity	Modularity	10%	100	100	100	100	100	100
Total Rating				79.7%	100.0%	88.5%	100.0%	81.0%
Total of weighted criteria				79.7%	100.0%	88.5%	100.0%	81.0%

MS Rating Matrix



• Integration Concepts

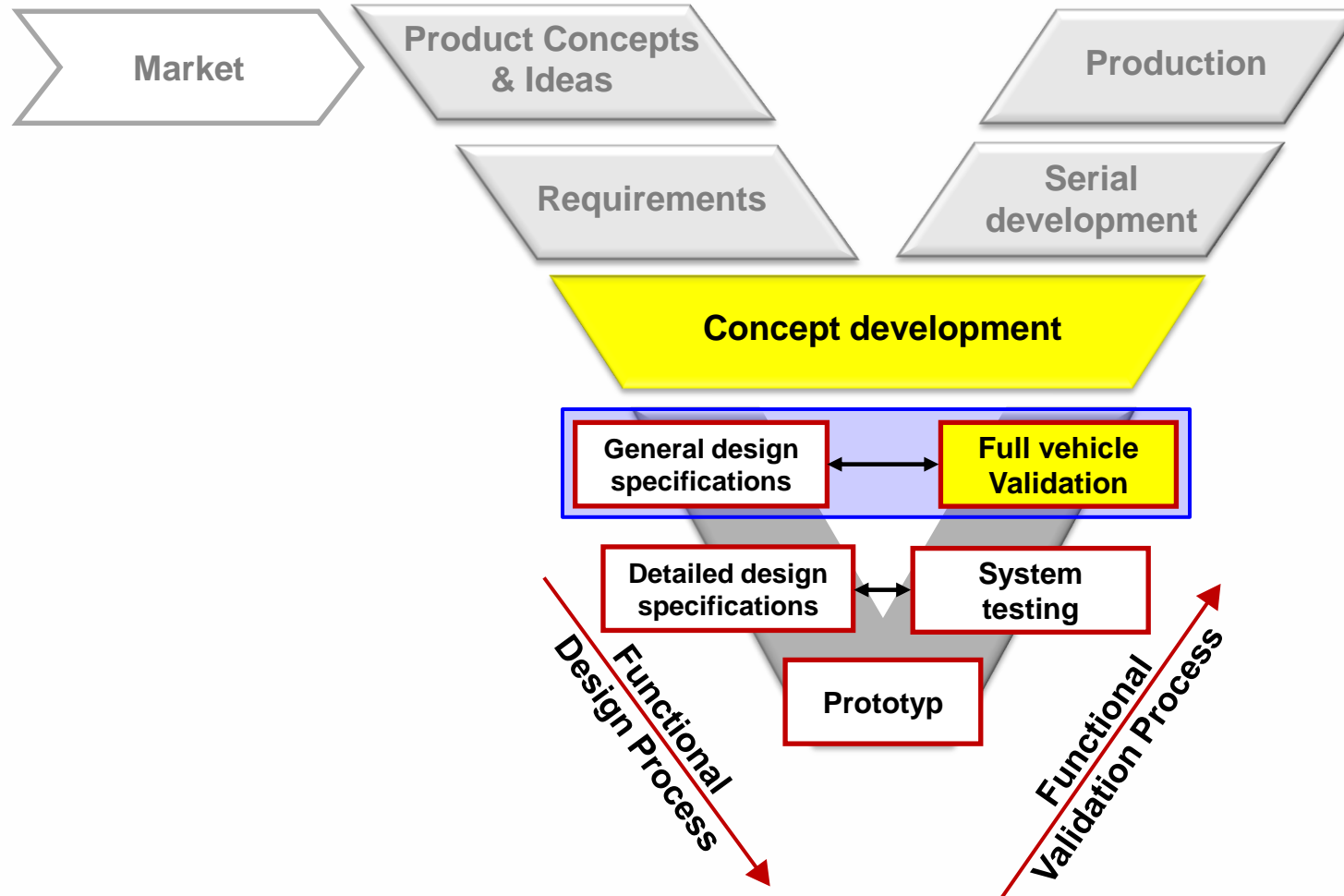
- Hardware
- Function
- Different suppliers
- Modularity
- Exchangeability for hardware (actuators) and software (modules)
- Cost-effective basic configurations + easy upgrade possibilities (optional features)



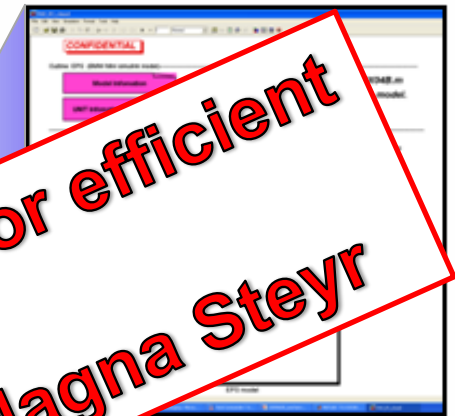
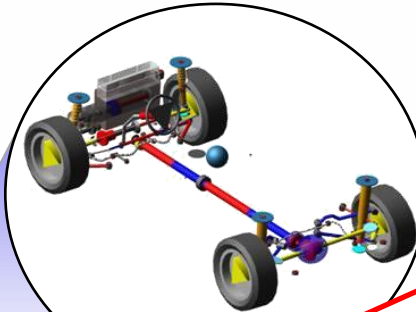
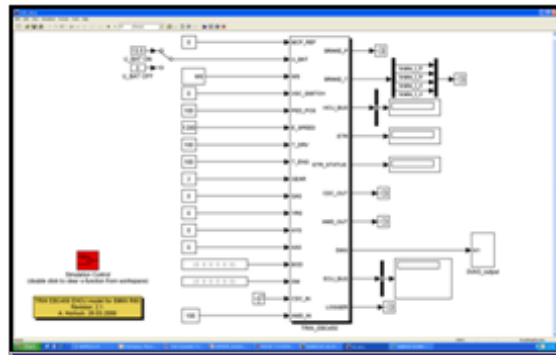
ESP Electronic Stability Program
 AFS Active Front Steering
 RWS Rear Wheel Steering
 ARS Active Roll Stabilization
 TV Torque Vectoring

The Integrated Approach

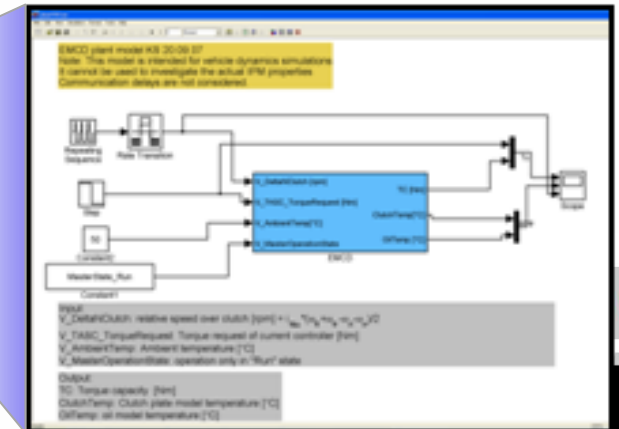
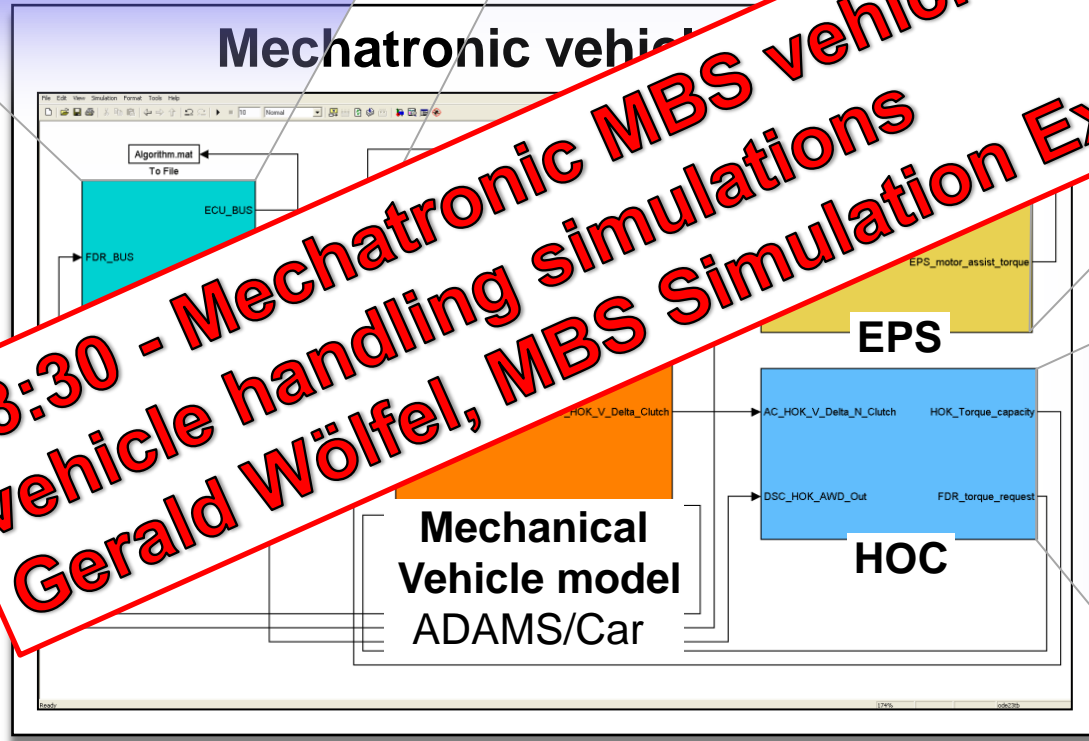
... in the **development process** of advanced Vehicle Dynamics Control concepts



General design specifications: Validation

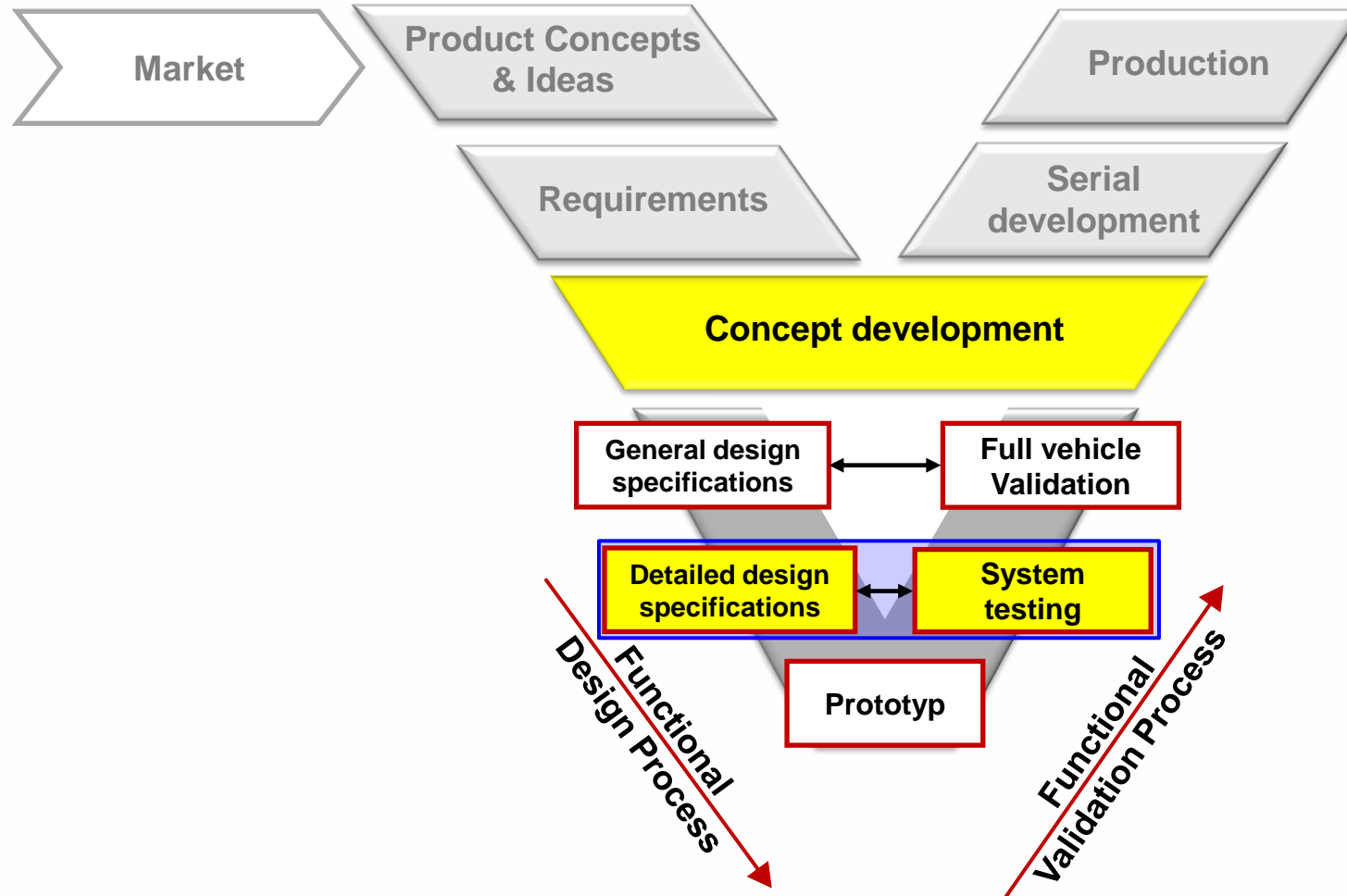


13:30 - Mechatronic MBS vehicle models for efficient vehicle handling simulations
Gerald Wölfel, MBS Simulation Expert, Magna Steyr



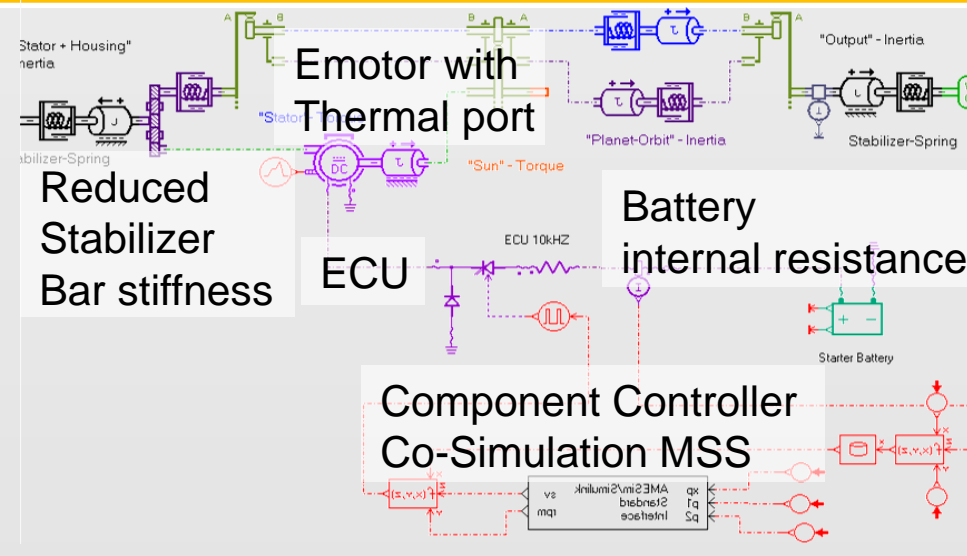
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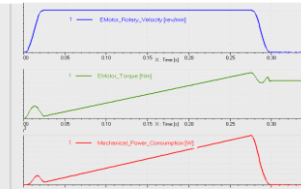
Detailed design specifications: Design

e.g. AMESIM: Planet Gears with Inertia, Coulomb Friction, Viscous friction torque, Stiction Torque and Tooth & Bearing Losses

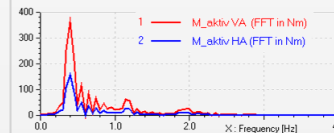


Tests

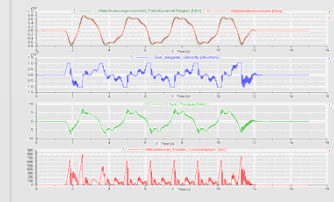
Static & Dyn.
Load
Profiles



Power &
Energy
Profiles



Thermal
Load
Profiles



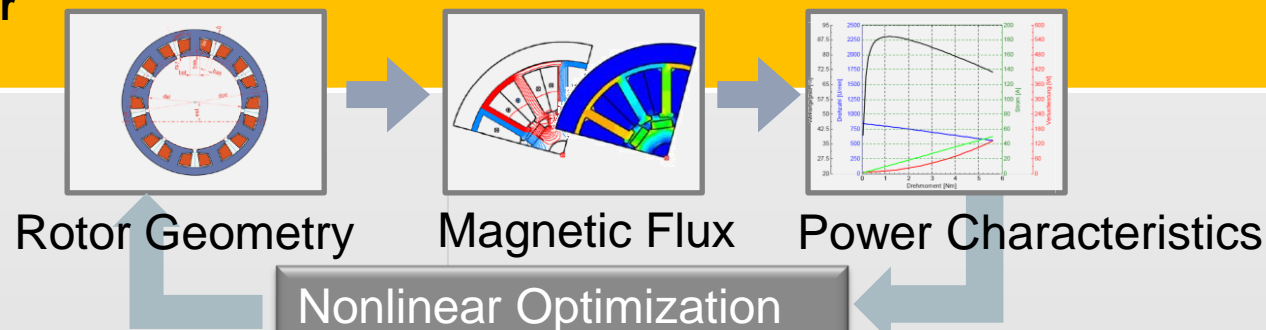
Characteristics

Actuation torque
800Nm in 300ms
Decoupling

Reduced Power
demand Recu-
peration
Potentials

Handling Course
without
Functional
degradation

BLDC Motor Design

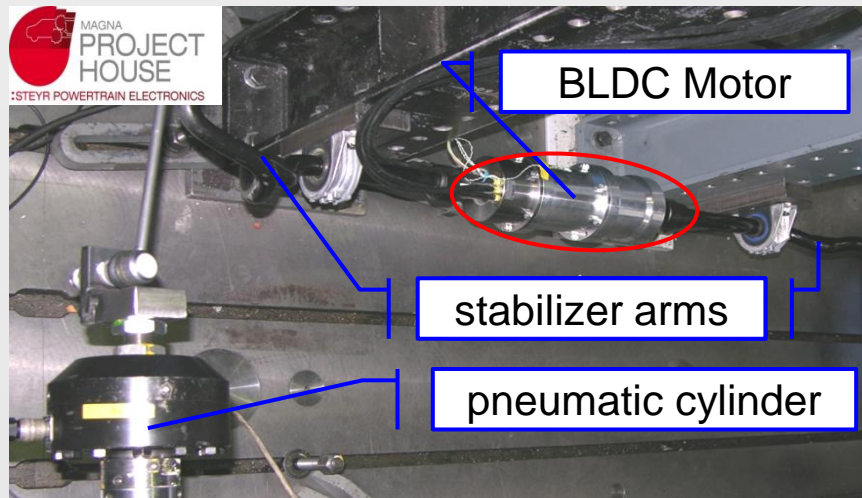


Detailed design specifications: Validation

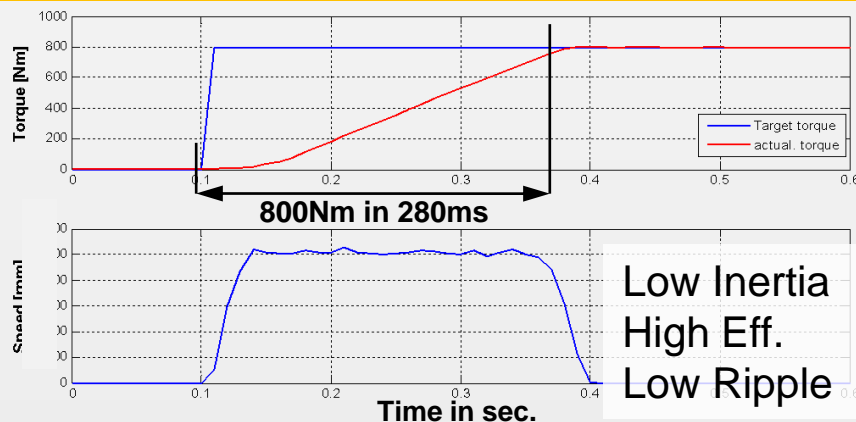
E-ARS

Electromechanical
Anti-Roll Stabilizer

- Test Rig
- Performance test



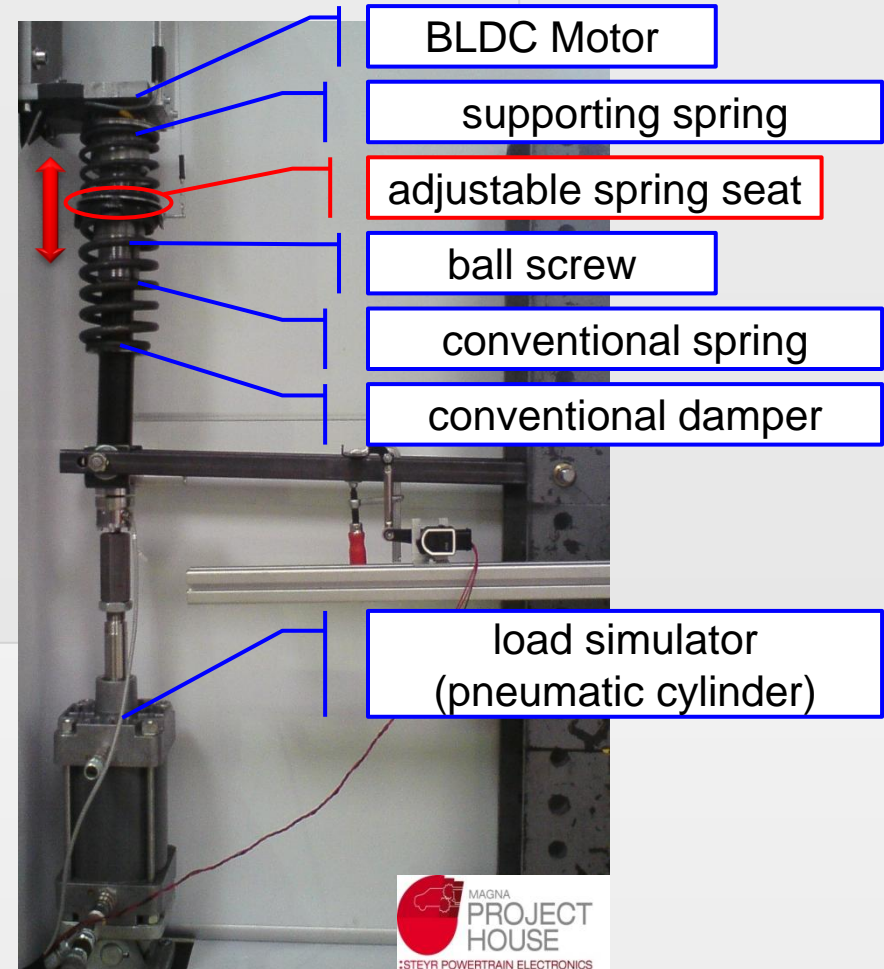
Ramp-Up



E-SAS

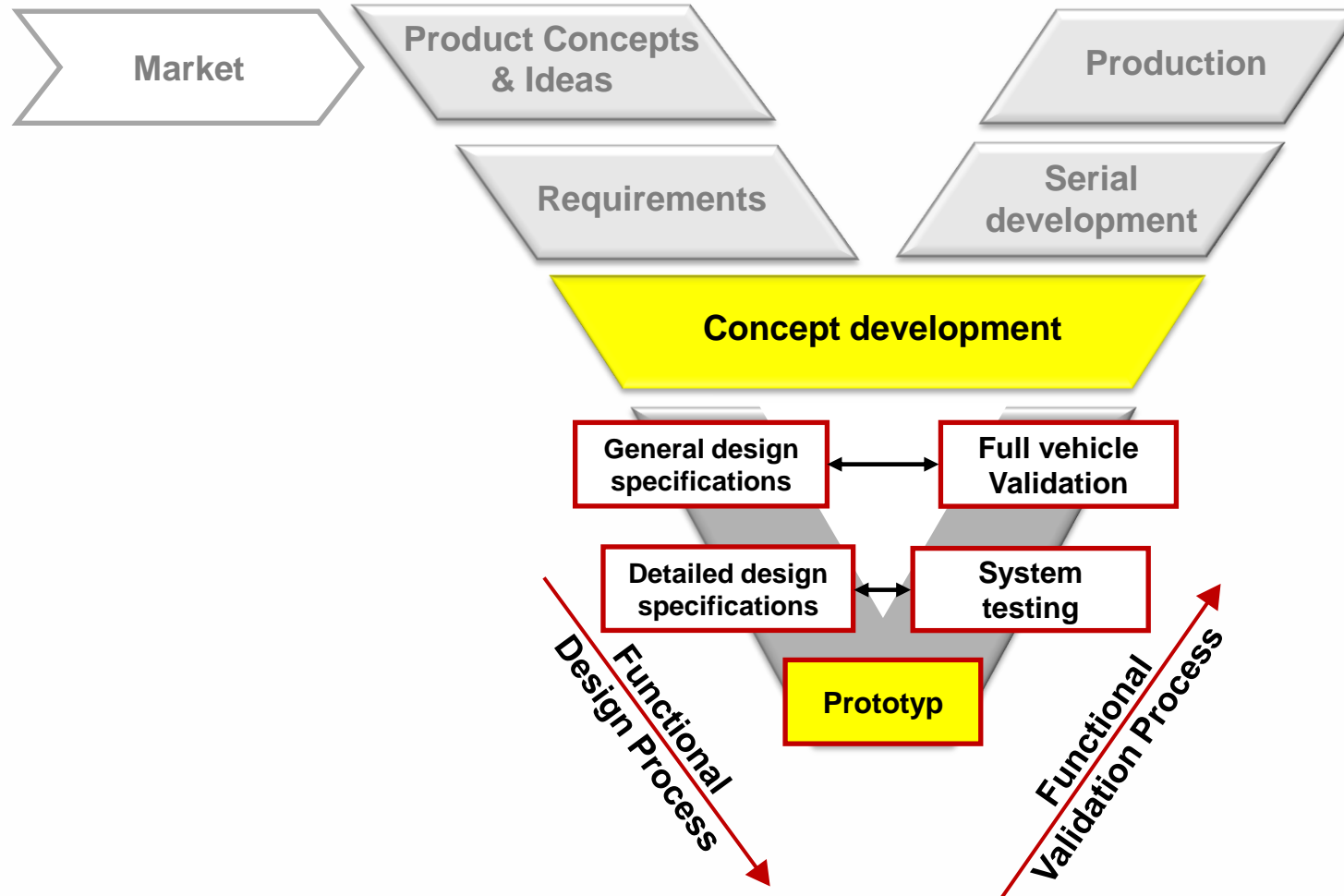
Electromechanical
Spring Adjustment System

- Vehicle level control
- Adjustment of the spring-preload


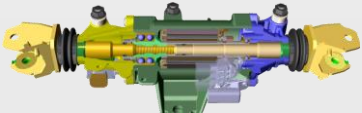



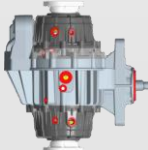



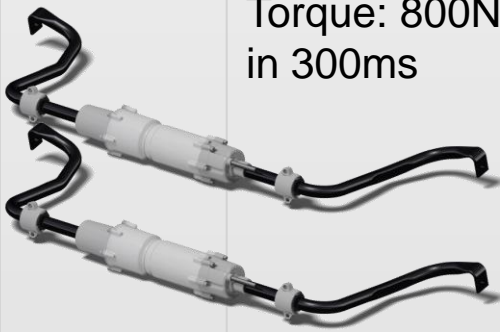
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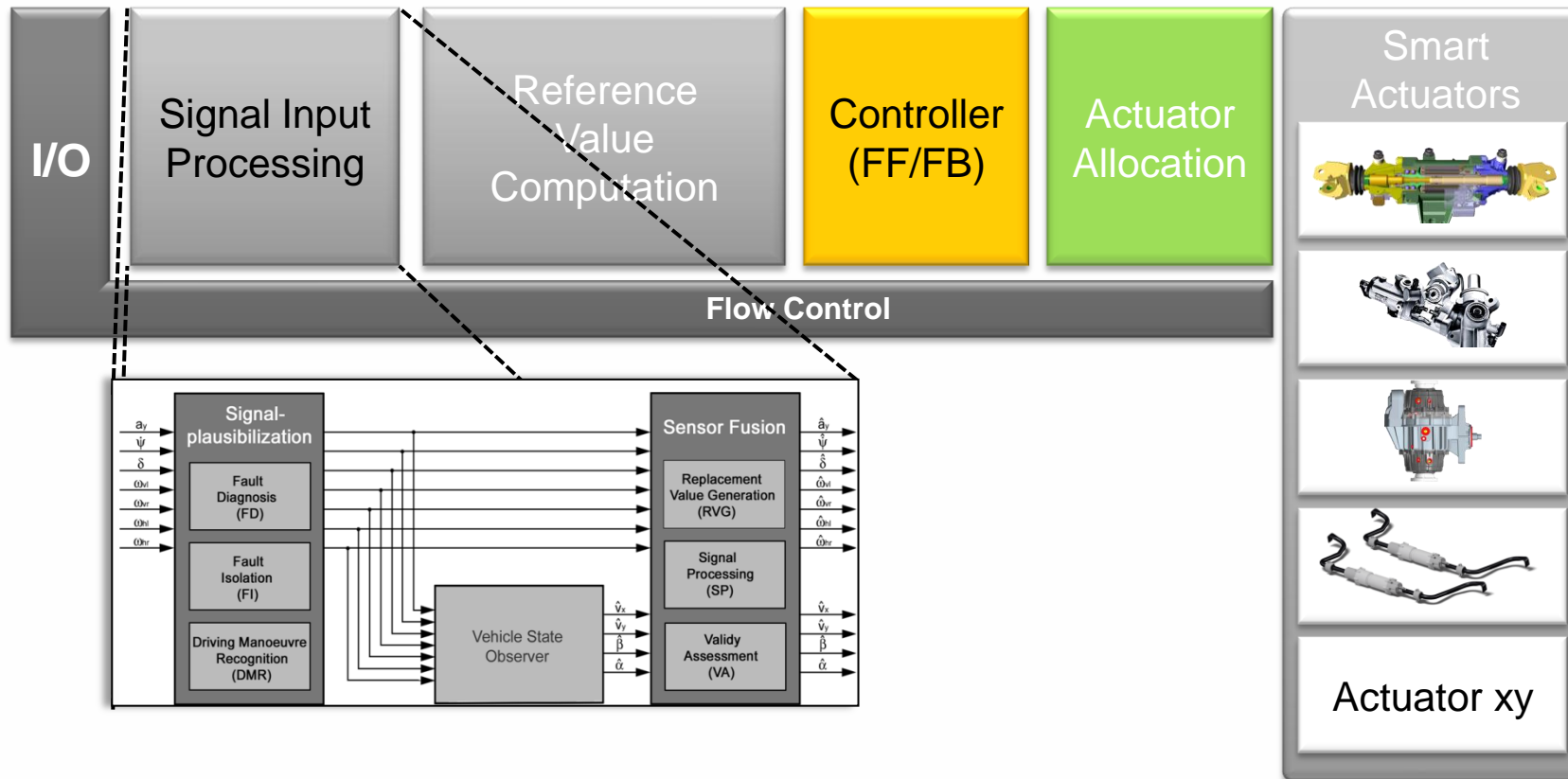
System	Characteristic	
Active Rear Steering 		Actuator stroke: 8,5mm → 3,5 in 200ms
Active Front Steering 		Variable steering ratio
Torque Vectoring 		max. transfer Torque: 1200Nm

System	Characteristic	
Active Anti-Roll Stabilizer Front + Rear 		Actuation Torque: 800Nm in 300ms

Prototype: Global Chassis Control

- **Magna Steyr Global Chassis Control**

- Centralized coordination of active chassis systems
- Extended possibilities (driver assistance systems, energy management)
- Improved functionality
- Less application effort and more modularity

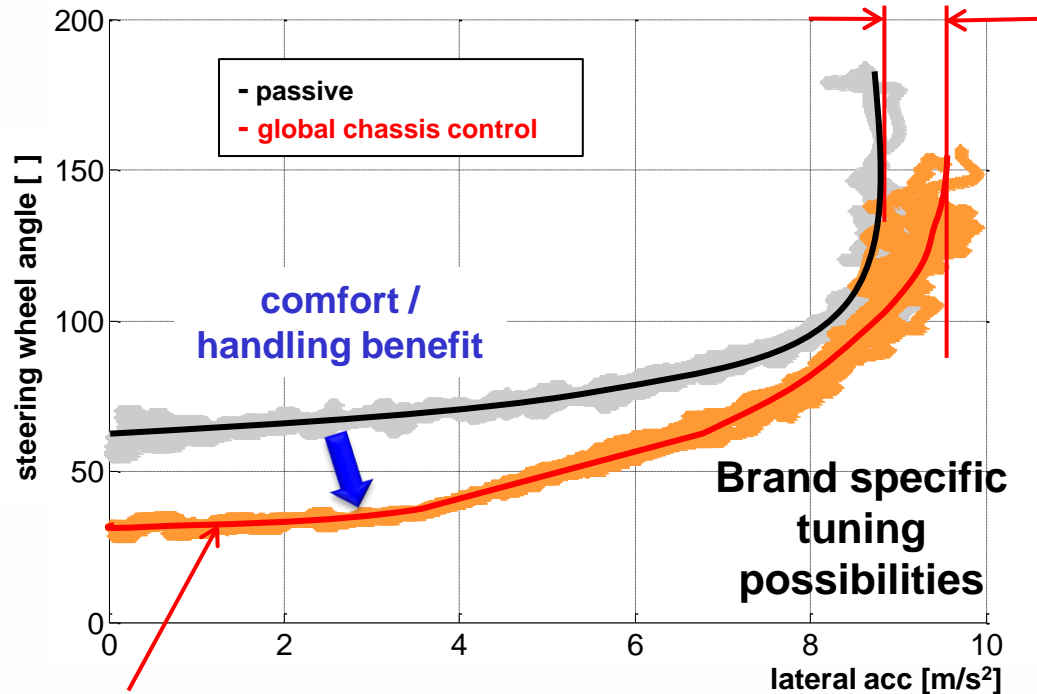


Prototype: Test results



• Steady state validation

safety / handling benefit



MSF Setup

- Improved driving safety
- Higher cornering performance
- Improvement of vehicle steering behavior
- Easier vehicle control + less steering effort

• Dynamic Validation

VIDEO

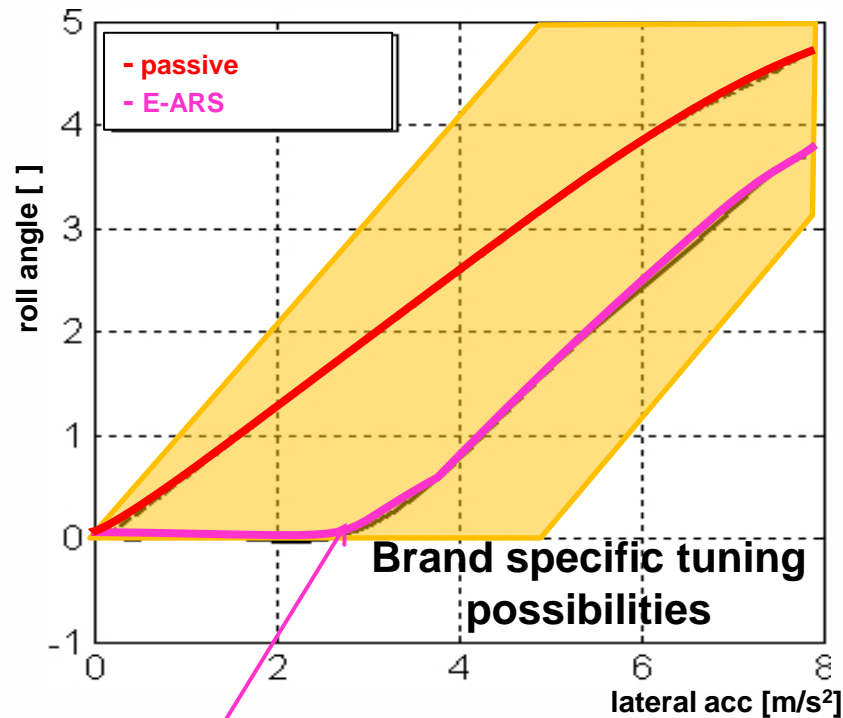


Maneuver	active	passive
VDA lane change		
Entrance velocity	72,43km/h	68,83km/h
Improvement +5,2%		
ISO lane change		
Average velocity	131,65km/h	123,51km/h
Improvement +6,6%		
18m slalom		
Average velocity	63,94km/h	61,00km/h
Improvement +4,8%		
36m slalom		
Average velocity	116,05km/h	109,06km/h
Improvement +6,4%		

Prototype: Simulation + Test results



• Steady-State Validation



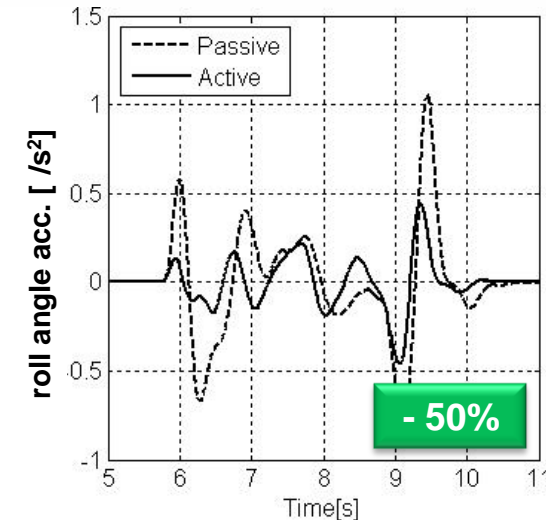
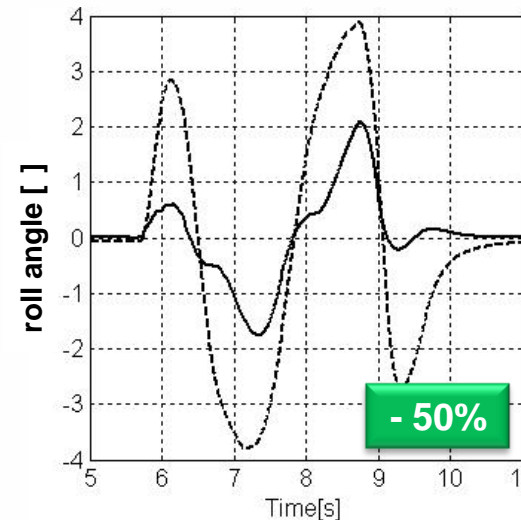
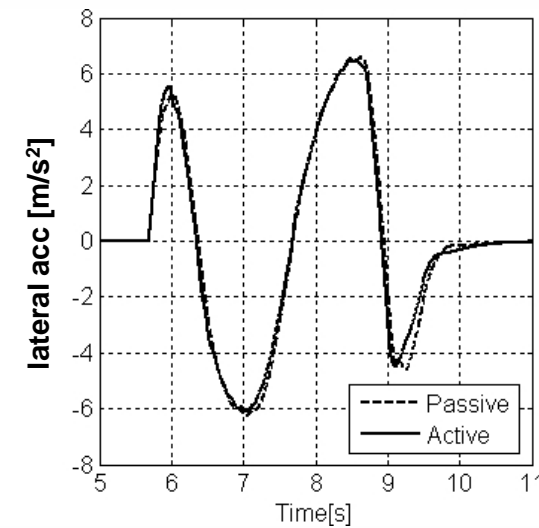
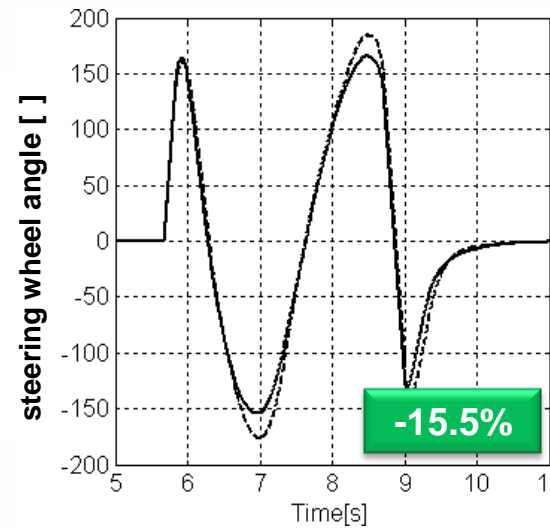
MSF Setup

- Reduced roll angle
- Improvement in safety and comfort
- Easier vehicle control
- Less steering effort

• Dynamic Validation

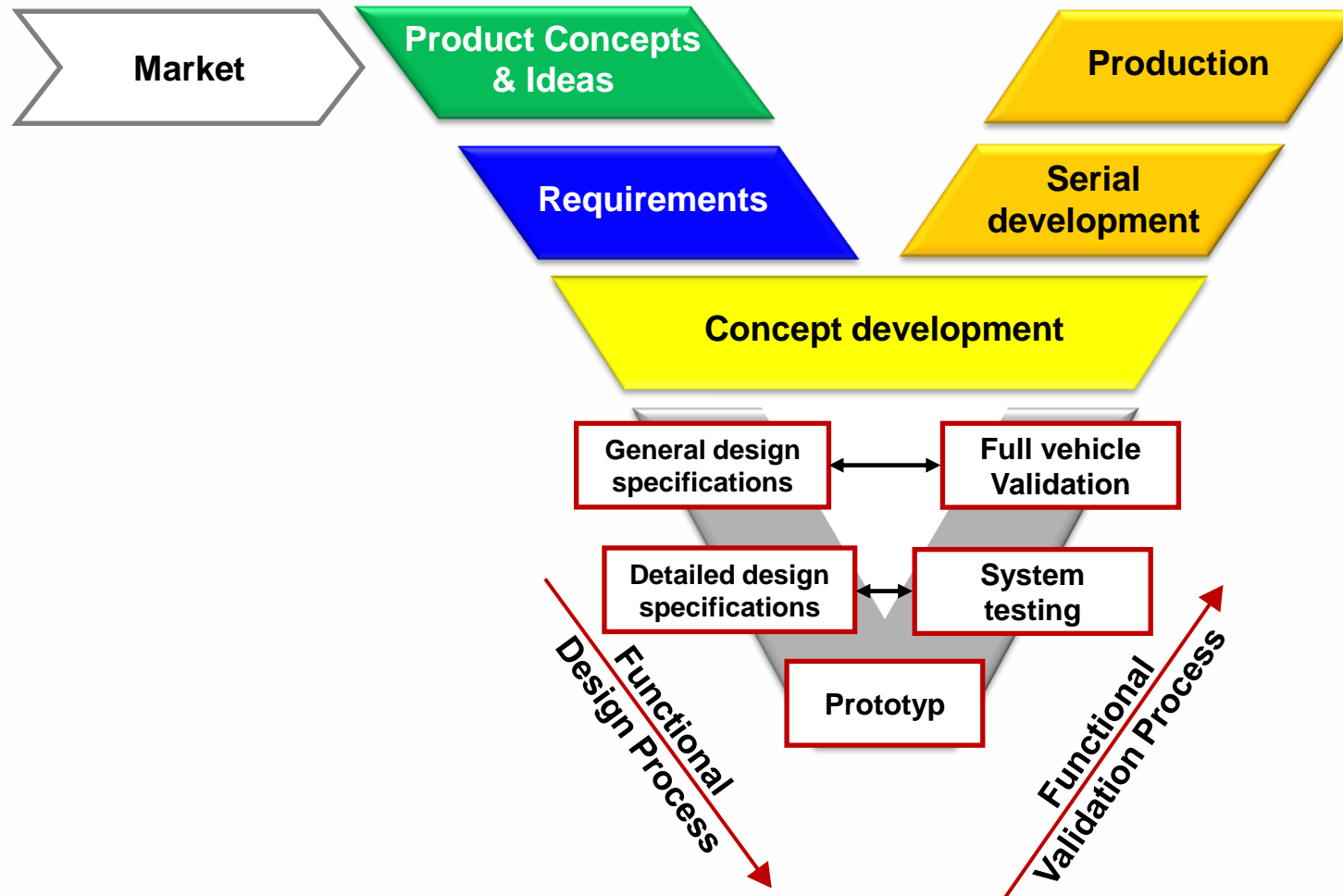


VIDEO



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