MOTION AND MOBILITY

Lightweight @ ZF Friedrichshafen AG

Derek Zhu, Head of Engineering, Chassis Systems

ZF Friedrichshafen AG



Agenda

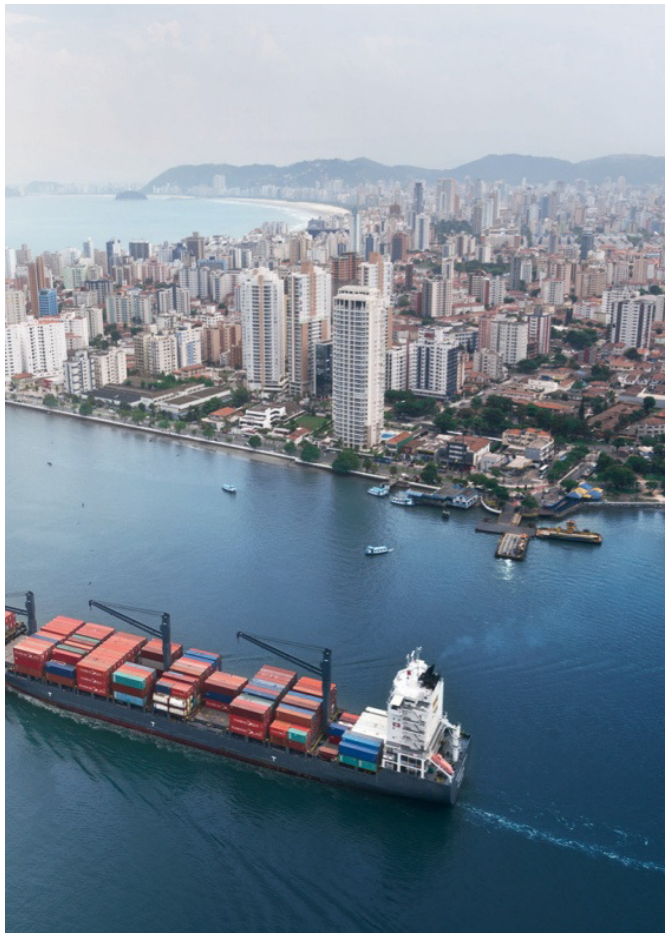
1. ZF Friedrichshafen AG
2. The Need for Lightweight Design
3. Hybrid Brake Pedal
4. Composite Leaf Spring Axle
5. Innovation as a Whole System
6. ZF Lightweight Design Capabilities
7. Retrospective

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ZF Group
Key Figures 2014

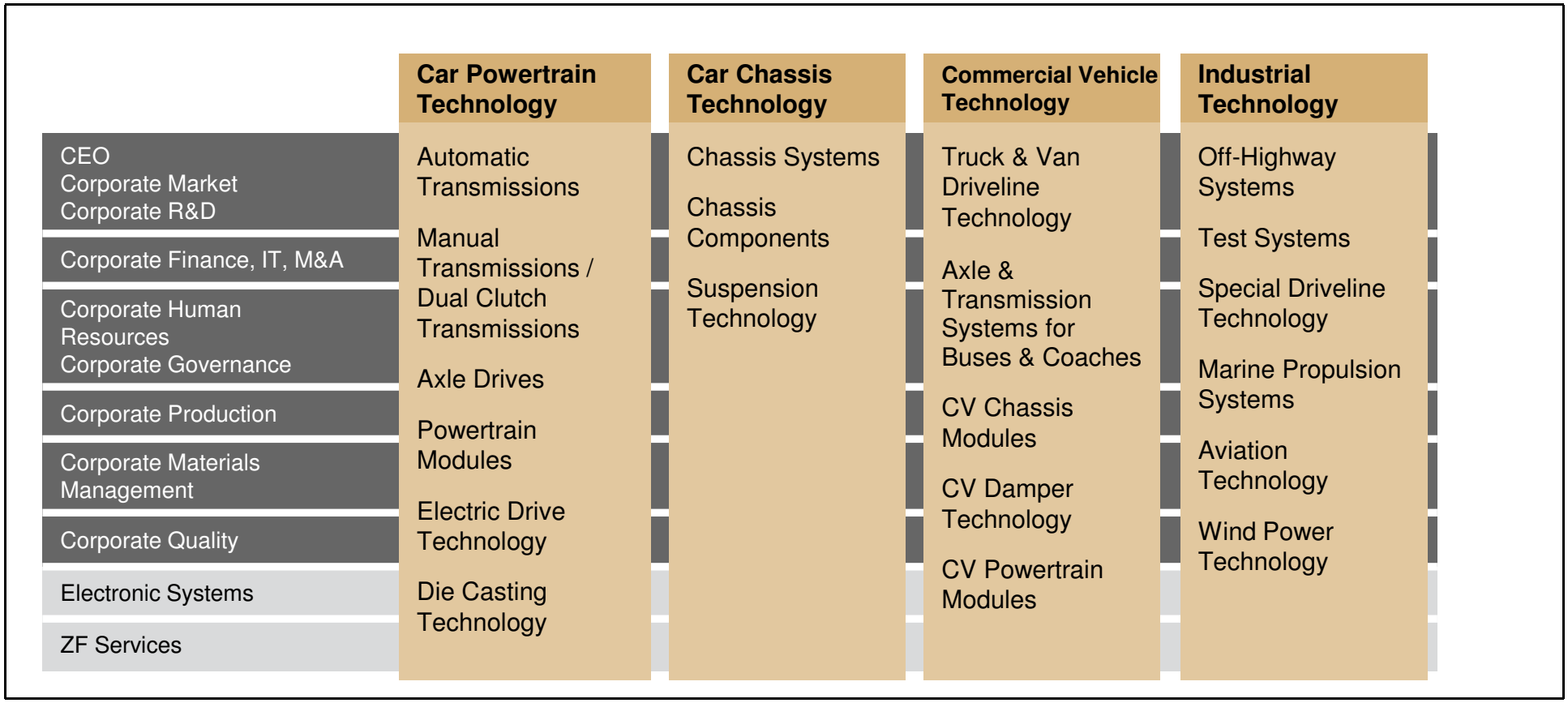
The ZF Group – An Overview		
	2014	**2014 / 2013***
Sales	€ 18.4 billion	+ 9 %
Employees (end of year) **	71,402	+ 5 %
Capital expenditure	€ 1 billion	+ 5 %
R&D expenditure	€ 891 million	+ 7 %
113 production companies in 26 countries		
7 main development locations in 4 countries		
33 service companies and more than 650 service partners		

*excluding ZF Lenksysteme.
**Without employees of the Rubber & Plastics business unit and without AIBC employees.



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Organization
Status: January 2015



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Car Chassis Technology Division

Car Chassis Technology Division

Corporate Functions Division

- Finance / Controlling / IT
- Human Resource
- Production
- Development
- Quality
- Materials Management
- Market

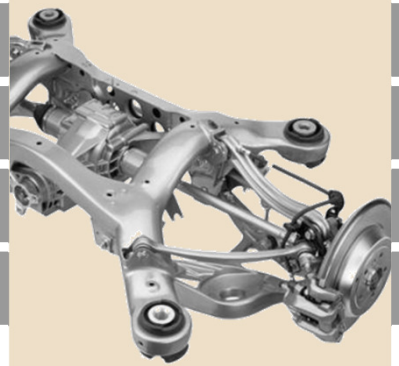
Chassis Components

- Suspension joints
- Cross-axis joints
- Tie rods
- Stabilizer links
- Control arms
- Wheel carriers and hubs



Chassis Systems

- Front axles
- Rear axles
- Corner modules
- Active Kinematics Control (AKC®)



Suspension Technology

- Active Systems
- Conventional Dampers



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Trends for the Future
4 Main Topics



LIGHTWEIGHT

ELECTRIFICATION

EFFICIENT

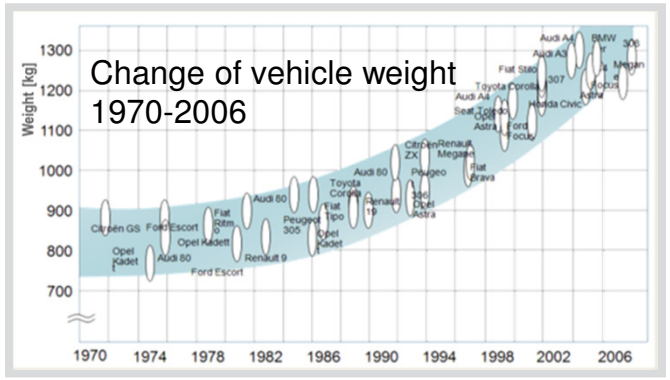
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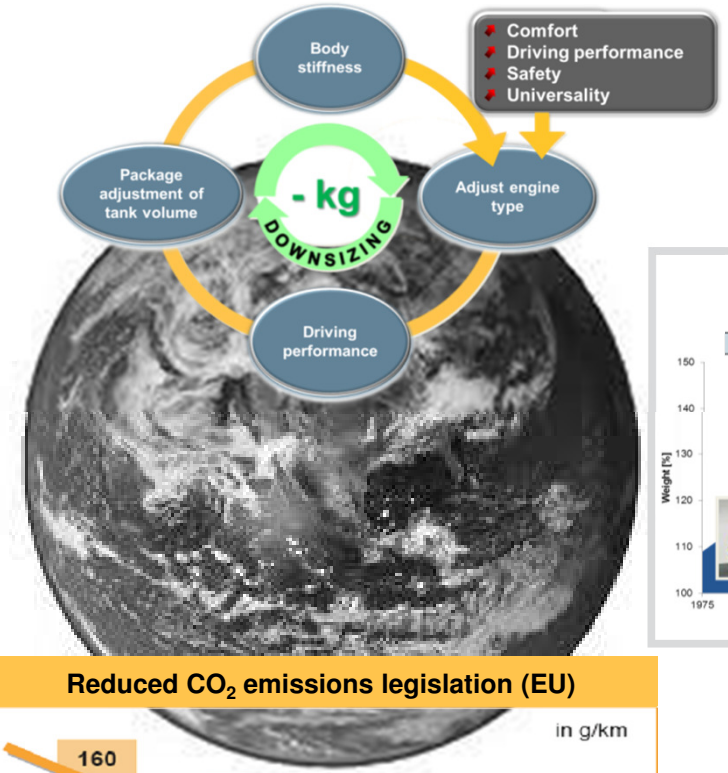
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Emission Laws vs. Passenger Car Weight

Increasing weight spiral

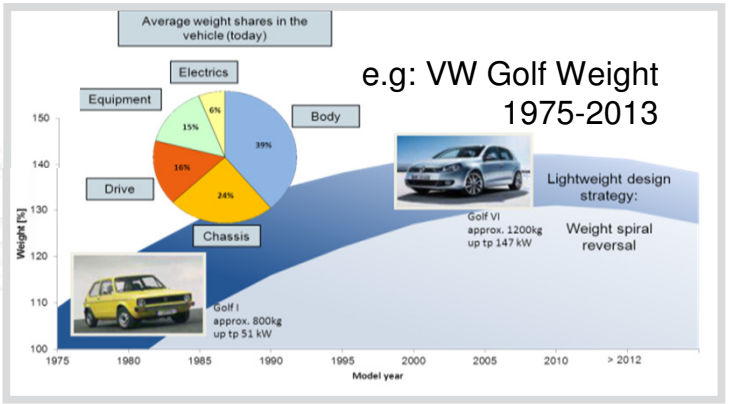
Due to additional equipment





Weight spiral reversal

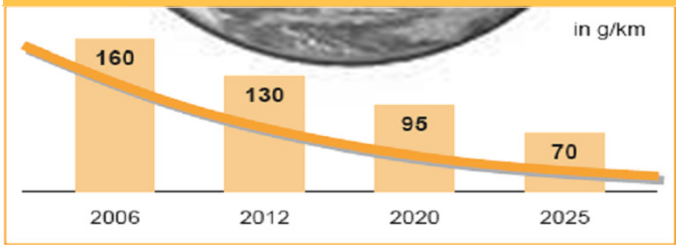
Targeted, innovative material use



More stringent requirements

CO2 reduction

Reduced CO_2 emissions legislation (EU)



Reduced weight

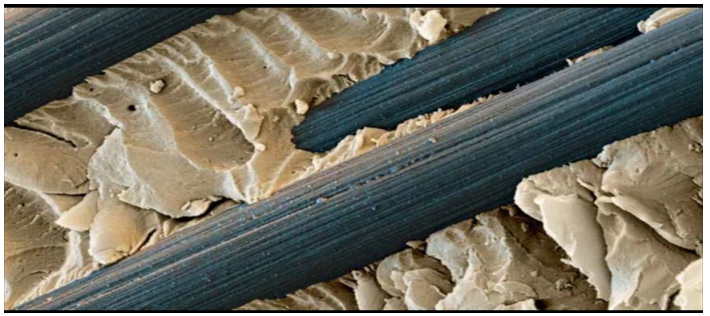
Thanks to new materials

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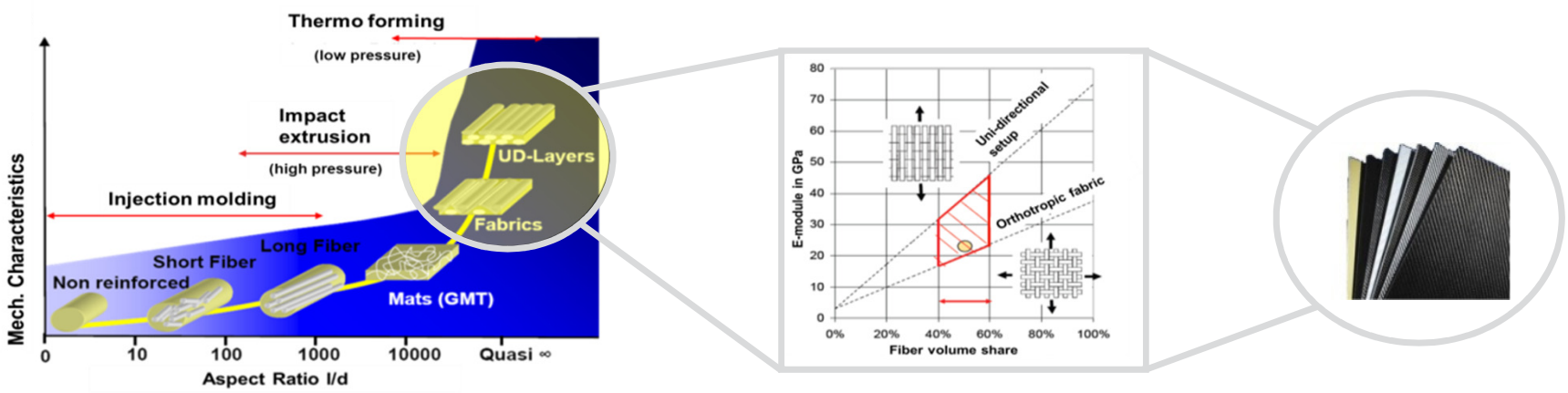
Fiber-Reinforced Plastic - FRP

Savings potential thanks to **weight reduction** of 100 kg

- Consumption: 0.3l/100km
- CO_2 emissions: 7.5g/km CO2



- Weight reductions thanks to functional integration
- Material use according to weight through endless fibers



Source: Bond Laminates

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Agenda

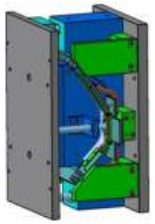
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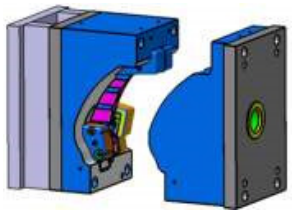
Hybrid Brake Pedal
Continuous Fiber Reinforced Composite

Steel pedal	Metal hybrid pedal	FRP hybrid pedal
		
Weight: **100 %**	**Weight:** **66 %**	**Weight:** **~ 50 %**
	Steel insert: 60 %	GFRP insert: 23 %
	Plastic: 40 %	Plastic: 77 %


organo sheet


tool


insert


injec. molding

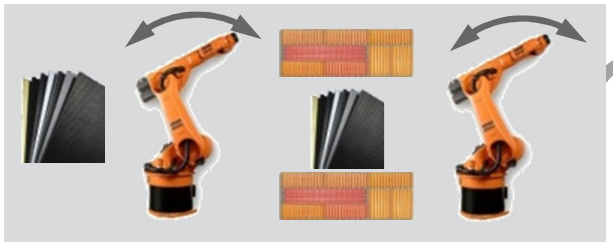

brake pedal

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Hybrid Brake Pedal
Processing Techniques – One Shot Process

Process technology at ZF

One-shot process
Thermoforming & injection molding



Organo sheet tailoring, plasticizing

Thermoforming & Injection molding





Granulate drying and loading



Component handling - fully automated

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Plastic Pedal Box

- Extended freedom of design with maximum functionality
- Lower weight saves fuel
- Reduced manufacturing costs





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Composite Leaf Spring Axle

Product Description

- FRP leaf spring axle with wheel control, suspension spring and anti-roll bar function
- Integration functionality associated with reduction of parts

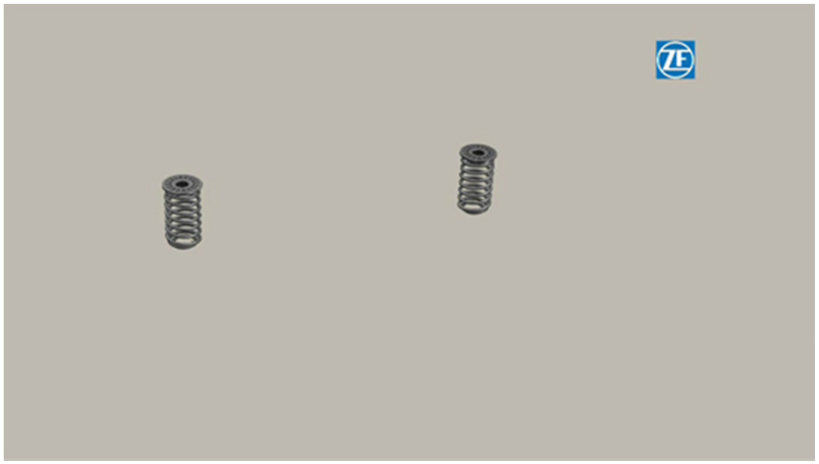
Benefits

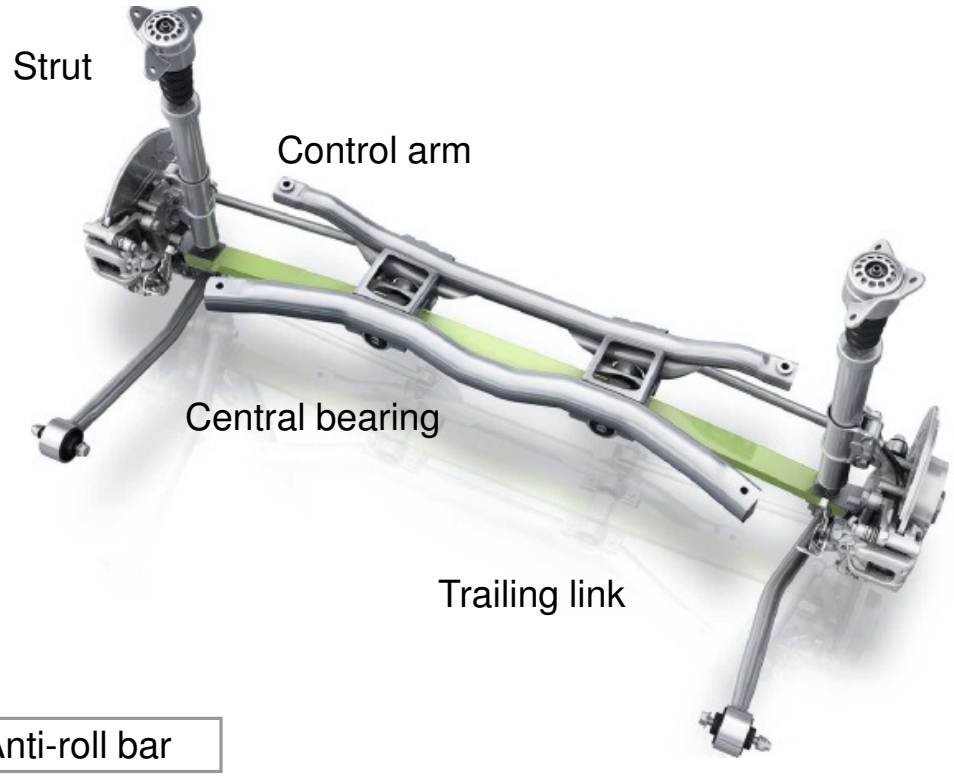
- 15 % weight reduction vs. 4-link suspension
- Optimal space as a result of reduction of parts
- Optimized driver performance vs. twist beam



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Composite Leaf Spring Axle
Functional Integration

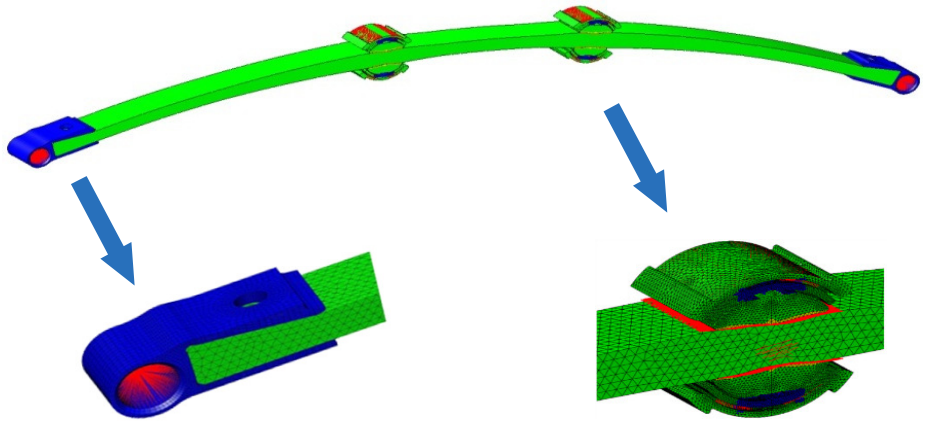




	Integration step 1	Spring			
	Integration step 2	Spring	Anti-roll bar		
	Integration step 3	Spring	Anti-roll bar	Wheel guidance	
→	Integration step 4	Spring	Anti-roll bar	Wheel guidance	Damper strut

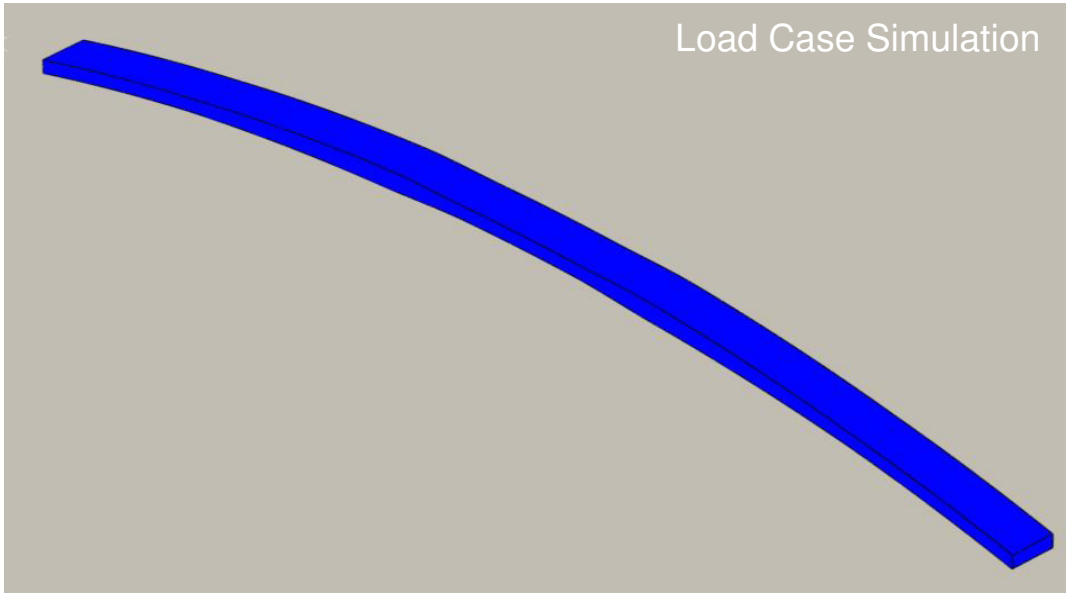
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Composite Leaf Spring Axle
FEM Simulation

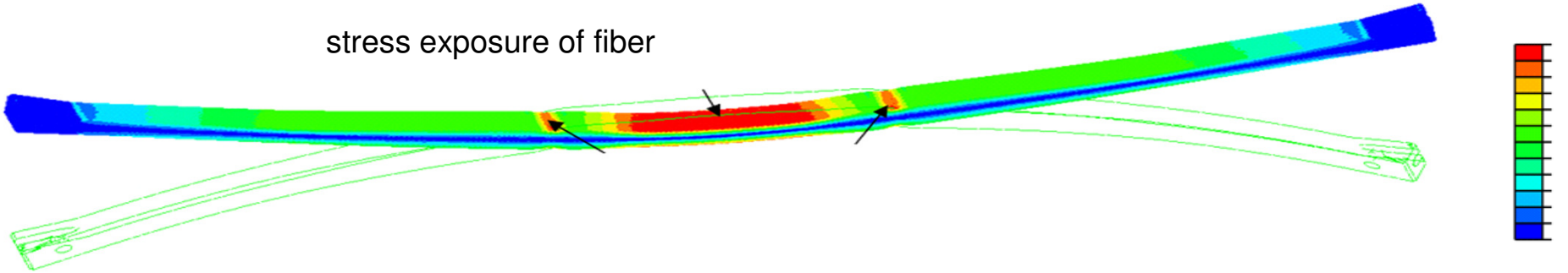


mount at knuckle

central bearing



stress exposure of fiber



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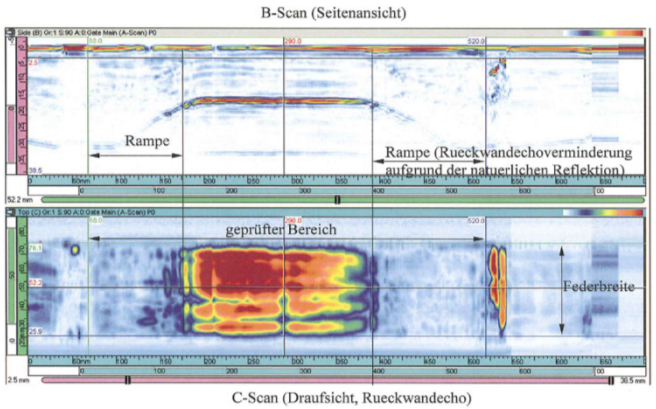
Composite Leaf Spring Axle
Testing Base Materials

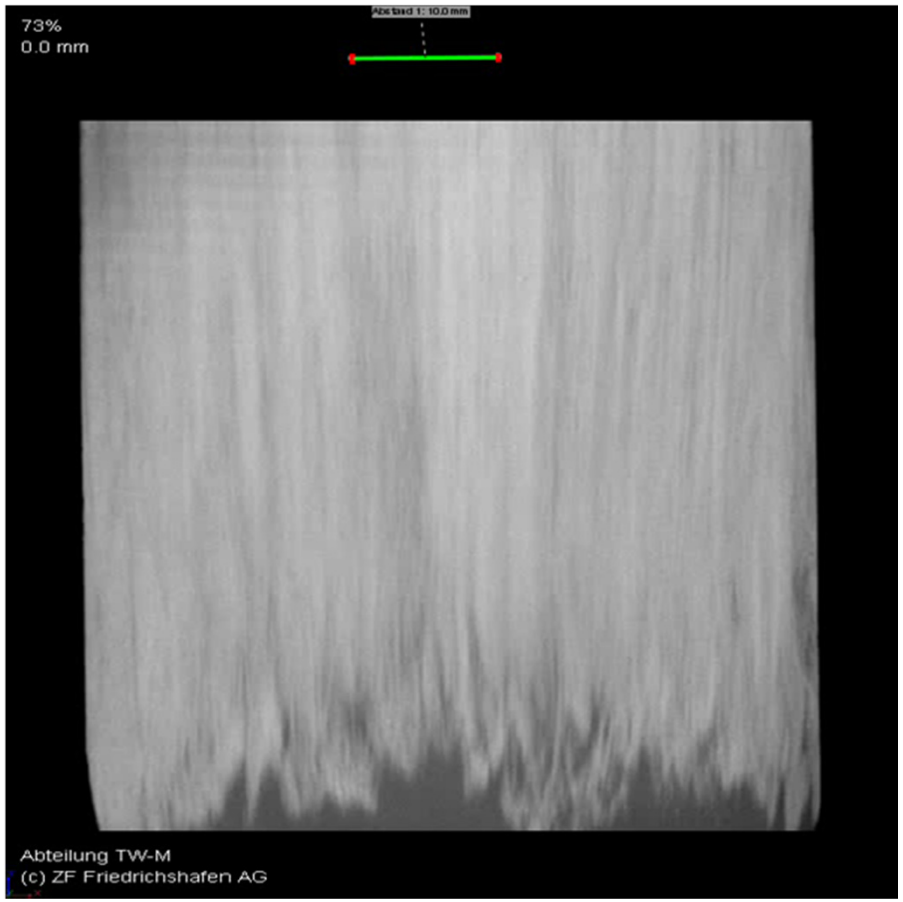
Several test devices on lab and part level within ZF quality tests

- fiber volume percentage
- CT scanner
- ultrasonic sound
- etc.

Geometry tests

- dimensional
- tolerances
- distortion
- etc.





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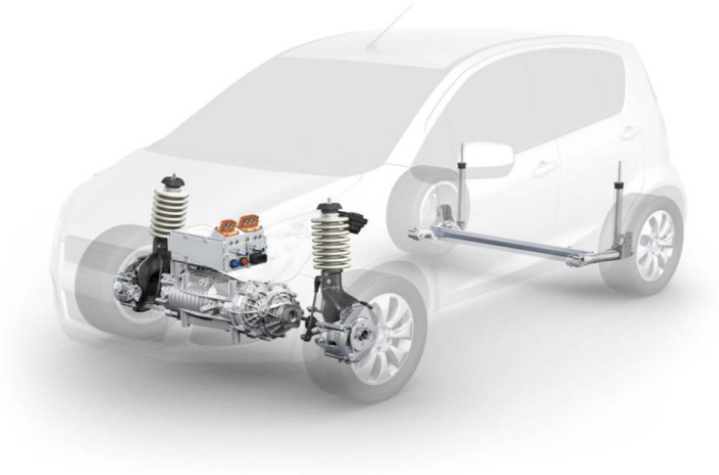
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ZF Innovation Car

- E-mobility in combination with optimized suspension light weight
- Innovative e-drive
- Increased traveling range
- CO_2 reduction
- Optimized driving performance

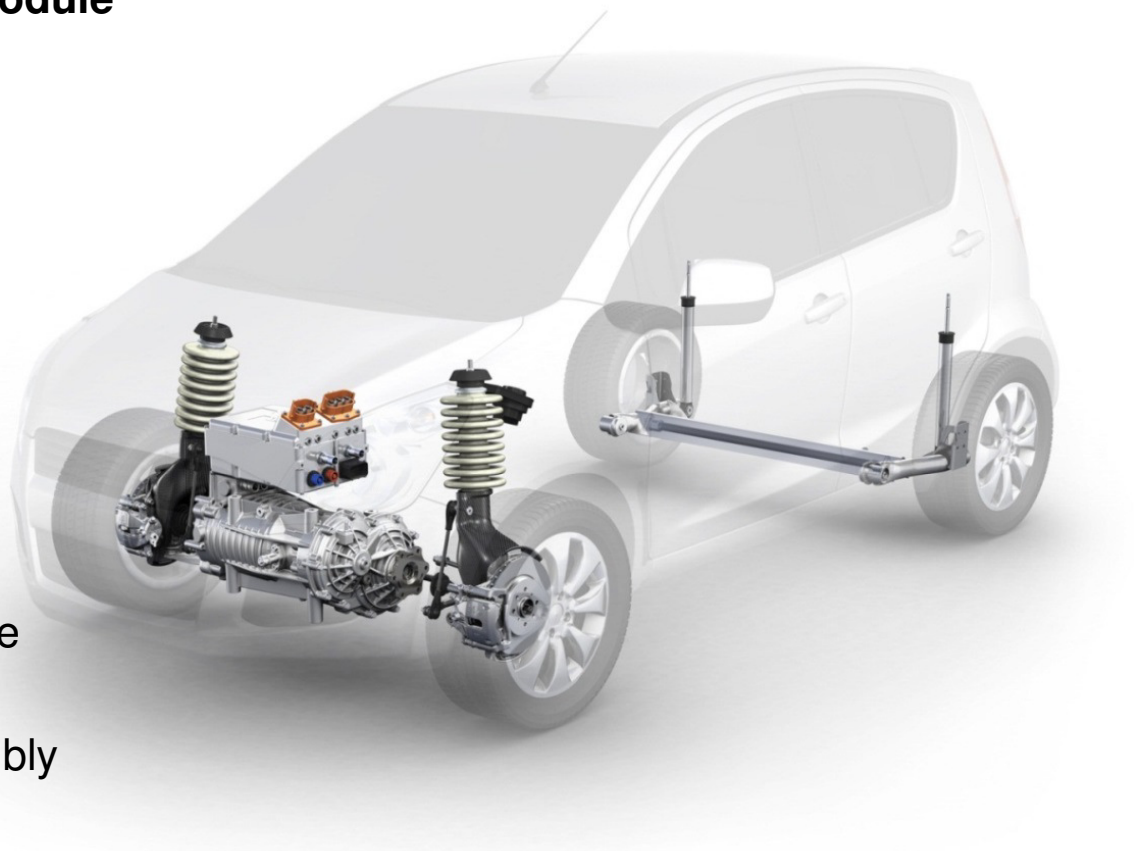


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ZF Innovation Car
Combination of Electric Drive and Lightweight Chassis

Lightweight suspension strut and knuckle module

- Innovative FRP design with closed surface
- Integration of damper strut and knuckle
- Usage of fiber-reinforced plastics
- Advantages for driving dynamics thanks to reduction of unsprung masses
- Up to 40 % weight reduction



Lightweight damper

- Aluminum cylinder tube instead of steel tube
- Integration of bottom plate, ring eye and rubber joint into one plastic joint assembly
- Up to 25 % weight reduction

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Process Technology
Dielingen Plant + Schweinfurt Plant

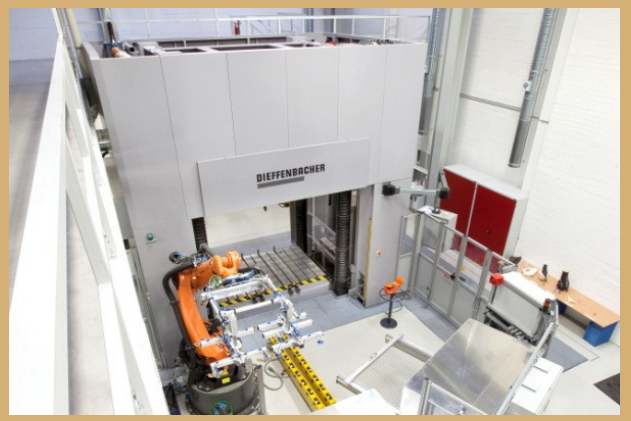
Dielingen Plant

Thermoplastics

Process Technology

- Injection molding
- Insert technology
- Thermoforming
- One shot
- Handling
- Prototyping
- Small series





Schweinfurt Plant

Duroplastics

Process Technology

- RTM
- HP-RTM
- C-RTM
- Prepreg hot pressing
- Handling
- Preforming
- Cutter

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Retrospective



LIGHTWEIGHT



EFFICIENT

- Innovative combination of materials
- Integration of functions
- Usage of alternative materials (CRP and GRP)
- Integration of manufacturing steps
- Advantages for driving dynamics thanks to reduction of unsprung masses

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Thank you for your attention



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