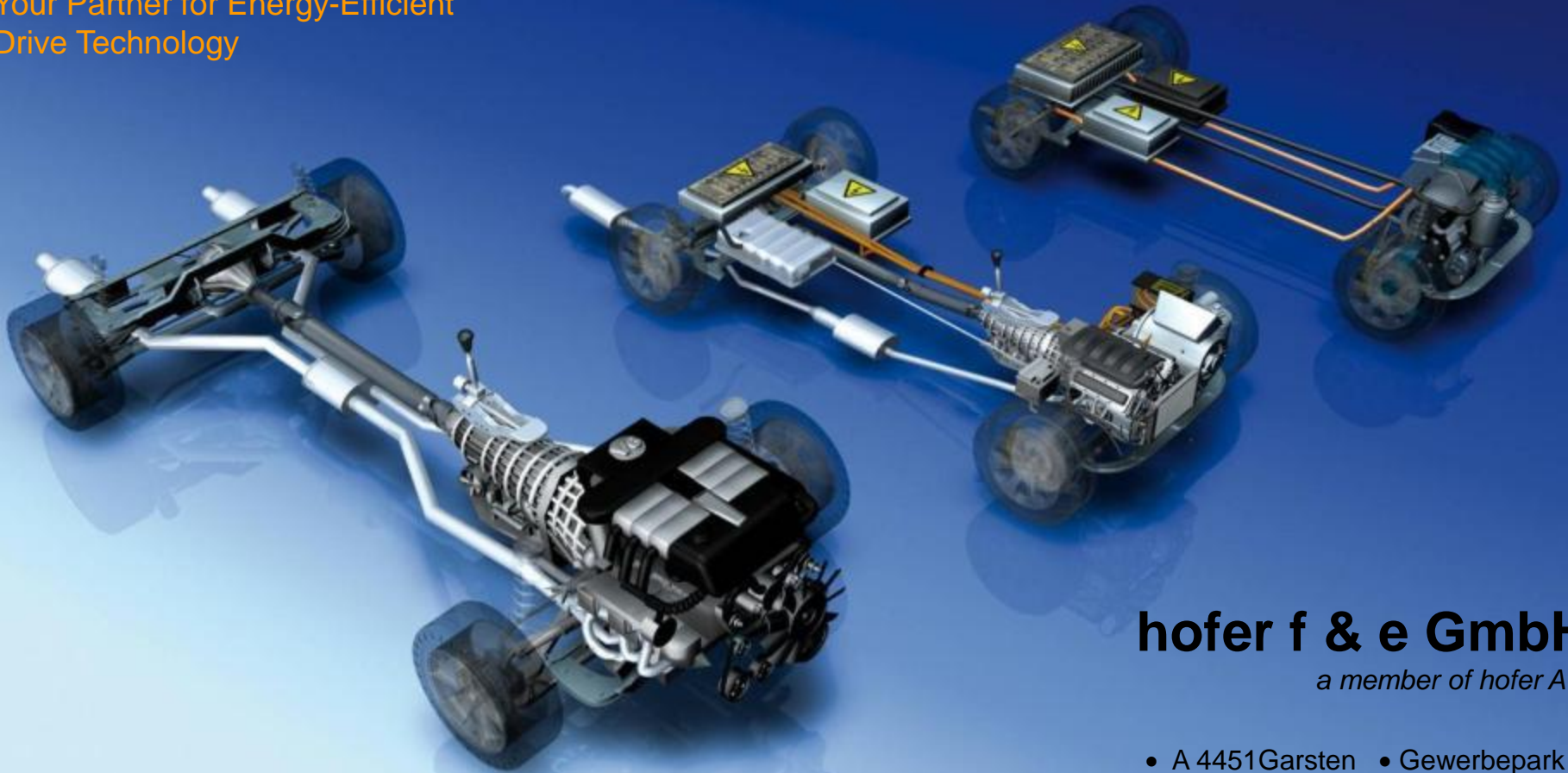


Development of commercial vehicle transmissions for Chinese market – potentials and risks

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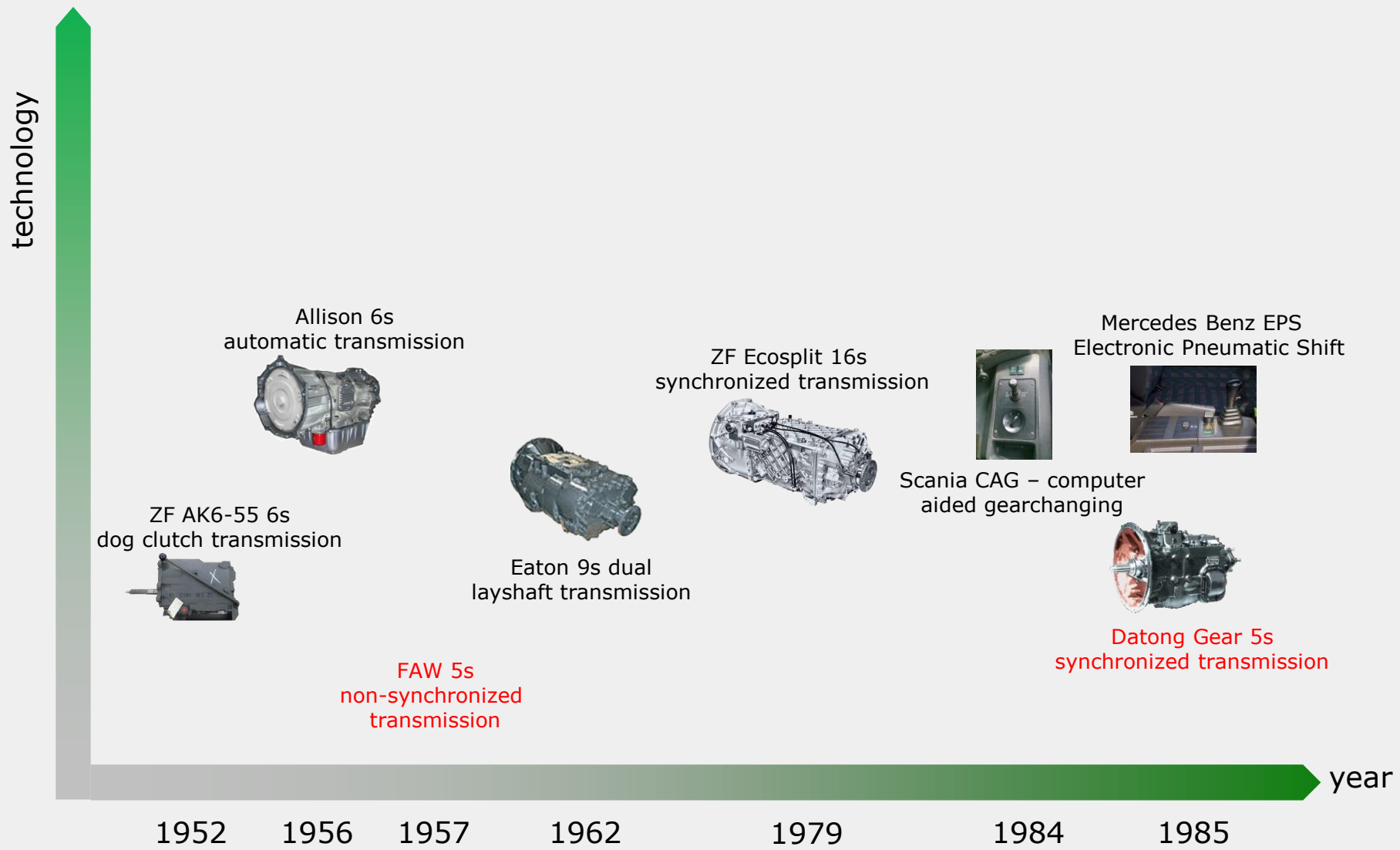
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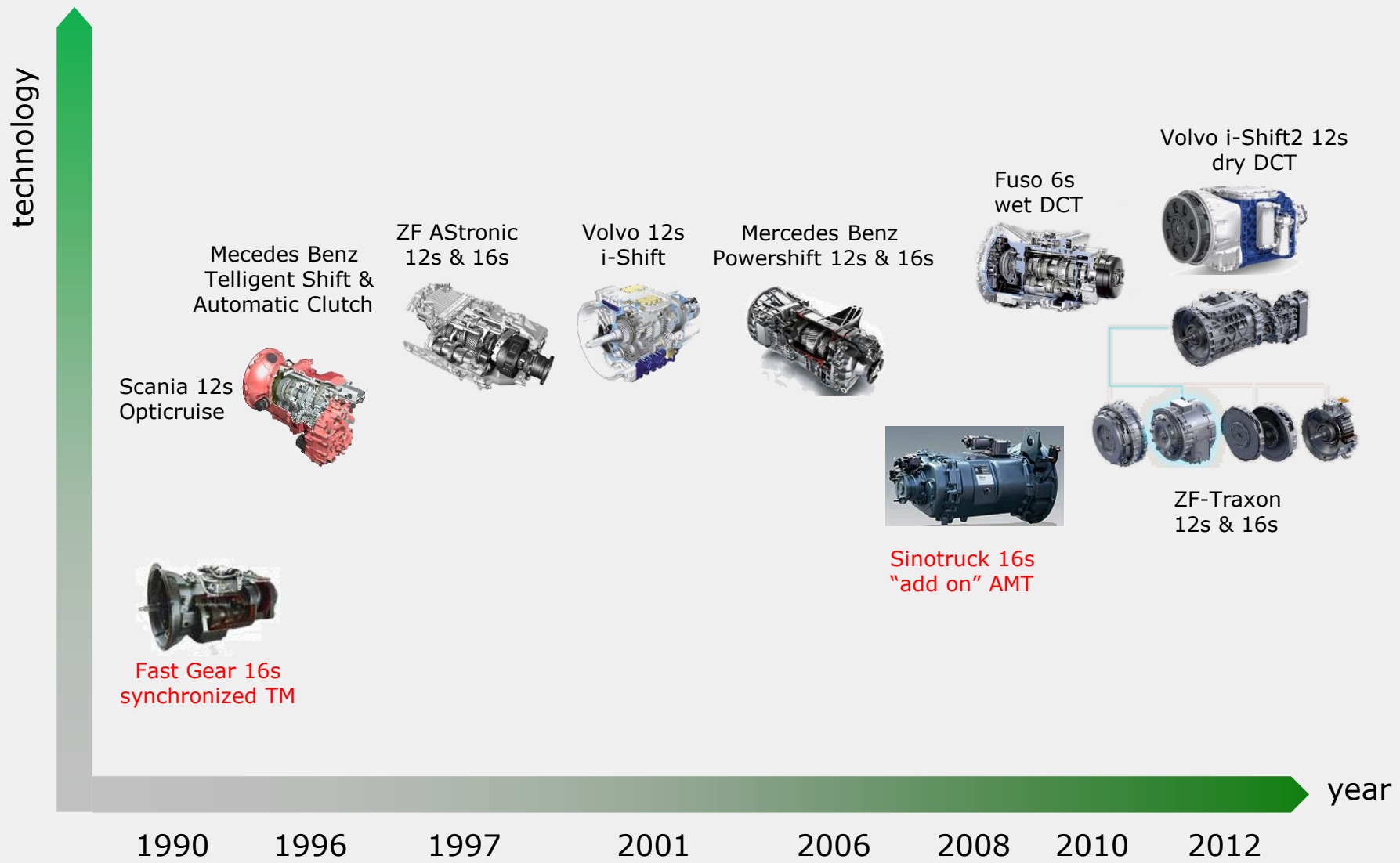
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Milestones of truck transmissions -1990



Milestones of truck transmissions -2013



- until mid of 80's mechanic innovations
 - dog clutch & synchronized transmission
 - dual layshaft transmission
 - automatic transmission

- mid of 80's first electronic control innovations
 - add on shift actuation, automatic shift control

- end of 90's first integrated AMT transmissions
 - features automatic clutch and shift actuation

- until 2005
 - all OEM's established significant AMT marketshare
 - AMT need about 20 years from first innovations

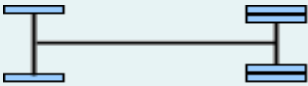

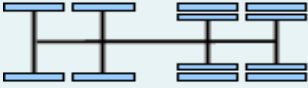
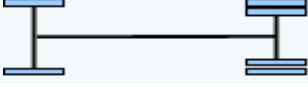



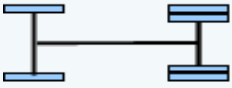
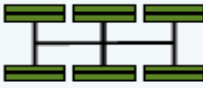


- 2010
 - first DCT for LD truck was announced

Market Share of Truck Transmissions

	Technology	speed	EU Market Share	CN Market Share
LD truck <12tons	Manual Transmission - MT	5,6,9	~70 %	~100 %
	Automated Manual Transmission - AMT	6,9	~30 %	0 %
	Double Clutch Transmission - DCT	6	<1 %	0 %
MD truck <18tons	Manual Transmission - MT	6,9,12	~60 %	~100 %
	Automated Manual Transmission - AMT	6,9,12	~40 %	0 %
	Automatic Transmission - AT	6,7	<1 %	<1 %
HD truck >18tons	Manual Transmission - MT	12,14,16	~40 %	~100 %
	Automated Manual Transmission - AMT	12,16	~60 %	<1 %
	Automatic Transmission - AT	6,7	<1 %	<1 %

Market requirements EU		Market requirements CN	
++	Fuel consumption	+	Fuel consumption
o	Robustness (overload)	++	Robustness (overload is common)
++	Reliability	+	Reliability
+	Product cost (cheap)	++	Product cost (cheap)
o	Ease of repair	++	Ease of repair
+	Simple driver operation	++	Simple driver operation
+	Driving assistance features	o	Driving assistance features
+	Shift comfort	o	Shift comfort

Maximum legal weights EU - CN

Axles Truck	Axles Trailer	EU ₉₆₋₅₃ tons	CN tons	difference [%]
		18	20	+11%
		25 26*	30	+20% +15%
		32	40	+25%
		28	30	+7%
		36	40	+11%
		40 44**	50	+25% +14%
		40 44**	55	+38% +25%

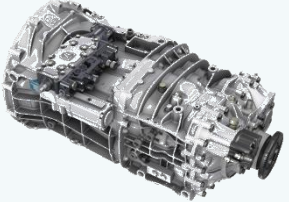
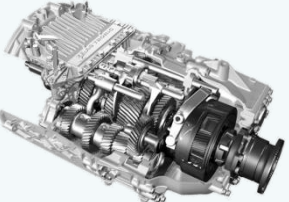
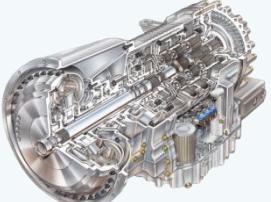
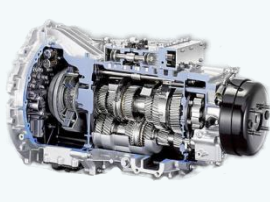
* driven axle has air suspension

**ISO container if road combined traffic railway/ship

- Chinese legal vehicle weights up to 38% higher than EU
- Chinese popular loading condition is: “overloading”
 - needs robust technologies which are easy to repair
 - EU trucks payload optimized, not for overload



Truck transmission technology comparison

MT	AMT	AT	DCT
Manual Transmission	Automated Manual Transmission	Automatic Transmission	Double Clutch Transmission
			
<p>ZF Ecosplit/Ecolite Volvo Mercedes Benz Eaton</p>	<p>ZF-ASTronic / Traxon Mercedes Benz Powershift Volvo i-Shift Scania Opticruise Eaton Ultrashift</p>	<p>Allison 2/3/4000 series ZF-Ecomat Volvo Powertronic</p>	<p>Mitsubishi Fuso (wet) Volvo i-Shift2 (dry)</p>
<p><u>Product Performance:</u></p> <ul style="list-style-type: none"> ▪ Series configuration of trucks, cheap ▪ High efficiency ▪ Driver has significant influence on fuel consumption and wear (clutch, synchronizer) ▪ MT has limited possibilities in protection against misuse operation of driver ▪ Ease of repair, well known technology 	<p><u>Product Performance:</u></p> <ul style="list-style-type: none"> ▪ Is more and more standard configuration of trucks in EU ▪ Simple, relaxed operation ▪ Durability and wear less driver dependent, better warranty than MT ▪ Fuel consumption less than MT vehicle fleet (automatic shift control) ▪ Good protection against misuse operation of driver ▪ Repair & Service: needs diagnosis tools and better skills than MT 	<p><u>Product Performance:</u></p> <ul style="list-style-type: none"> ▪ For specific applications ▪ Simple, relaxed operation ▪ Powershift, high acceleration performance of vehicle ▪ Torque converter, AT very robust, no wear parts ▪ Complex technology ▪ Less efficiency than MT/AMT 	<p><u>Product Performance:</u></p> <ul style="list-style-type: none"> ▪ New, complex technology for trucks ▪ Simple, relaxed operation ▪ Powershift, high acceleration performance of vehicle ▪ Better efficiency than AT

Trends Europe

- ✓ AMT increasing market share. AMT is more and more standard configuration
- ✓ DCT new on the market
- ✓ Higher integration of the transmission in the powertrain & brake control strategy
- ✓ Enhancements of control strategies as
 - shift strategy
 - roll mode
 - engine start - stop
 - driver assistance systems
 -
- ✓ Optimization of mechanic efficiency
 - dog clutch
 - servo synchronizer
 - ...

Trends China

- ✓ Development of new manual shifted transmissions with high torque capacity
- ✓ Improvements of existing manual transmissions in terms of function and robustness
- ✓ Comfort improvements of manual shifted transmissions "servo-shift"
- ✓ Automated manual transmission "Add-On AMT" and improvements in control strategies, need cover difficult overload conditions
- ✓ Import of modern technologies out of Joint Ventures
- Automated transmissions will need 5-10 years until market volume. Market need time to have confidence into that technologies.

- huge market with high growing rates
 - high amount on commercial vehicles, because high investments in new infrastructure & economic growth
 - need for higher operational availability of vehicles (more robust & durability)
 - Chinese suppliers often “parts producers”, european suppliers have better “know-how” to develop quality products
 - European suppliers have high acceptance in Chinese automotive industry

- legislative regulations (emission standards) needs new technologies
 - needs technology which match Chinese market requirements
 - European trucks too expensive and technologically over-engineered for Chinese market
 - European truck ~100.000€ vs. Chinese truck ~40.000€

- load spectrum and real operation difficult to know
 - overloading is common: “vehicle misuse”

- step from prototype development to mass production is difficult
 - complicated relationship and management
 - western suppliers have high risk to be replaced by cheaper Chinese domestic suppliers

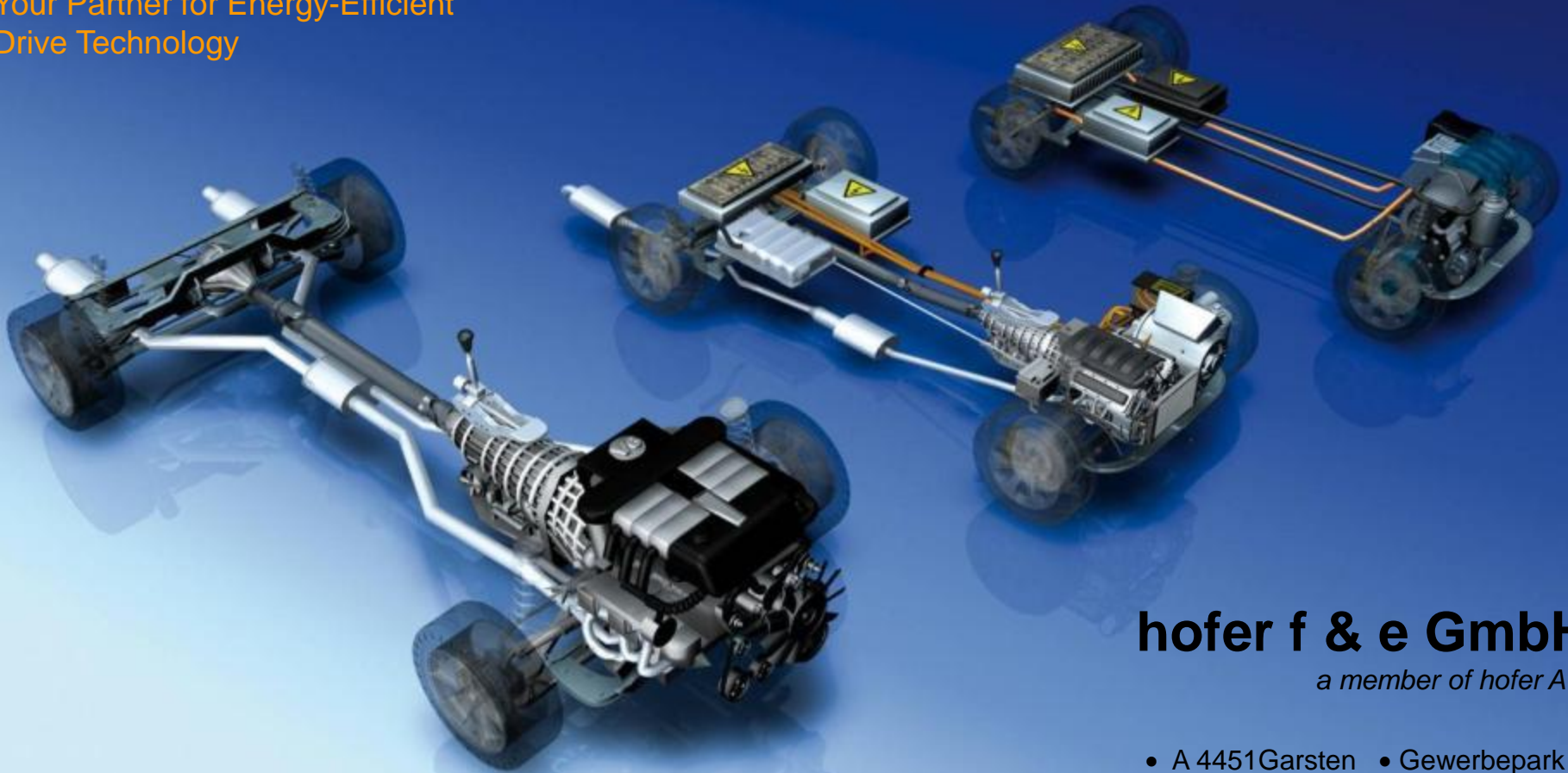
- different culture and way of problem solving
 - “better do nothing than make a mistake and loose face”
 - “good is not good enough”

- service infrastructure
 - know how about komplex technology in vehicle after sales service (service network, repair skills & management)



Thank you for your attention!

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