

# Two Mode Hybrids – Adaptionstärkern eines Intelligenten Systems

## *Two Mode Hybrids – Adaption Power of an Intelligent System*

Dr. Andreas **Truckenbrodt**  
DaimlerChrysler AG, Troy, USA

Larry **Nitz**  
General Motors

Dr. Wolfgang **Epple**  
BMW Group



### **Two – Mode – Hybrids** - Adaptation Power of an Intelligent System -



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**BMW Group**

*Troy Hybrid Development Center*

*Andreas Truckenbrodt*

*Martin Engelmann*

*Pamela Gamache*

Fig. 1

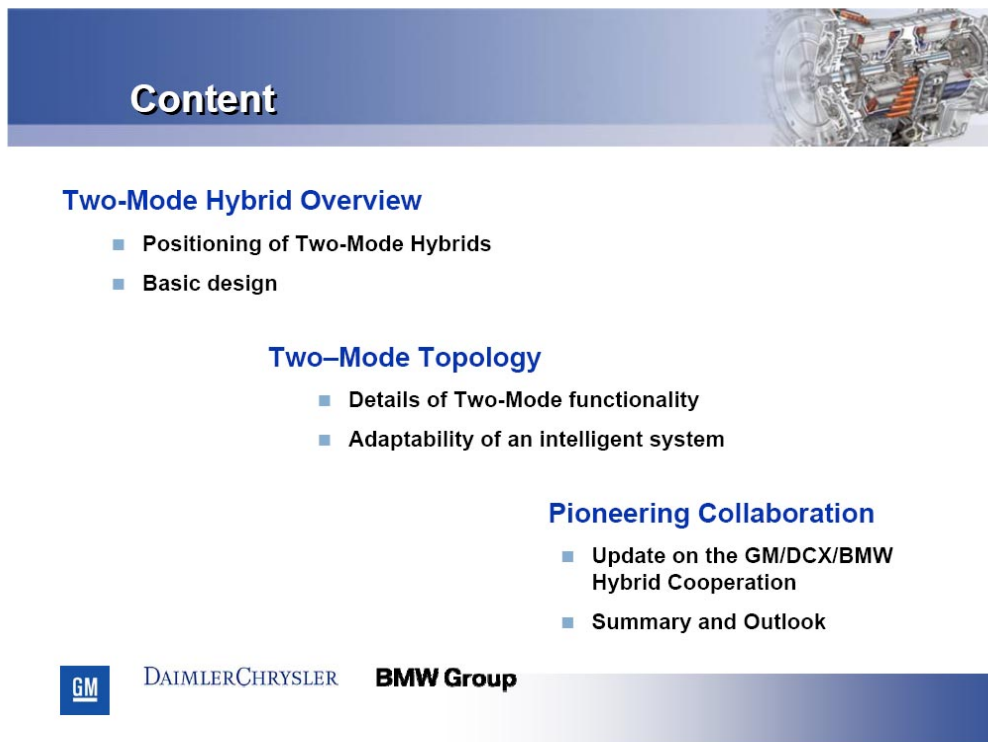


Fig. 2

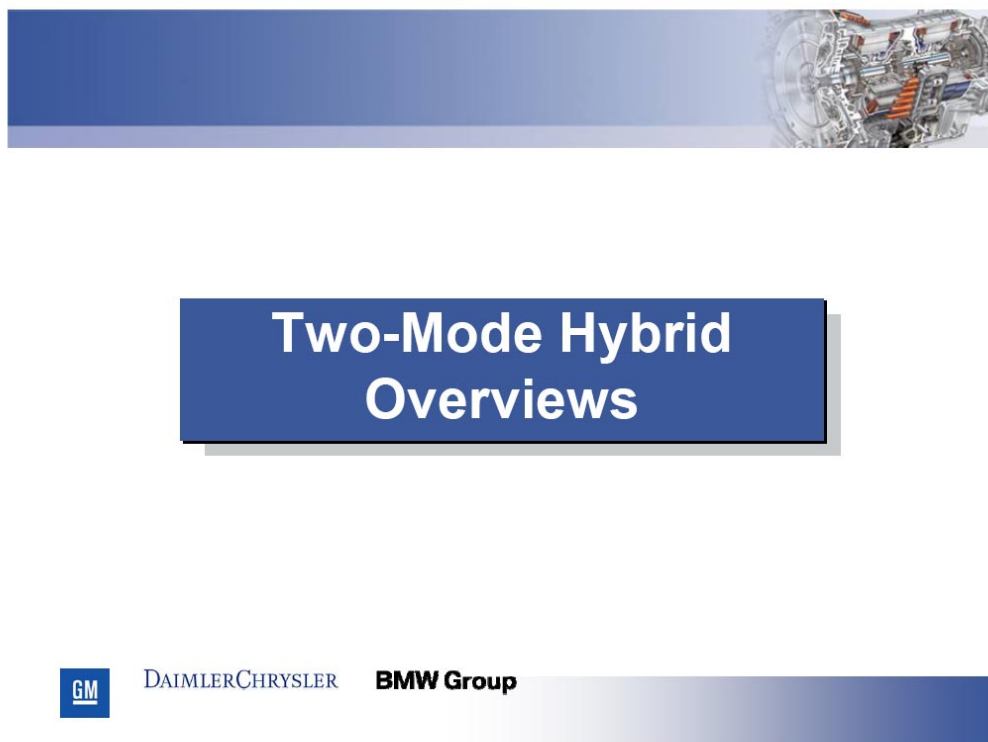


Fig. 3

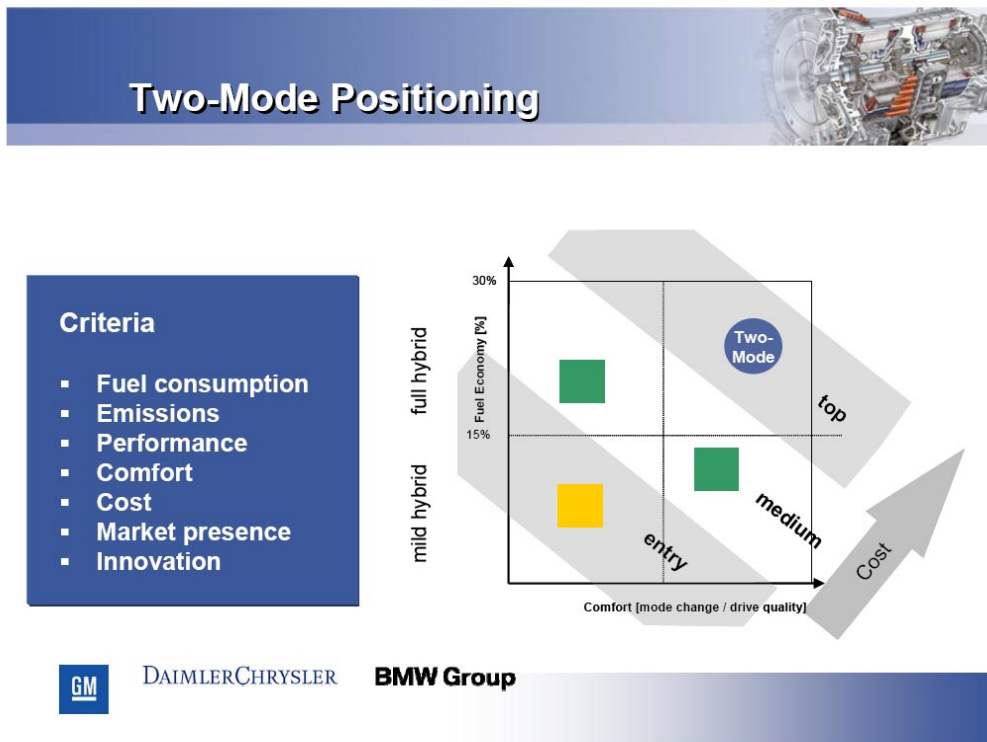


Fig. 4

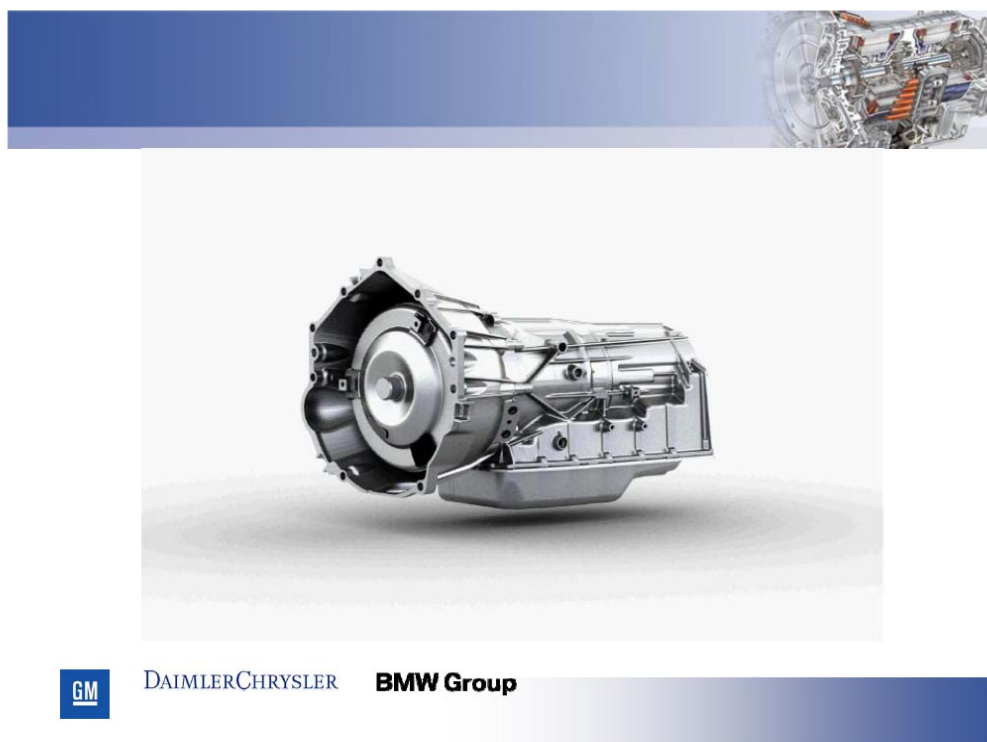


Fig. 5



Fig. 6



Fig. 7



Fig. 8



Fig. 9

## Two-mode hybrid with 4 fixed mechanical gears



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Fig. 10

## Two-Mode Advantages



### Two-Mode Hybrid System

- is a superior technology
- is a scalable portfolio of products for both FWD and RWD
- Optimizes the balance of electric motors and transmission content (smaller motors, smooth operation)

### 4 fixed mechanical gears increase efficiency with

- no compromise to performance
- all the benefits of an automatic transmission



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Fig. 11





## Two-Mode Topology



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Fig. 12



## Range of functionality

### 6 mechanical modes

- Input split EVT range (continuously variable, "mode 1")
- Compound split EVT (continuously variable, "mode 2")
- First fixed gear ratio with electric boost / braking (2 motors)
- Second fixed gear ratio with electric boost / braking (1 motor)
- Third fixed gear ratio with electric boost / braking (2 motors)
- Fourth fixed gear ratio with electric boost / braking (1 motor)

### Specific situations

- E-Drive
- Cold / warm start
- Regen braking
- Boosting
- ...



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Fig. 13

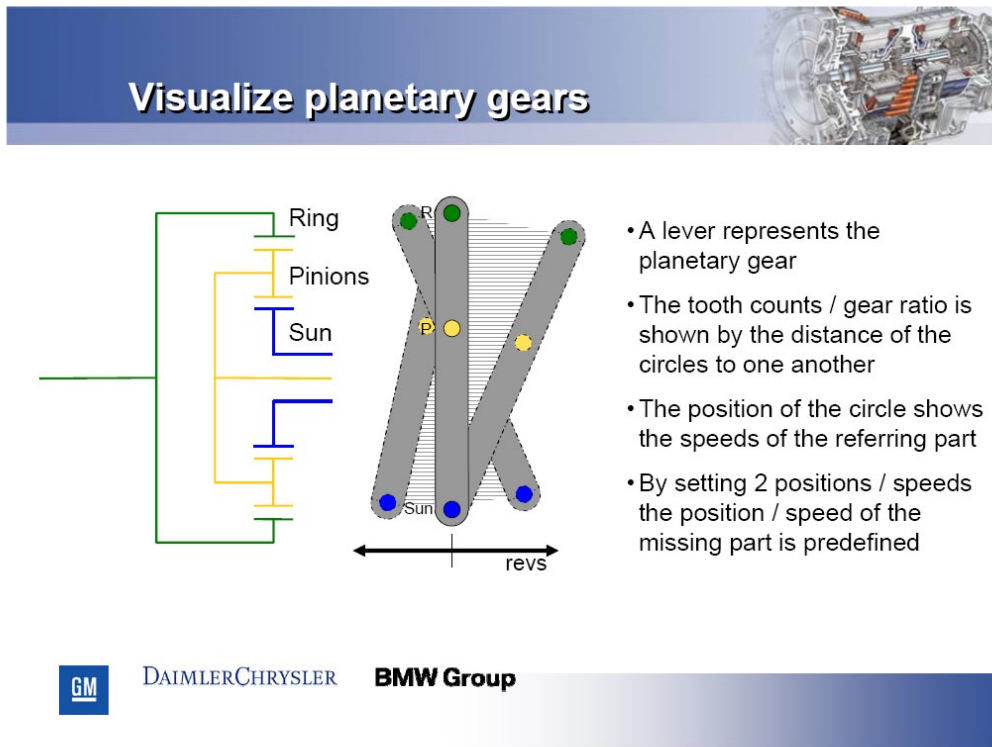


Fig. 14

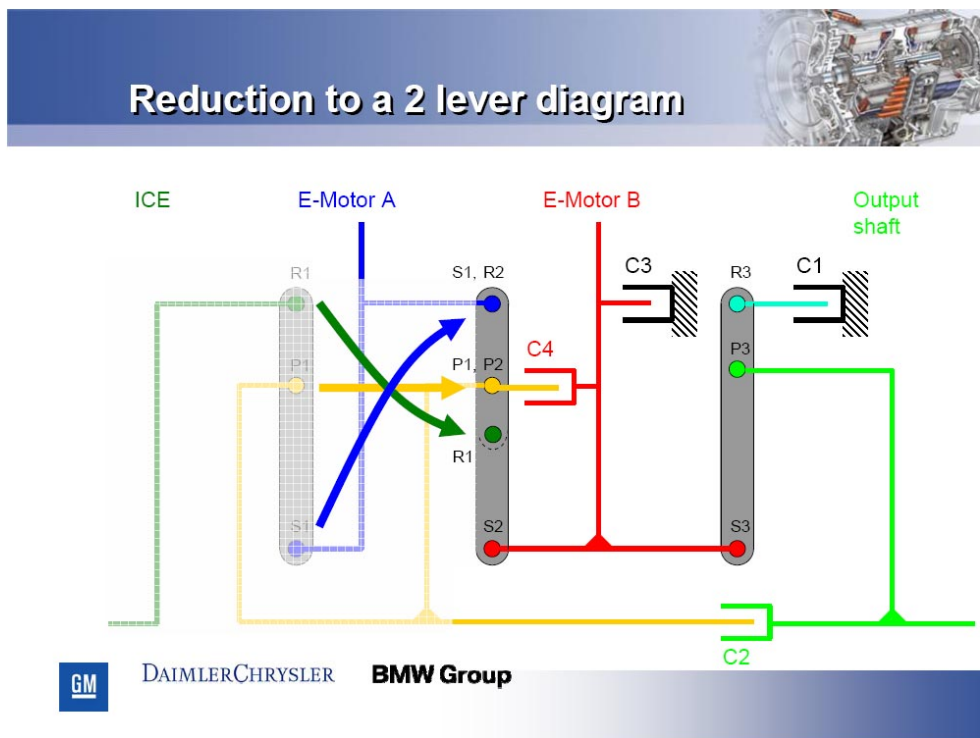


Fig. 15



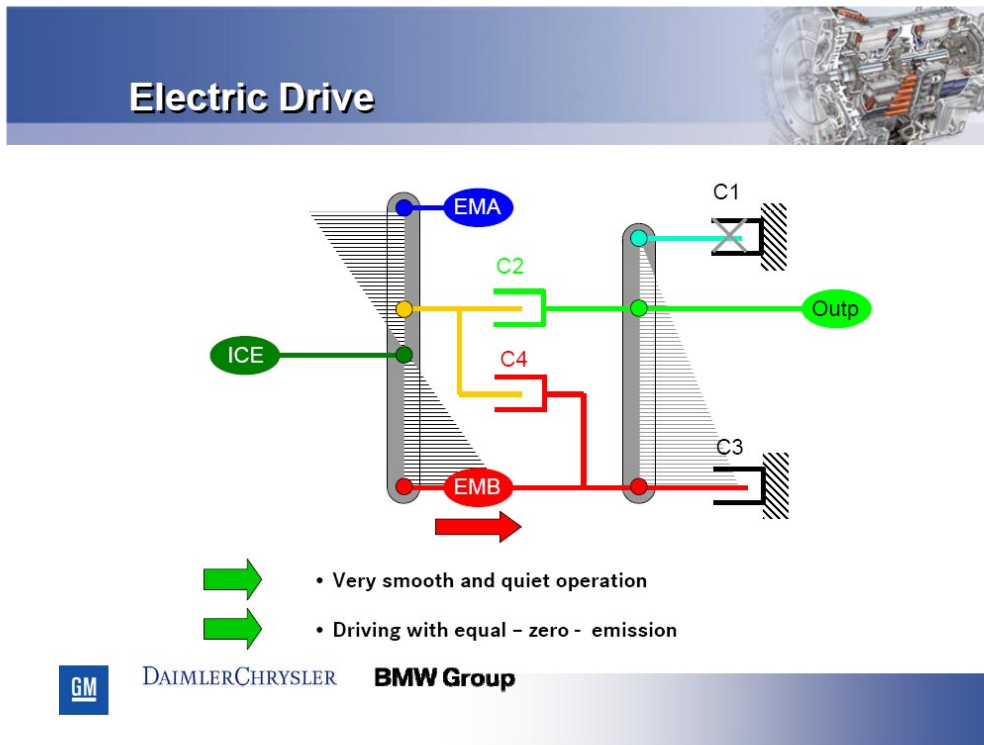


Fig. 16

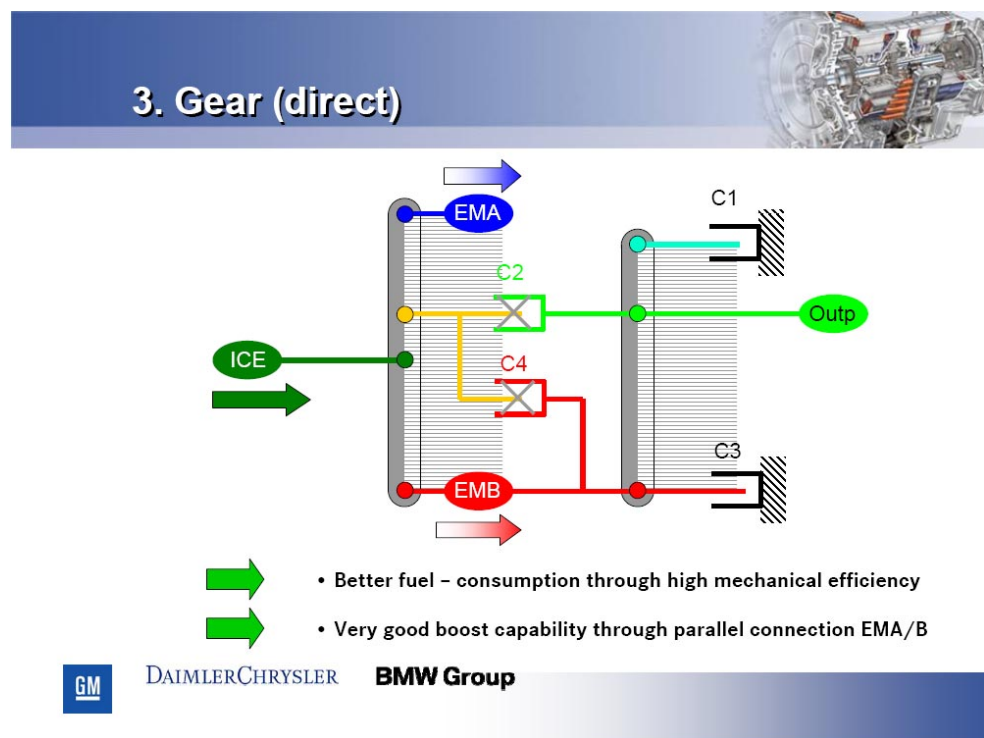


Fig. 17

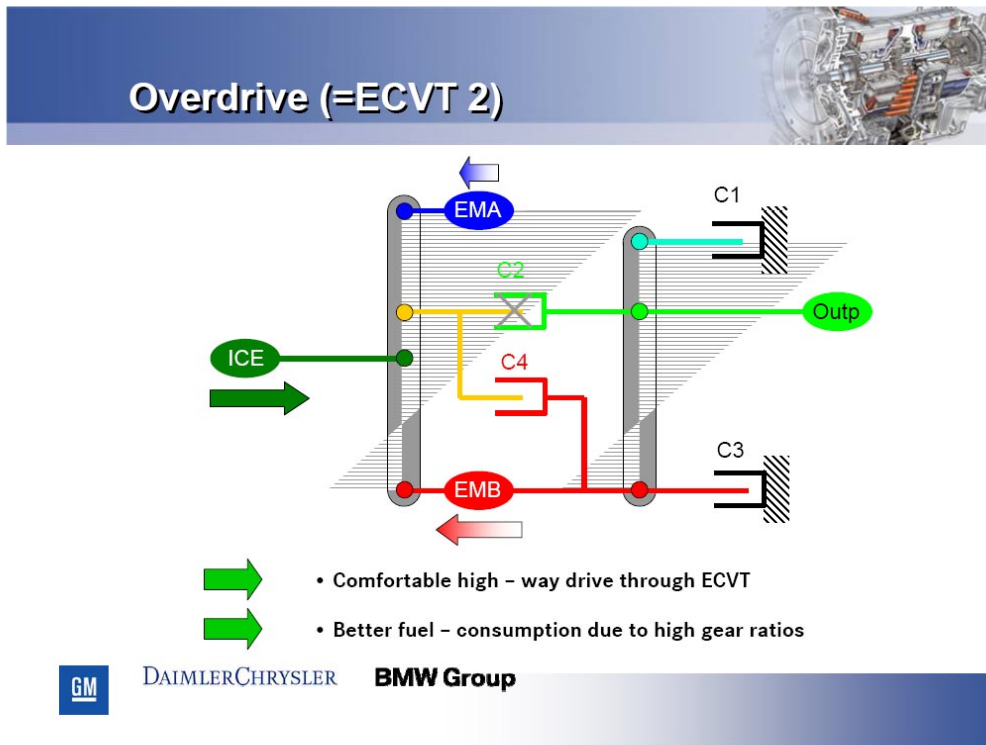


Fig. 18

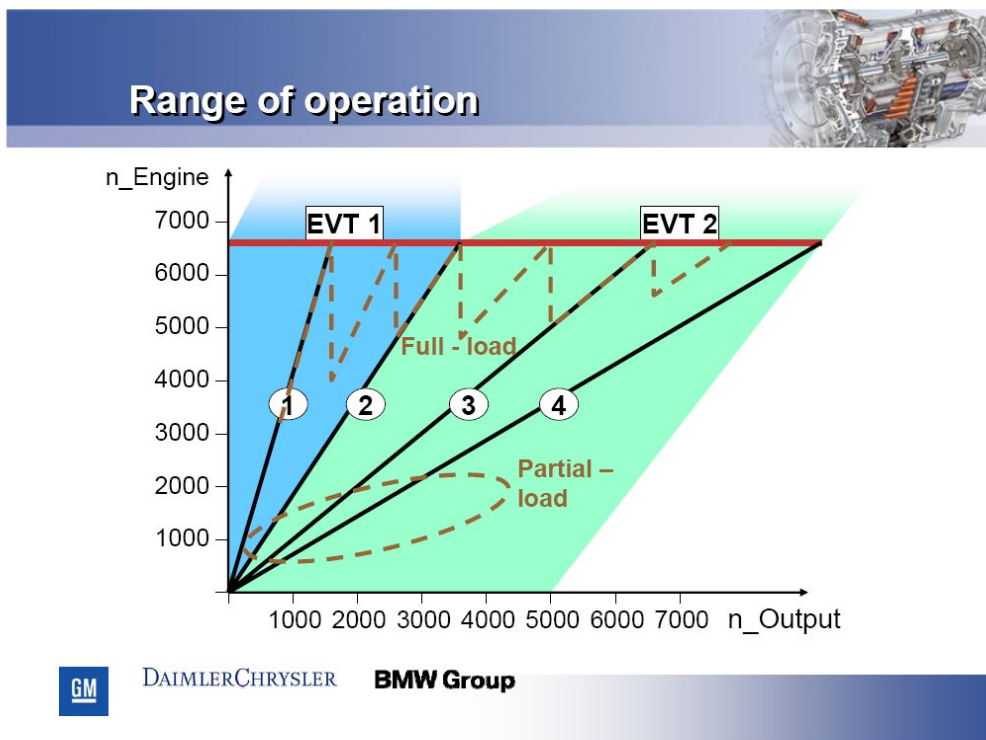


Fig. 19

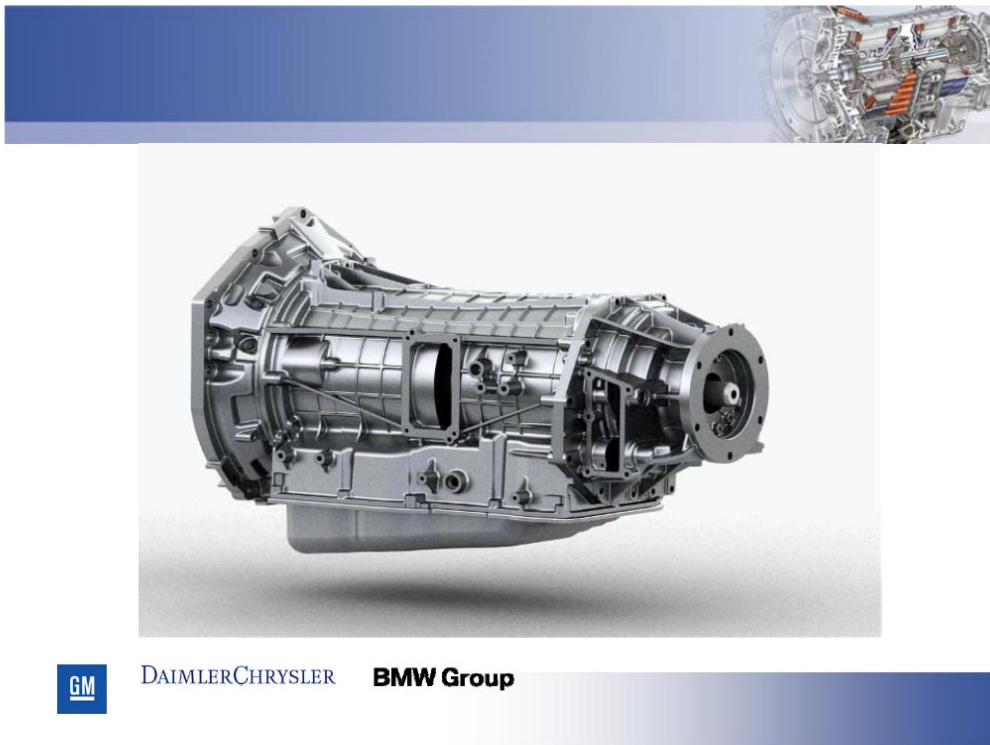


Fig. 20

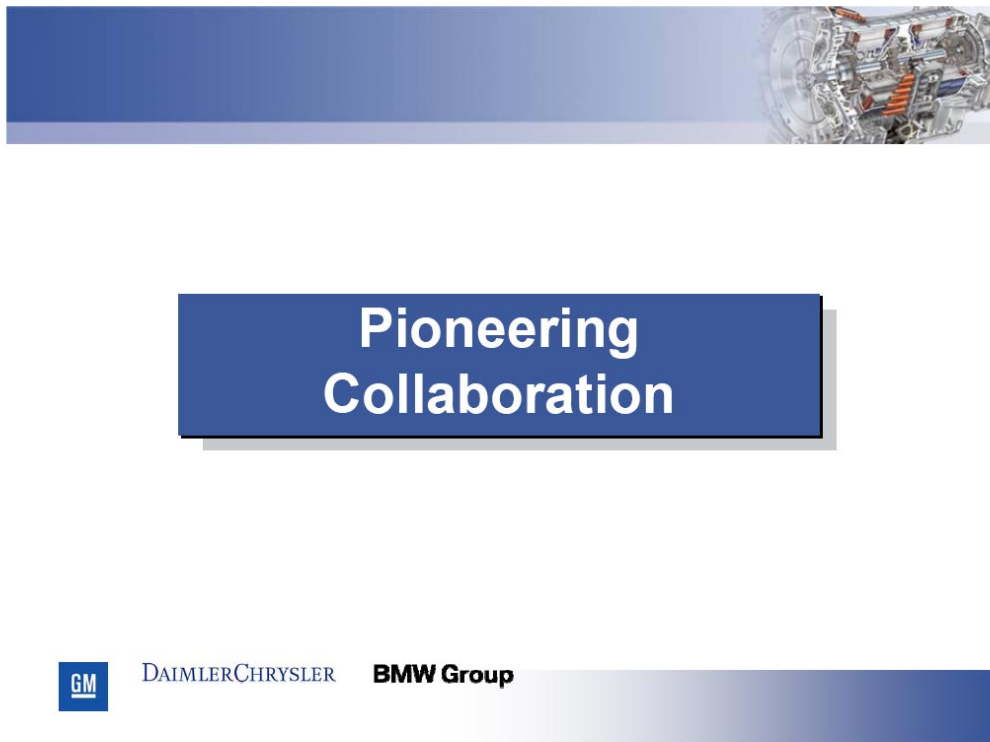


Fig. 21

## Joining Forces

- Operating in Troy, MI since 2005
- Total workforce in excess of 500
- Engineers co-located by work function

Fig. 22

## Technical Complexity

**Conventional Powertrain**

Driver demand (gas pedal) → AGC → ICE → TCM → [Engine/Wheels]

**Hybrid System**

Driver demand → Hybrid Controller ← HV Battery

Hybrid Controller → DC/DC → [ICE, MCP-A, MCP-B, TCM, RBS] → [Engine/Wheels]

Driver demand

Hybrid Realtime Optimizer

Determined by Hybrid Controller

Result of Hybrid Operation

Fig. 23

## Business Complexity



### Three large, diverse and global organizations

- Geographic challenges
- Different overall business objectives, corporate cultures, policies and processes
- Competitors...yet, collaborators
- Well-defined and appropriately bounded scope of cooperation required → takes time, up front!



Fig. 24

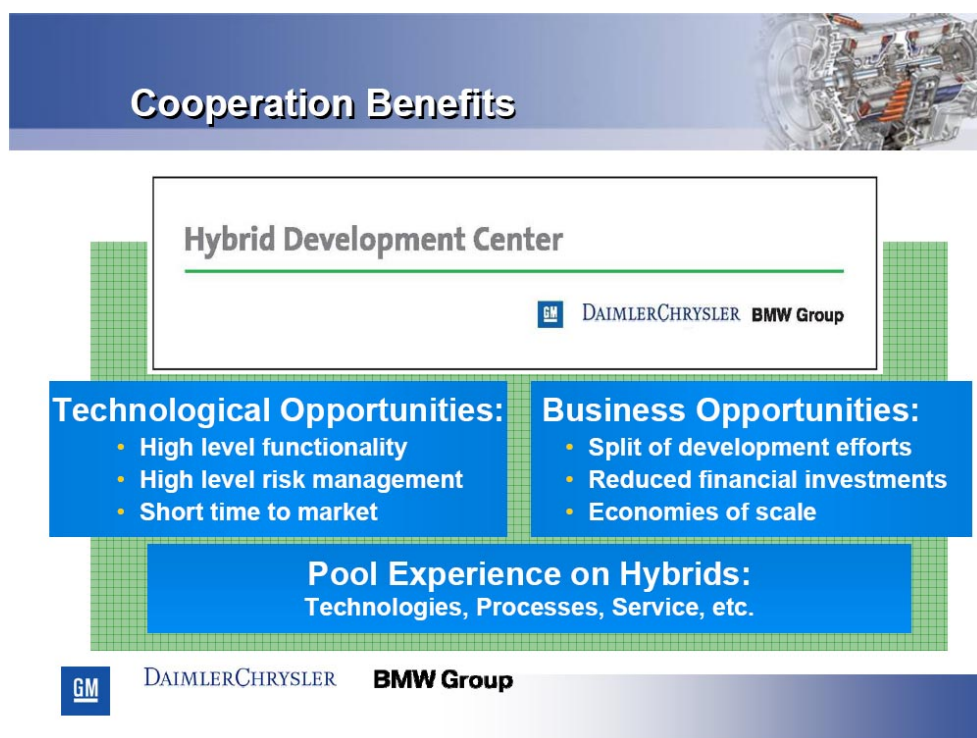


Fig. 25



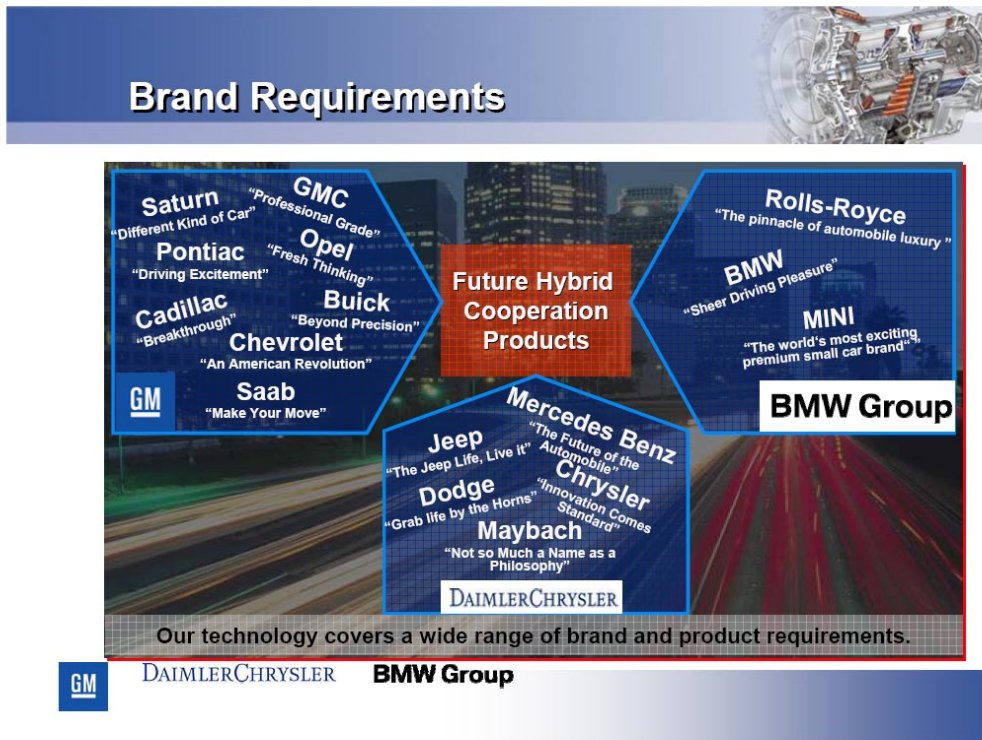


Fig. 26

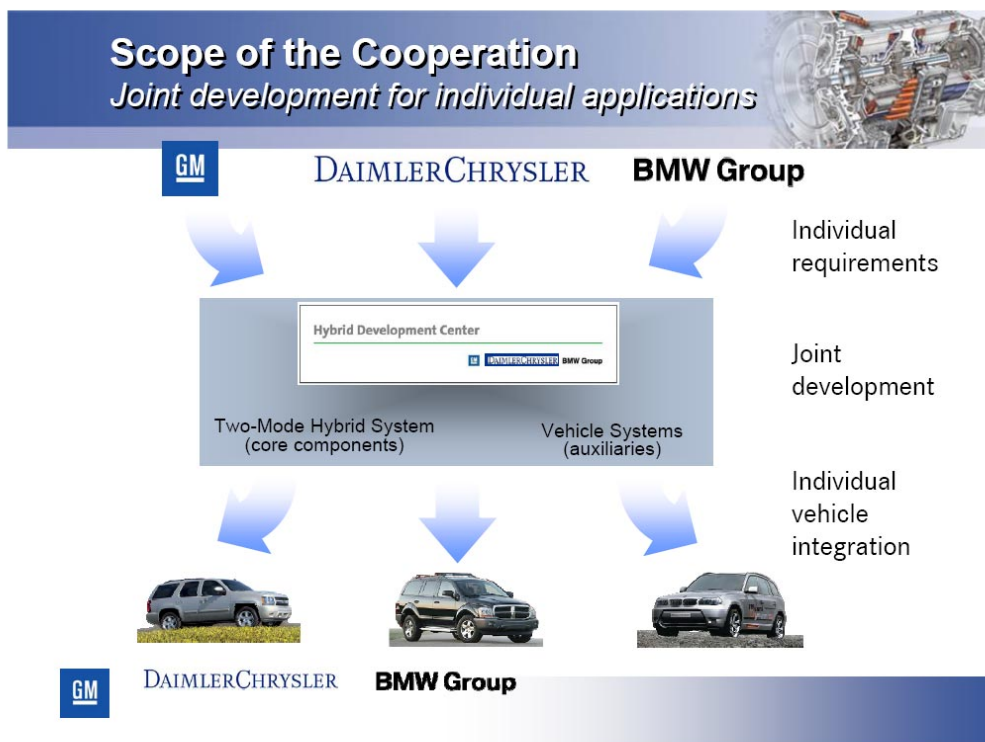



Fig. 27



## Summary



**The two-mode hybrid provides an optimal solution for**

- Fuel Economy
- Comfort
- Performance
- Adaptation to multiple powertrain and vehicle architectures
- Cost

**Cooperation**

- Sets standards with a family of products
- Increases technical expertise
- Shares elements of costs, risks and benefits
- Gives us volume that leads to economy of scale

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Fig. 28



**Thank you !**



Fig. 29



Fig. 30