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Lauer & Weiss

Optimization of the lubrication system of the intermediate gearbox of EleNa II

Dr.-Ing. Albrecht Gehring

Dipl.-Ing. Matthias Heitele

Dipl.-Ing. (FH) Simon Lang



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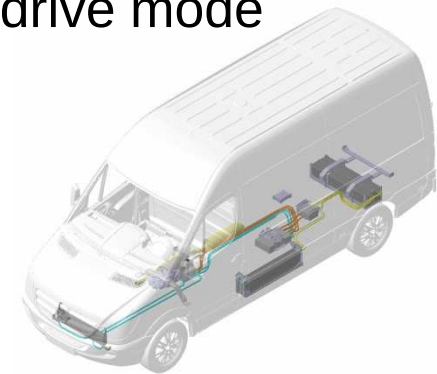
- ▶ Introduction: Project EleNa II
- ▶ Scope of new development
- ▶ Optimization process
- ▶ Results
- ▶ Summary and conclusions

Introduction: Project EleNa II

(Electro retrofit package for a Mercedes-Benz Sprinter)

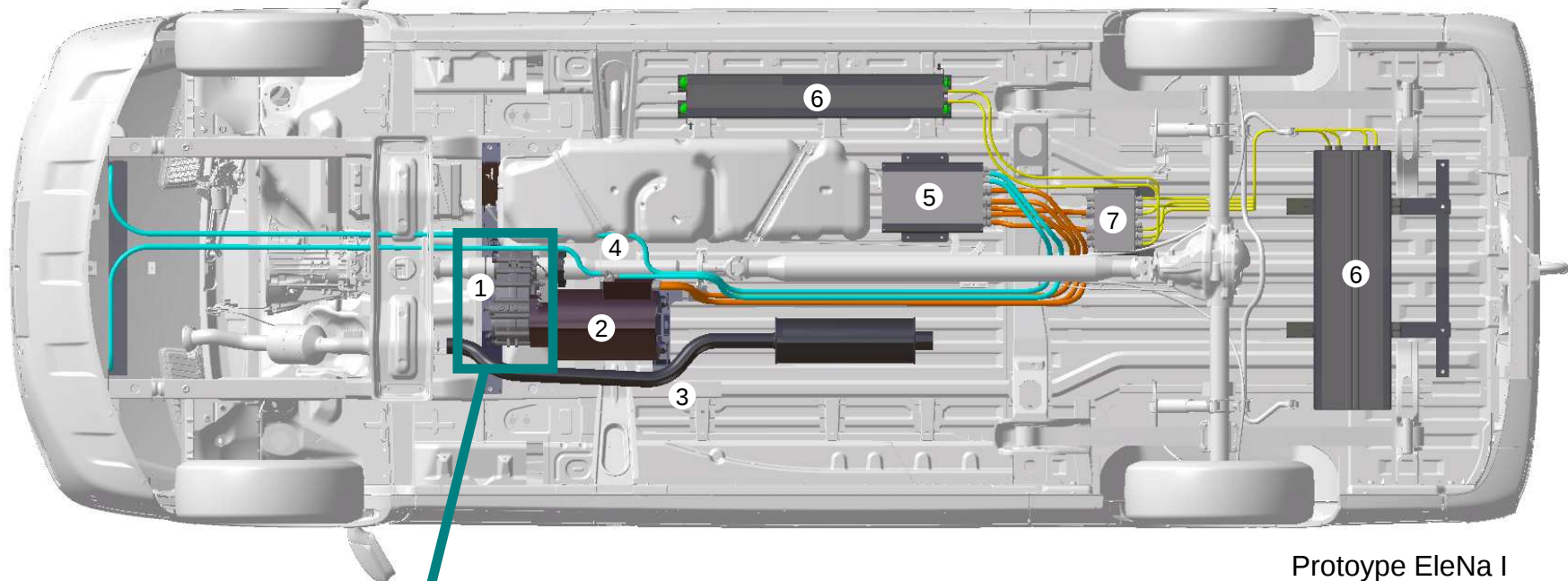
What is EleNa (ElektroNachrüstsatz)?

- ▶ Electric drive for a transporter (Mercedes-Benz Sprinter)
- ▶ Integration of the electro retrofit package into the drive shaft with minor modifications of the overall system
- ▶ Cost-effective upgrade for vehicles which are now banned from cities due to fine dust emissions
- ▶ Enables the vehicle to shift to a zero emission drive mode (pure electric) in cities
- ▶ Consortium of SMEs and academic institutes



Introduction: Project EleNa II

(Electro retrofit package for a Mercedes-Benz Sprinter)



1. Intermediate gearbox

2. Electric motor

3. modified exhaust system

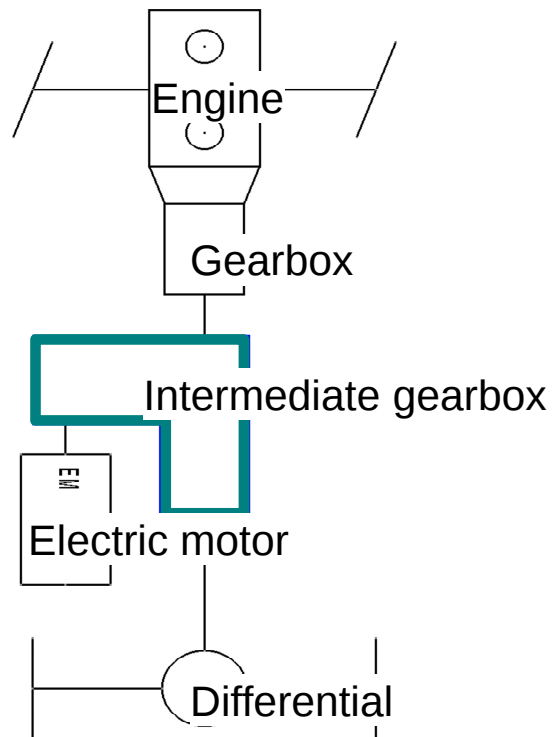
4. Drive shaft

5. Converter

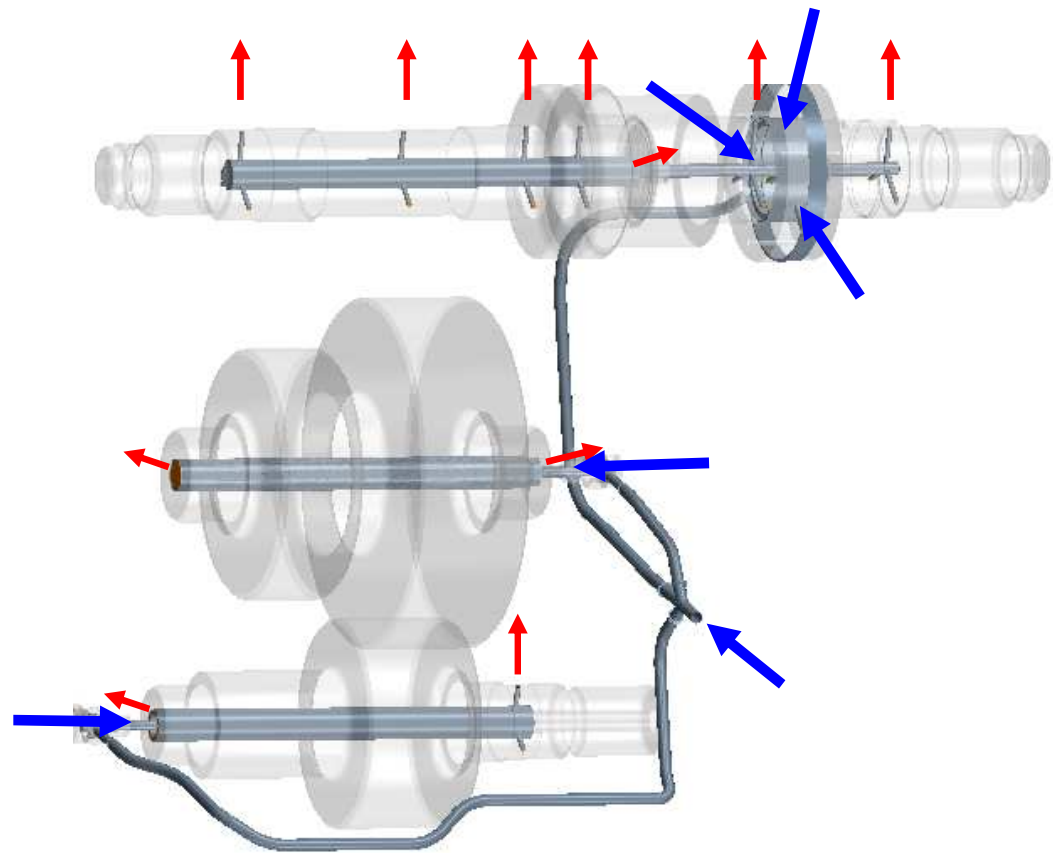
6. Batteries

7. HV-connection converter– battery

Scope of new development



Powertrain



Lubrication system of intermediate gearbox

Objectives of development of the lubrication system

Due to the high rotational speed of the shafts, the objective is to ensure, that the system is sufficiently lubricated:

- ▶ Reduction of friction and wear
- ▶ Control the dissipation of heat
- ▶ Protection against corrosion

Design and optimization of lubrication system with CFD-analyses

- ▶ Short development time using HPC
- ▶ Find best design and specification for the pump
- ▶ Substitute real tests

Details of CFD model

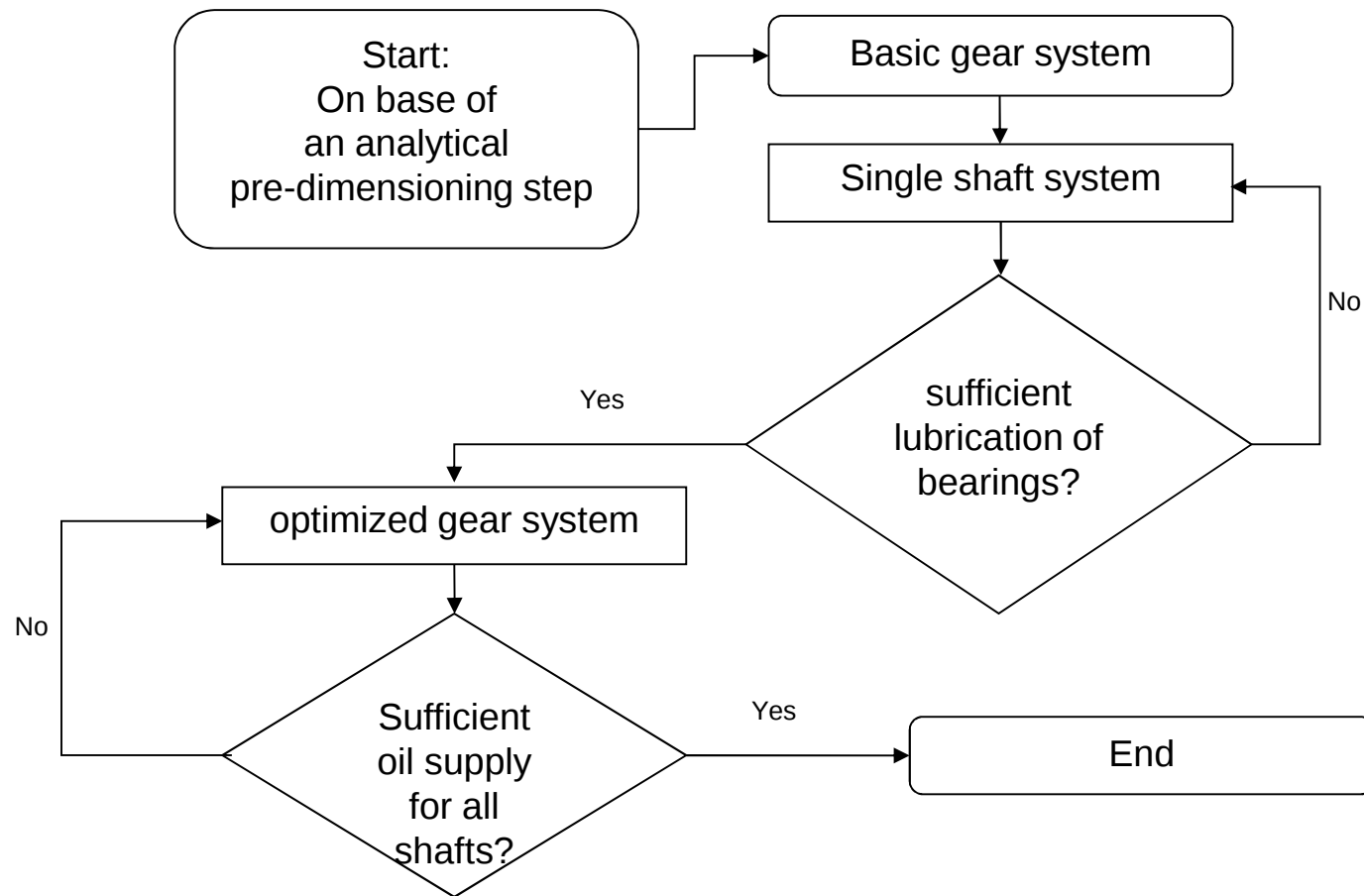
The analysis accounts for the following effects:

- ▶ 2-phase fluid: oil phase is calculated in air phase
- ▶ Different rotational speed of shafts are accounted by multiple-reference-frame method (MRF or „frozen rotor“)
- ▶ Gravitation of system
- ▶ Turbulent effects

Boundary conditions:

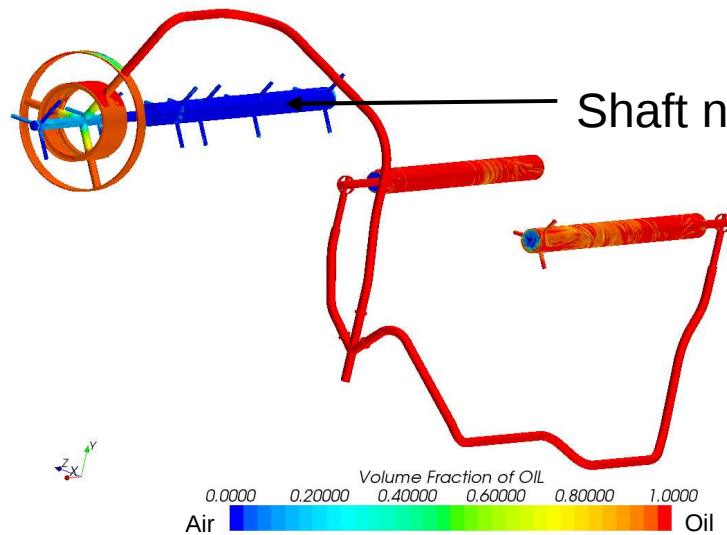
- ▶ Constant ambient pressure at all outlets
- ▶ Constant flow rate of 2 l/min at the central inlet (100% volume fraction oil)
- ▶ Rotational speed of the shafts from 0 rpm to 12.000 rpm

Optimization of lubrication system



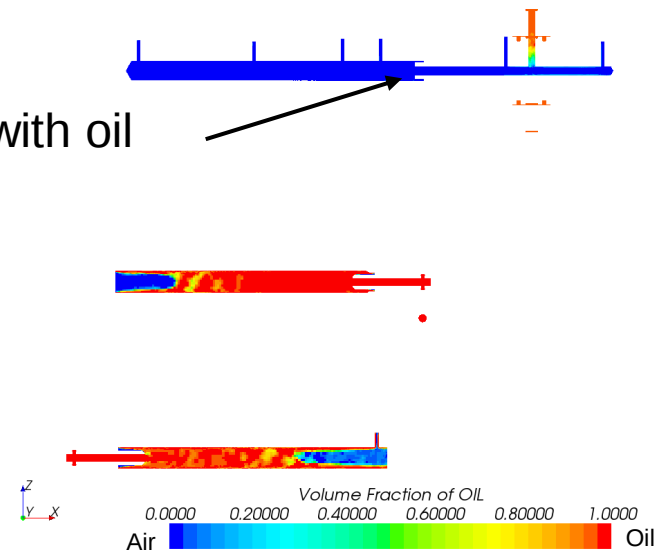
Results: Basic gear system

Basic gear system



Shaft not supplied with oil

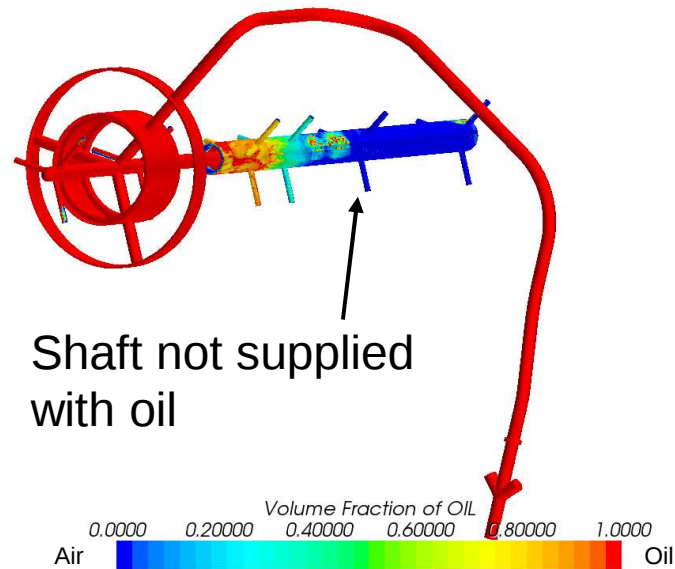
Cut through shafts



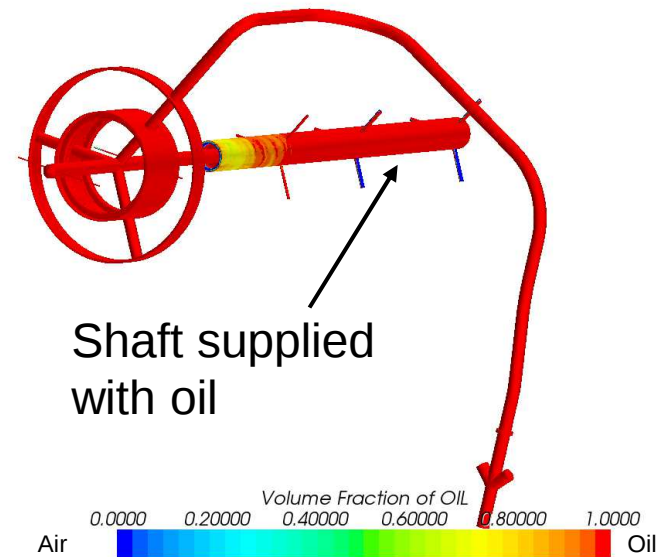
- ▶ Oil flows only in bottom shafts
- ▶ Top shaft is not supplied with oil due to centrifugal forces in the feedthrough

Results: Single shaft system

Single shaft before optimization



Single shaft after optimization



Measures:

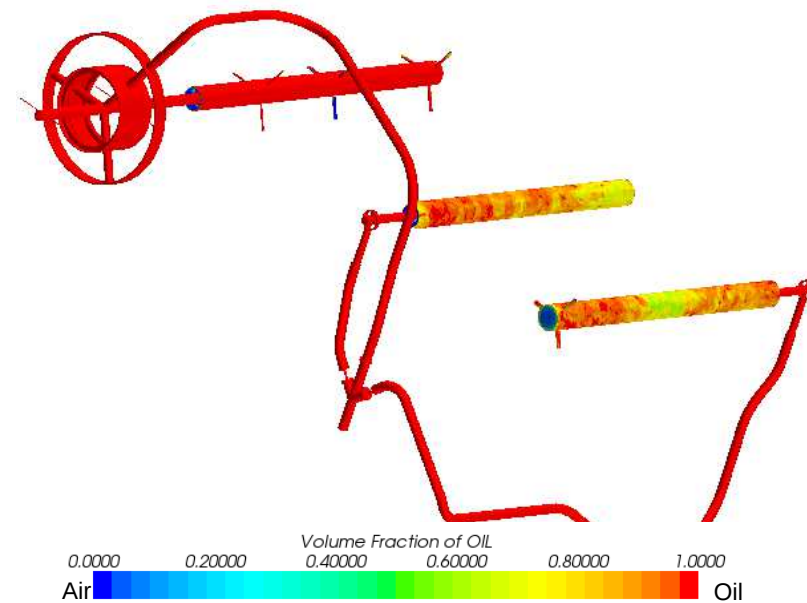
- ▶ Reduction of diameter of drill holes in shaft
- ▶ Reduction of number of holes in shaft

Results: Optimized gear system

Gear system with optimized shafts



Optimized gear system



As all shafts are supplied by one pump, the pressure losses in all shafts should be equal to achieve equal flow rates

- Baffles are build into the leads to the bottom shafts

Summary

The lubrication system of the intermediate gearbox for a transporter is designed and optimized with CFD analyses:

- ▶ a three step analyses is used
- ▶ two phase flows in rotating shafts are predicted realistically

The objectives of the process are achieved:

- ▶ all bearings are supplied with oil
- ▶ dimensions of leads and drills are optimized
- ▶ specification of the pump

Conclusions concerning HPC

The use of HPC in the project EleNa II has the following advantages:

- ▶ reduction of development time
- ▶ complexe physical problems can be analysed numerically
- ▶ comparison of different solutions is possible (number of simulations in short time)

For SMEs, the use of HPC in the development process is limited

- ▶ due to high costs for software licences
- ▶ unflexible licences models (e.g. pay per cpu time often not possible)

Thank you for your attention

Acknowledgments:



Gefördert durch:



aufgrund eines Beschlusses
des Deutschen Bundestages





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gemeinsam voraus.

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