

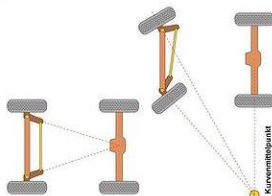
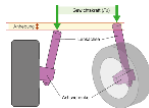
# E-Mobility & Steer-By-Wire

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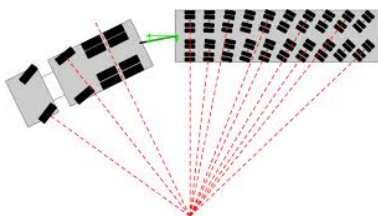
## Motivation – Advantages

The steer-by-wire technology shows some unique advantages and new degrees of freedom for car design, control and safety. In addition by applying these novel opportunities also car efficiency and reliability can be improved. In particular this are:

- **space-saving design**
  - allows innovative designs for vehicles, i.e. space between wheels can be used else
  - possibility to increase passive safety, due to the absence of a steering rod
- **larger mechanically possible steering angles**
  - improved shunting and parking performance
- **sense of steering and vehicle reaction are decoupled**
  - novel steering features can easily be implanted by software, i.e. human-machine-interfaces (HMI) or advanced driver assistance system (ADAS)
  - improved steering comfort, i.e. feedback from brake mechanism and/or power drive can be eliminated
- **active control of vehicle reaction in case of critical driving situations like**
  - breaking on surfaces being driven on with different adhesion
  - driving fast around a curve, i.e. enhanced car stabilization
  - vehicle skidding, i.e. controlled countermotions
- **reduction of production cost**
  - reduced number of version for different types and sizes of vehicles
  - easy installation especially in case of mass production
  - left-hand drive or right-hand drive easily interchangeable
- **energy saving, due to absence of permanent operating auxiliary oil pump**
- **in case of additional single-wheel steering compliance with Ackermann steering geometry can be controlled**



- reduction of wheel friction in cases with low side acceleration (driving straight ahead or slowly around curves)
- increase of road adherence in cases with high side acceleration (driving fast around curves)



- **single-wheel steering easily feasible even multi-wheel vehicles of any types and sizes**

## Problem – Safety

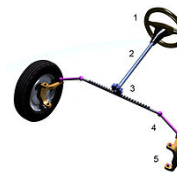
One of the still discussed open points of the steer-by-wire technology are reliability and safety aspects. A failure in steering – especially at high speed – is a very critical situation and can cause dangerous accidents. Therefore the reliability and failure free function of a steer-by-wire system has to be guaranteed anytime.

There are three main features which – if they fail – will give a malfunction of the car steering:

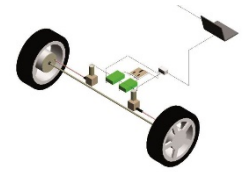
- **mechanical components**
- **hardware**
- **software**
- **power supply**

Concerning mechanical components of car steering many years of experience in industry are available. The design and production process is well known and established. Therefore no enlarged risks are expected, even a novel single-wheel steering or steer-by-wire will be realized. The same applies for soft- and hardware design. As long as the qualification and implementation procedures are followed and adequate tests are performed, no addition measures has to be undertaken.

Much more critical is the power supply. In present car design only one power grid – the 12 V net – usually exist. Any failure in the 12 V supply could directly or indirectly influence the car steering.



Conventional Steering



Steer-By-Wire

## Solutions

To resolve this leak of safety and reliability a redundant path is needed, which has to be supplied by an independent power source. The effort to realize that within conventional car design will be substantial and costly.

In case of an electro or hybrid vehicle with four individual powered wheels, it would be possible to build up an absolute autonomous steering facility by torque-vectoring. By individual control of each wheel torque a momentum to the car can be induced, which leads the vehicle to the right or left. Depending on the strength of applied torques car steering can be realized. The most interesting aspect at this solution is the fact, that the realization is only a question of programming. All the other parts needed, i.e. electro motors, controllers and independent power supply exist existing.

### Steering by Torque-Vectoring

