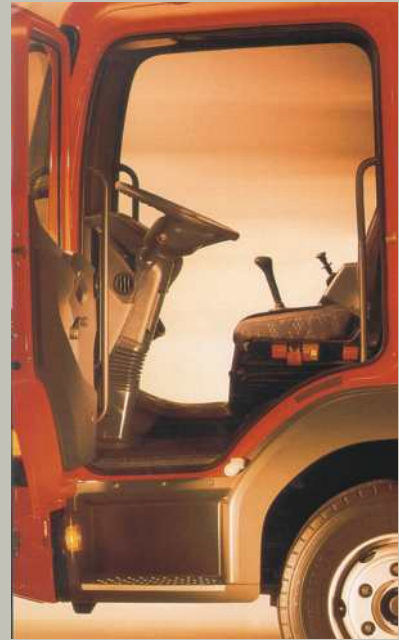


Automated Trucks and other Serial Vehicles



Götting KG dpt. **FOX**



The Task

The human being is a very intelligent creature. It realises complex situations and can react to these very quickly. Its optical and acoustical warning ability in e. g. every day traffic is enormous.

However, the human being tires quickly and is not reliable in its reactions. During transportation most accidents and damages are caused by human error. Therefore transportation systems have to be developed in order to relieve the driver or to replace him.

The Answer / The Solution

The problems are solved through the automation of the vehicle:

- No accidents
- No stress
- No wasted journey
- Reduced fuel consumption
- Highly reliable
- Exact vehicle positioning
- Careful transportation of vehicle and load
- Exact route planning
- Optimal route control
- Reduced labour costs.



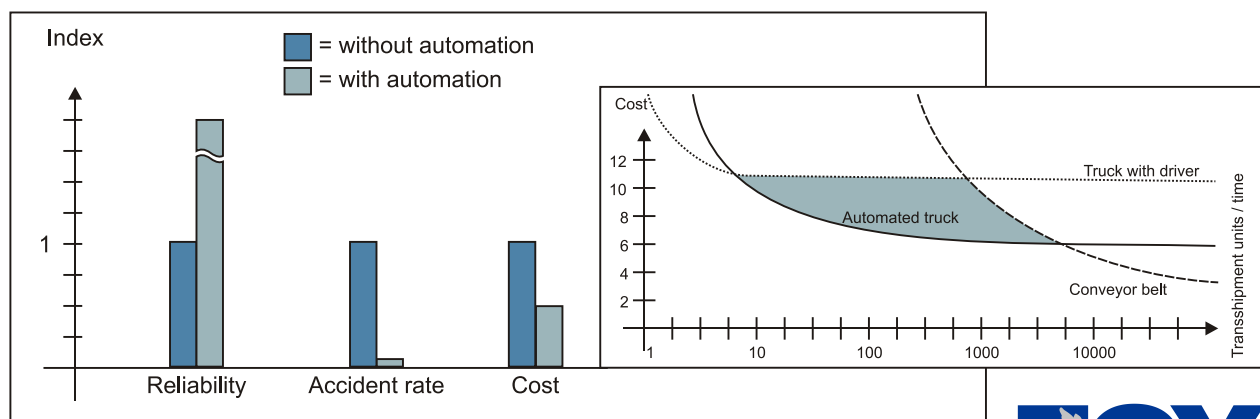
The Principle

Automation of vehicles is always advantageous if:

- A high degree of precision and reliability is required (sensors don't fatigue)
- The operational area is too dangerous for people, i. e. danger for peoples health (dust, poison, radioactivity, heat, cold, night shifts, etc.)
- Labour costs have to be reduced, especially in companies operating in multiple shifts.



Cost-Benefit-Analysis



Automated Vehicles

Efficiency of the system leads to multiple benefit for the customer

- Series production vehicle
 - low cost of purchase
 - widely available
 - tried and tested equipment
 - world-wide service
- Automated driving
 - low costs
 - reduced labour costs
 - optimal transportation
 - no human error

The Experts

The answer to the system task is guaranteed through a strong partnership. Tried and tested vehicles with intelligent technology offer the highest reliability and productivity.

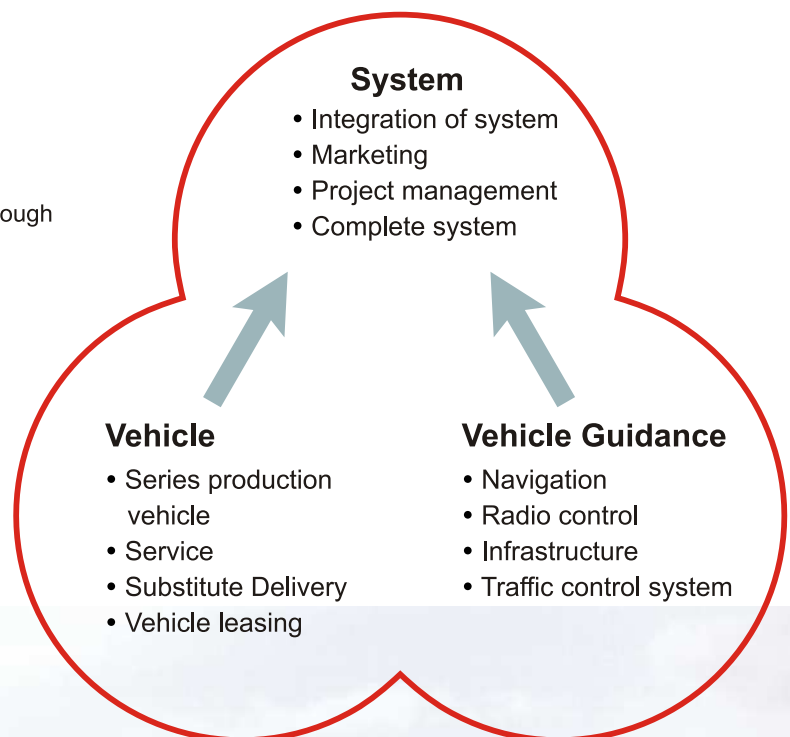
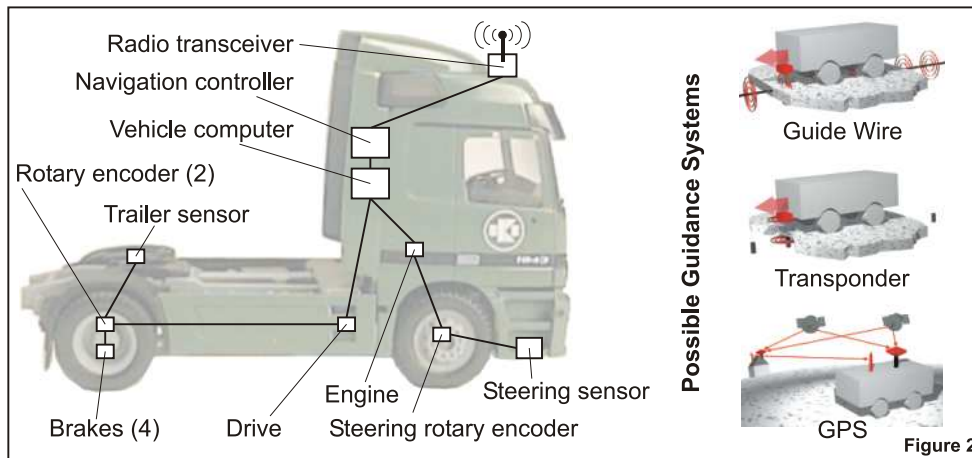


Figure 1 Example:
Mercedes-Benz Actros
forward and backward
shunting with satellite
navigation (PDGPS / 30 km/h)
(Accuracy: ± 2 cm)



Vehicle Setup



The new series of heavy goods vehicles have the ability to be fitted with various track guidance systems. Dependant upon the area of operations guide wire, transponder, satellite navigation (GPS), laser or even camera guidance systems can be used.

In addition rotary encoders are used to register the steering angle and driven route. Laser, ultrasound or radar systems are available as an optional means of detecting obstacles.

Due to the new (CAN-) controllable vehicle elements, e. g. steering cylinder, speed controller, automated gear box, brakes etc. it is possible to automate almost every vehicle with a minimal amount of alterations. The vehicle can be driven manually or automatically at any time.

Advantages:

- shunting of trailers
- moving of swap bodies
- loading and unloading of roll-on roll-off containers
- transportation of piece and bulk goods
- vehicles in long-term tests
- transports in an area, dangerous for personnel or transports of dangerous goods

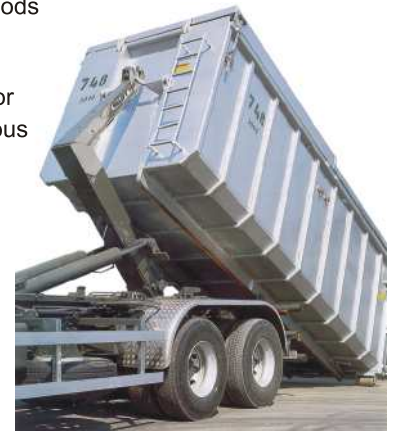


Figure 3 Automatic loading and unloading of roll-on roll-of containers

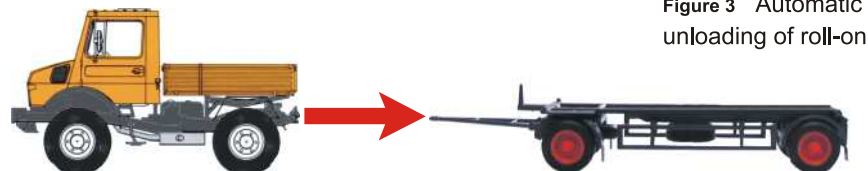


Figure 4 Automatic coupling



Figure 5 Tow truck for internal transports



Figure 6 Swap trailer mover

Automated Vehicles

Reference

Automatic driving truck UZIN, Ulm



Figure 7
Automatic Loading
and Unloading:
Seamless transition
between driverless
transport and stationary
conveyor system

In the first project of this kind FOX GmbH has automated 2 Mercedes Benz Actros for UZIN, Ulm, Germany.

The trucks are guided by transponders within the ground. This method allows accuracies of 2 cm to be achieved (docking accuracy ± 1 cm) at a speed of 5 km/h.

In addition to track guiding the trucks are equipped with laser scanners and bumpers for obstacle recognition. By using automated conveyor belts and rolling gates not only the transport, loading and unloading of europallets will be automated as well.

The whole transportation system will be controlled and visualized by a computer based guiding system. Each vehicle permanently transmits data to the base station by radio. By this data concerning positioning, logistics and vehicles can be requested on visual contact and can be transferred by telephone or internet to further users when required (remote diagnosis).

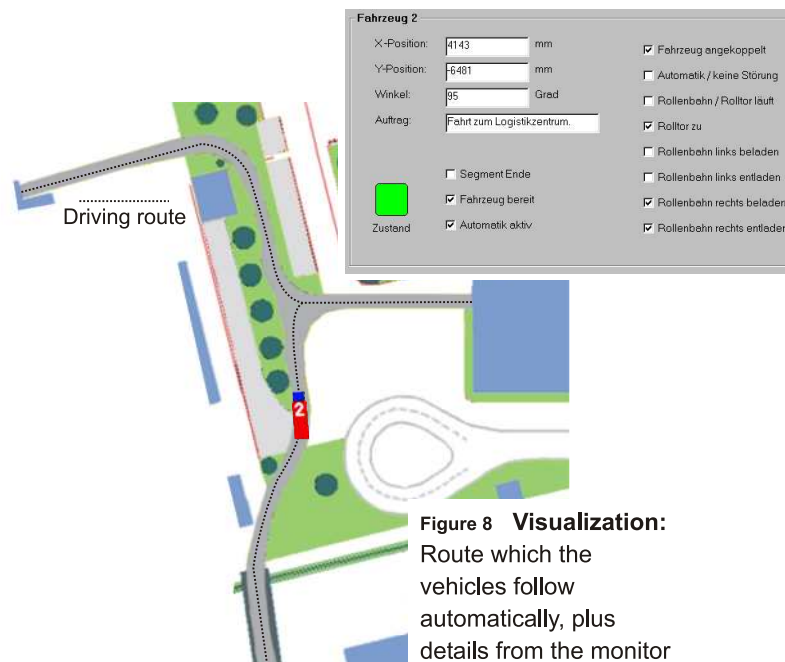


Figure 8 Visualization:
Route which the
vehicles follow
automatically, plus
details from the monitor

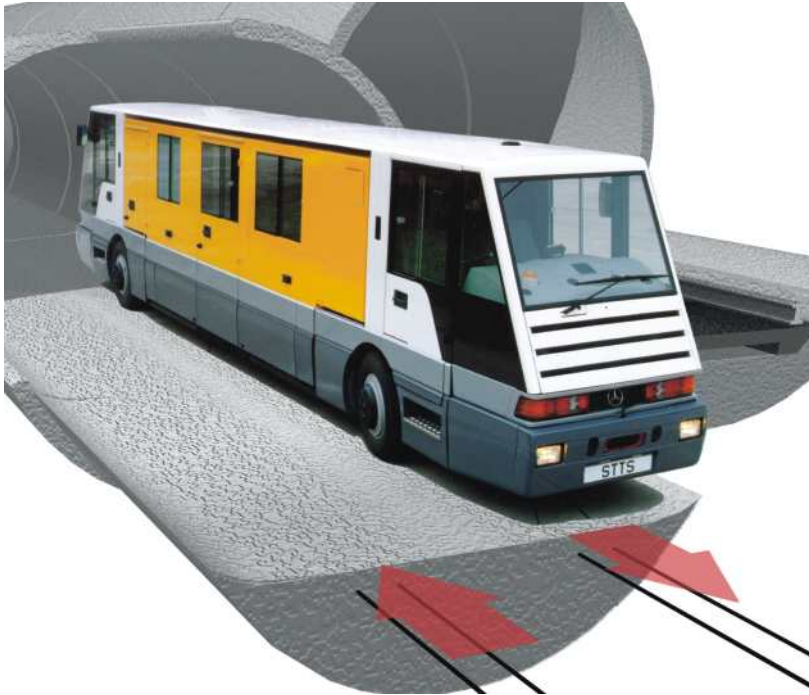
Protokollierung		
Letzte Meldung:		
Servicedaten Fahrzeug 1, Ölstand:	OK	00:00:30
Fahrzeug 1 Kraftstoffwarnung: Reserve		16:45:09
Fahrzeug 1 Störung: Notaus vorn		17:34:22
Fahrzeug 1/2 Lichteingeschaltet		18:00:04
Ampelanlage: Nachtbetrieb		20:00:01
Servicedaten Fahrzeug 1, km-Stand:	12234 km	00:00:12
Servicedaten Fahrzeug 1, Öltemperatur:	89 °C	00:00:22
Servicedaten Fahrzeug 1, Kraftstoff:	123 L	00:00:25



Figure 9
Converted truck on
the route which is
hardly broader
than the truck itself



Automated Vehicles



Applications

Figure 10 People-Mover:
In the service tube of the eurotunnel people-mover guided by guide wires have been proven as a reliable means of transport. In oncoming traffic they are able to drive at a speed of **90 km/h**. The distance is only 8 cm, the accuracy ± 2 cm



Figure 11
Container Terminals

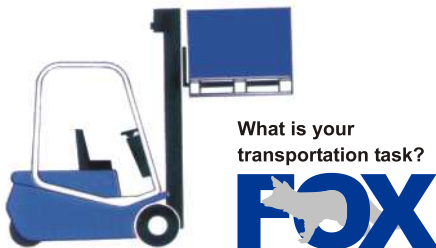
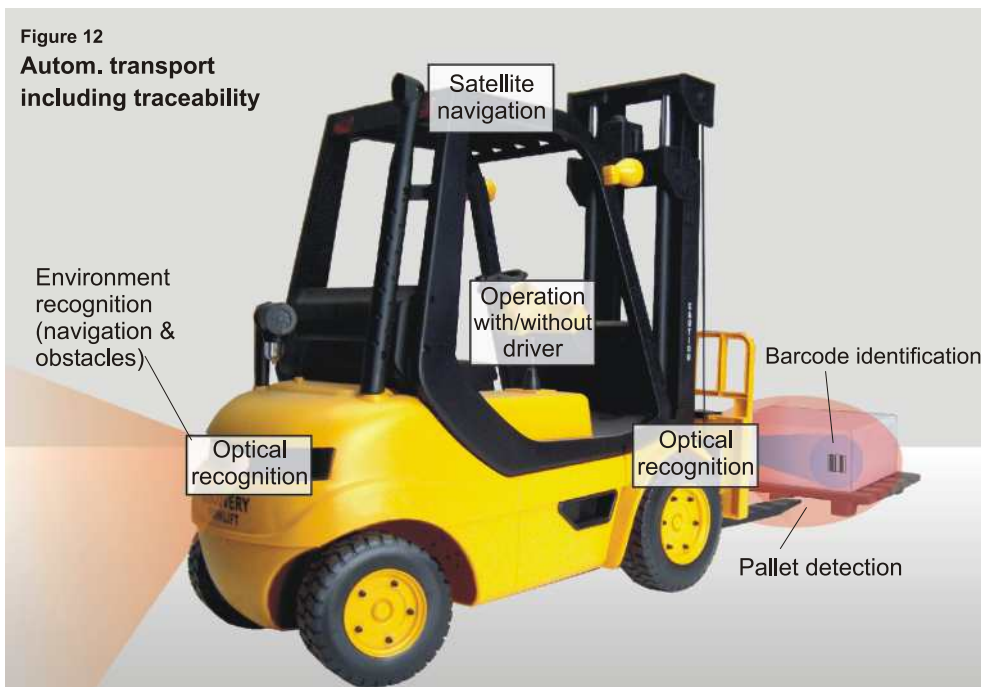


Figure 12
Autom. transport
including traceability



Internal
Transports
with Automated Guided Vehicles (AGV):
Trucks, forklift trucks, etc.



Applications

Figure 13
Automated Truck
shunts backward if required
with an accuracy of ± 2 cm

The use of automated vehicles is a valuable alternative on:

- long routes
- continuous transport
- flexible track set-up (in comparison to rail mounted vehicles or conveyor belts)
- areas or loads hazardous to people, i. e. contaminated areas with
 - explosive or radioactive material
 - high rate of air pollution (dust, gases)
 - dangerous routes
- very precise track guidance
- complicated shunting



- underground engineering
- routine driving
- driving in convoy
- Replacement for "Road-Trains"
- tunnel projects
- underground mining

Figure 14 **Endurance Test**



Figure 15
Multiple operation:
Driver of the excavator
controls several automated
guided trucks



Figure 16 **Convoy:**
The convoy is lead by a
driver in the first vehicle.
All other vehicles follow
closely without drivers (2 - 8 m)



Figure 17 Automated Wheel Loader



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12/2009



Figure 18

Automated series production vehicles:
With or without driver



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