

Summary

This report concerns an investigation into internal transport systems that are used to automatically move cars around in an enclosed infrastructure, like buildings. The investigation into internal transport systems for moving vehicles concerns automobiles that do not need a driver and that do not use their engine to move.

Because the boundaries of such an investigation are still very broad, the terms transport, car and automatic mover are specified. The definitions of these terms are interpreted as follows:

Transport, also referred as movement, displacement or conveyance in this report, is the occasion on which transit or transfer actually occurs, where transit is defined as conveyance or transfer. Transport can be done in several directions. The directions of transport considered in this report are transport in horizontal longitudinal, horizontal transversal, vertical and radial yaw direction.

A car, also referred as vehicle or automobile in this report, is a self-propelled passenger vehicle that usually has four wheels and an internal-combustion engine, used for land transport. A car is commonly supported by its four wheels. This report, however, also considers something being a car when the vehicle tires have not yet been installed.

An automatic mover, also referred as an (automated mechanical) transport system in this report, is the acting or operating of a mechanical transportation system in a manner essentially independent of external influence or control, with minimal human intervention, that enables the movement of a vehicle in a certain direction. This report considers an automatic mover to be a completely distinct transport system with its own system boundary, which has to be completely distinct from the system boundary of an automobile. Automated guided vehicle systems or other automated conveyance systems implemented in the automobile itself are therefore not considered in this report.

The boundaries of the investigated substance are still very wide. This makes a comparison between the different transport systems for moving cars very difficult. This report, therefore, classifies four different transport systems. These are:

1. System transporting a vehicle, whereon vehicle tires are installed, in a horizontal direction in transversal OR longitudinal direction.
2. System transporting a vehicle whereon vehicle tires are installed in a horizontal direction, both in transversal AND longitudinal direction.
3. System transporting a vehicle, both in a longitudinal horizontal direction AND vertical direction AND radial direction. The car can be installed with wheels or not.
4. System transporting a vehicle, comprising the following vehicle directions: longitudinal horizontal AND transversal horizontal AND vertical AND radial. The system only transports vehicles whereon wheels are mounted.

The investigated enclosed infrastructures, wherein vehicles are automatically moved, are:

- Vehicle assembly line;
- Automated parking garage;
- Car wash tunnel.

A vehicle assembly line is the manufacturing process of a vehicle, in which usually interchangeable parts are added to a vehicle, in a sequential manner using optimally planned logistics to create a finished product much faster than with handcrafting-type methods. For this purpose, several automatic transport systems are used, which convey a finished car with wheels or an unfinished car without wheels. Within the vehicle assembly line, a distinction between three different types of

conveyors is made. These are a floor conveyor, an overhead conveyor and a transferring device between different conveyors.

A floor conveyor is a conveying system in which the vehicle is supported above the conveyor. The conveyor itself is mounted near or flush with the assembly floor. Different vehicle floor conveying systems can be distinguished. This report distinguishes the following floor conveyors: Skillet conveyor, skid conveyor, belt conveyor, slat conveyor, flat top conveyor and innovative floor conveyor solutions. These floor conveyors are able to transport the vehicle in horizontal longitudinal or horizontal transversal direction. Some innovative floor conveying solutions also allow horizontal curves.

An overhead conveyor is a conveying system in which the vehicle is hung and supported below the conveyor. The conveyor itself is placed high above the ground to allow a vehicle body being transported below the conveyor. This report distinguishes the following overhead conveyors: EMS conveyor, overhead chain conveyor, overhead power and free conveyor and friction drive conveyor. All discussed overhead conveyors can be installed as floor conveyors, also referred as inverted conveyors, too. The inverted conveyors use exactly the same techniques which are commonly the mirrored version of the overhead conveyor type. The described overhead conveyors are able to transport the vehicle in horizontal longitudinal or horizontal transversal and vertical and radial direction.

Transferring devices between different conveyors which are commonly used are lifting devices, shuttle conveyors, turn tables and positioners. Every transferring device has one certain conveying direction of a vehicle. A combination between different transferring devices is therefore a common use.

An automated parking garage is a vehicle parking garage that uses automated conveyance techniques to automatically store and retrieve automobiles inside a parking facility and that provides automated movement of a vehicle to facilitate the parking of a vehicle and in this matter obtain a higher utility volume of the parking garage. Automated parking garages are suitable to convey vehicles whereon vehicle tires are mounted. During conveyance, the vehicles are constantly horizontally aligned. A distinction between a fully automated parking garage and a semi-automated parking garage can be made.

A fully automated parking garage provides fully automated vehicle parking service with the use of automated conveyance. Within the fully automated parking garage a distinction between three different garages is made. These are: Shuffle puzzle system, store shelf stacker system and a paternoster system. Fully automated parking garages are able to convey a vehicle in at least two different directions. The shuffle puzzle system and the store shelf stacker system combine transversal and longitudinal horizontal movements. These systems can be extended by appending vertical and radial movement. The store shelf stacker system commonly possesses all four mentioned movements. The paternoster system combines transversal horizontal or longitudinal horizontal movement with vertical movement of the vehicle.

The principle of a semi-automated parking garage is to move one or more cars in a certain direction to give other vehicles the possibility to park on certain parking spots which are otherwise not accessible for these vehicles. The vehicle is placed on a platform which conveys the vehicle in one certain direction. The direction wherein the vehicle on the platform is moved is vertical, horizontal (transversal or longitudinal) or radial.

A car wash tunnel is a facility used to clean the exterior and, in some cases, the interior of automobiles with the use of a conveyor which automatically conveys one or multiple vehicles through the washing steps of a conventional cleaning cycle of the car wash. The conveyor used in the car wash conveys vehicles whereon wheels are installed in a longitudinal horizontal direction. Different conveyor types are used within the car wash tunnel. These are: conveyance by using a chain conveyor whereon pusher dollies are mounted, or conveyance by placing the vehicle or vehicle tires on a belt conveyor.

Different chain conveyors whereon pusher dollies are mounted exist. A dolly pushes one of the front or rear wheels of the vehicle. A distinction is made between above floor and below floor conveyors and on demand and not on demand conveyors. Below floor conveyors requires concrete work to make a pit in the floor to install the conveyor system. The above floor conveyors do not require concrete work and are completely above ground. The dollies mounted on the chain can be on demand or not.

Belt conveyors used in the car wash tunnel are plastic modular chained belts which are driven by a sprocket system. The vehicle can be fully placed on one belt; the vehicle can be placed on two separate belts where one belt carries and conveys the left wheels and one belt carries and conveys

the right wheels; or a single belt whereon pusher protrusions are mounted which push one of the front or rear wheels is used.

All transport systems in this report are classified in a 'Classified transport system', formerly discussed. The results of the categorization are shown in the table hereunder.

	Classified transport system 1	Classified transport system 2	Classified transport system 3	Classified transport system 4
- Skillet conveyor	X*		X*	
- Skid conveyor	X*		X*	
- Reinforced rubber belt conveyor <ul style="list-style-type: none"> o Single o Double 	X			
- Plastic modular belt conveyor <ul style="list-style-type: none"> o Single o Double o Single with pusher protrusions 	X			
- Slat conveyor <ul style="list-style-type: none"> o Single o Double 	X			
- Flat top conveyor <ul style="list-style-type: none"> o Single o Double 	X			
- Roller conveyor	X			
- EMS conveyor	X*		X	
- Chain conveyor	X*		X	
- Power and free conveyor	X*		X	
- Friction drive conveyor	X*		X	
- Shuffle puzzle system		X		X
- Store shelf stacker system <ul style="list-style-type: none"> o Pallet carrying the vehicle o Carrier clamping device o Conveyor belt o Rollers 		X		X
- Paternoster system				
- Horizontal longitudinal moving platform	X			
- Horizontal transversal moving platform	X			
- Chain conveyor whereon pusher dollies are mounted	X			
- Shuttle conveyor		X		
- Turn table				
- Lifting device				
- Positioner				

Recommended for further investigation is to further narrow the boundaries of the scope and to investigate only one classified system. The transport systems satisfying the specific 'classified transport system' conditions can be compared and subjected to different criteria.