MHP
A PORSCHE COMPANY

LOGISTICS 4.0

Intelligent, Integrated, Autonomous

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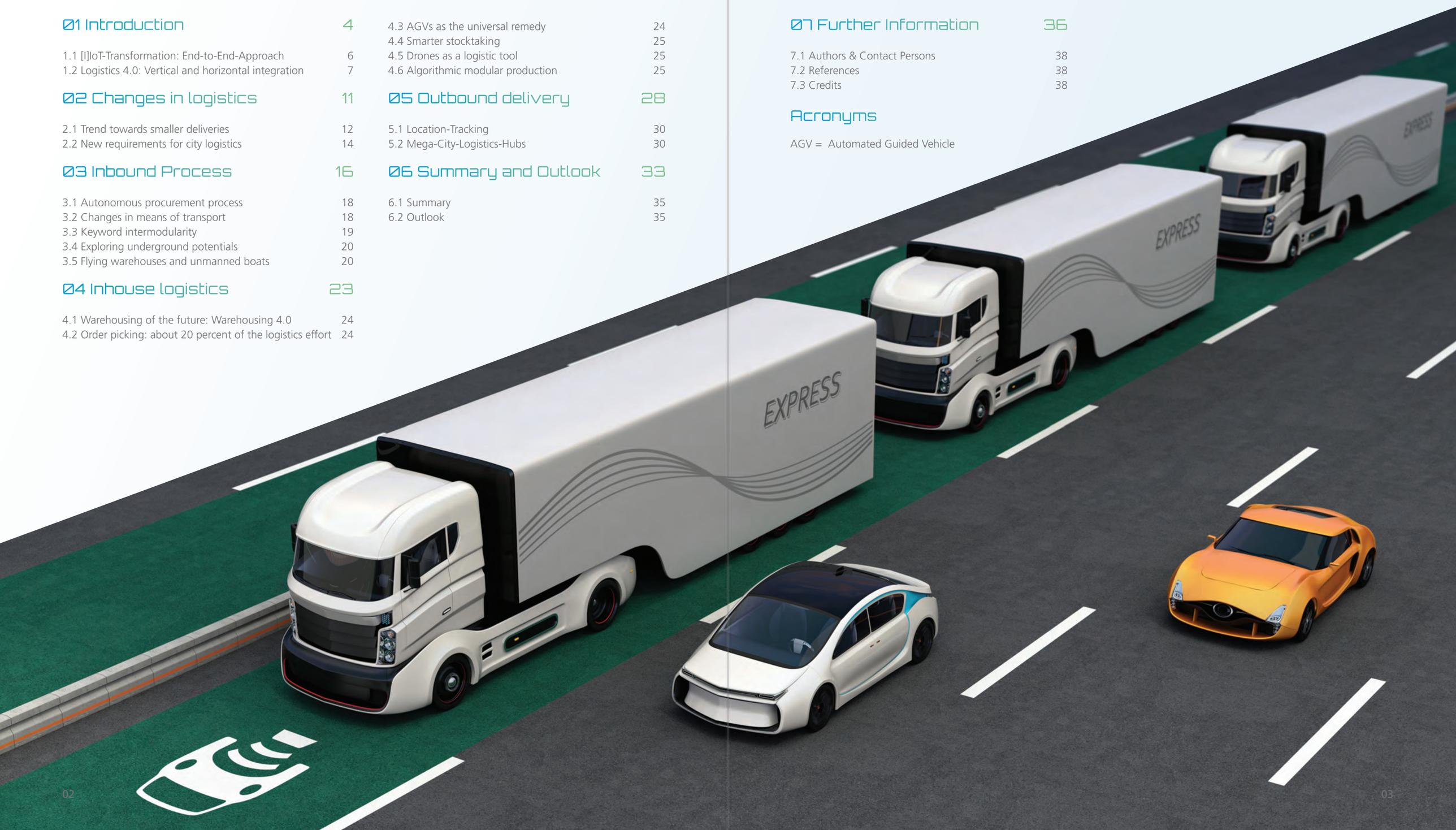
Acronyms

AGV = Automated Guided Vehicle



01

Introduction

An outlook on the logistics of companies and cities around the year 2040

With this white paper, we at MHP would like to give an outlook on the logistics of companies and cities around the year 2040. Using the value chain of manufacturing companies as an example, we present possible innovations in the logistics sector and show potential scenarios - from procurement logistics to production logistics and distribution logistics. Visions and innovative topics on which research is currently being conducted are outlined and explained in more detail. Due to the strong dependency and interaction between corporate and city logistics, we also discuss suitable synergies for conceivable use cases for possible design scenarios of a future city logistics around 2040. In principle, however, the topics presented can never be seen in isolation from the overall process of a company's digital transformation. In our opinion, the great potential of an Industry 4.0 environment can only be realized through the changeover to an end-to-end networked supply chain with a direct connection to the associated production.

1.1 [I]IoT-Transformation: End-to-End-Approach

The topics [I]IoT and Digital Transformation are multilayered and complex. On the one hand, fields of action and use cases for companies must be defined concretely and, if possible, in small projects or products. On the other hand, the embedding of all aspects in an end-to-end approach is extremely important.

Thus, in addition to the consistency of strategy, conception and roadmap through to the implementation and operation of solutions and technologies, the end-to-end view and the dovetailing of the individual subject areas is an essential success factor for [I]IoT transformation.

The use of IoT in smart and intelligent factories requires a smooth interaction of all disciplines represented (see graph no. 01) within the architecture of a digitisation project. Only with the right timetable and a focus on the relevant stations topics and technological solutions can be implemented profitably and, above all, sustainably. In this white paper, we take an end-to-end view, especially for the logistics sector.

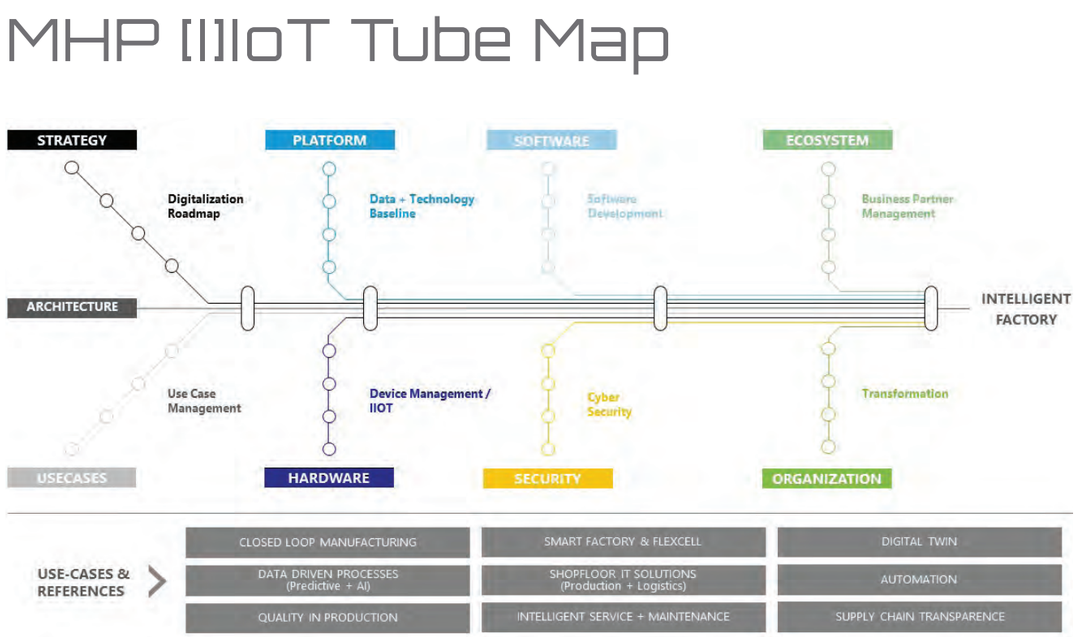


Chart no. 01: MHP [I]IoT Tube Map
Source: MHP

1.2 Logistics 4.0: Vertical and horizontal integration

Digitisation poses enormous challenges for the logistics industry worldwide. New technologies that enable digital innovations for the logistics industry are presented almost daily. In the context of supply chain digitisation, the view of horizontal and vertical integration in companies is of great importance.

„Vertical integration (within a company) is understood to mean the harmonization and integration of internal company information technologies, from the automated collection of high-resolution transaction data (e.g. through RFID) to the use of this data in higher-level planning and control systems (e.g. Manufacturing Execution System, or MES for short). Horizontal integration (inter-company) is understood to mean the cross-company exchange of relevant information along the supply chain. It enables companies to smoothly exchange electronic messages such as purchase orders, order confirmations, shipping notifications, etc. in a paperless manner and without much delay. At the same time, horizontal integration enables the efficient use of logistical cooperation concepts such as Collaborative Planning, Forecasting and Replenishment (CPFR), thus significantly reducing the risk of stock and order quantities building up (the so-called bullwhip effect)" [1].

Based on Industry 4.0 - the name for a digitalized industrial environment - a digitalized logistics infrastructure is called Logistics 4.0. This means the fully integrated networking of all supply chain components of a company. In the final stage of Logistics 4.0, a distinction is made between two dimensions: The first dimension describes the end-to-end process along the supply chain from supplier to customer. The second is defined by collaborative production networks, which in future will implement self-controlling and fully automated logistics processes in companies. As long as the target process corresponds to the actual process, the actual value-added process will take place in such a self-controlling supply chain - without any necessary external interaction. In the event of malfunctions, a distinction is made between first and second level support. First-level support incidents can be independently resolved by the system. Only in the case of serious problems that require a decision evaluation is the external intervention necessary - for example, by a logistics employee.

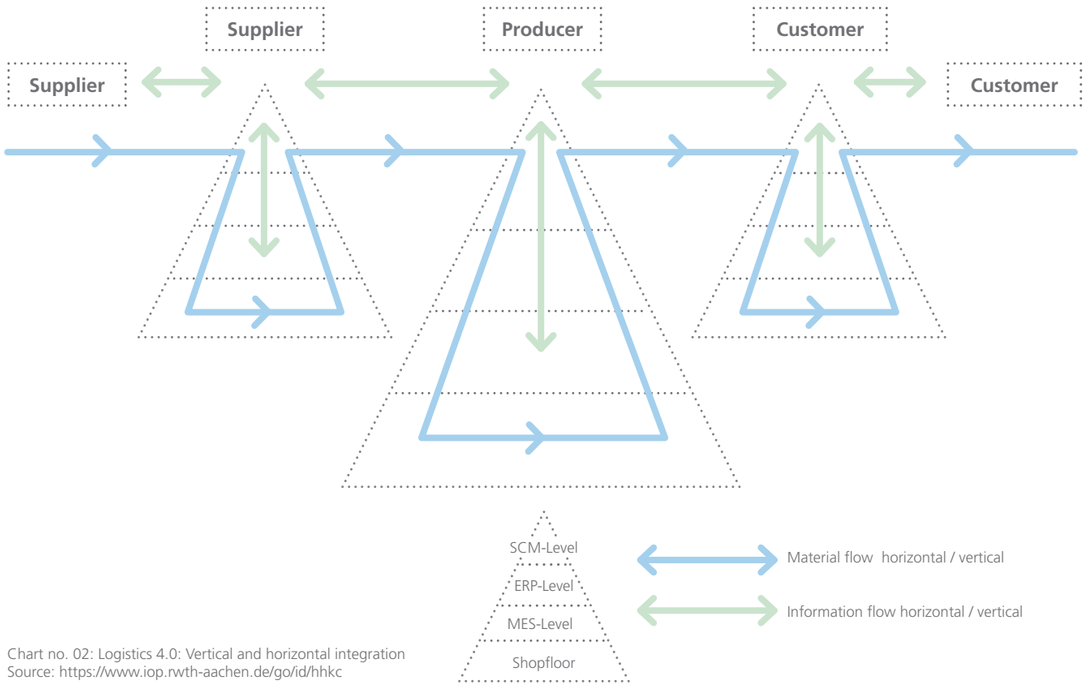


Chart no. 02: Logistics 4.0: Vertical and horizontal integration
Source: https://www.iop.rwth-aachen.de/go/id/hhkc

Global trade in goods and services is expected to more than triple in 2030.

Source: PWC 2012, Transportation & Logistics 2030 Volume 5: Winning the talent race

In urban metropolitan areas, overnight parcel delivery with low-noise vehicles can increase capacity by 20 to 30 percent.

Source: BVL 2018, 20 Trends die in der City die Logistiker bewegen

20%

of all road accidents resulting in fatalities are caused by goods road transport vehicles.

Source: Statistisches Bundesamt 2018, Verkehrsunfälle. Unfälle von Güterkraftfahrzeugen im Straßenverkehr 2018

By 2030 the volume of parcel deliveries will triple.

Source: McKinsey 2019, Bulky is beautiful: How Wayfair is poised to meet massive new demand for home goods – and home delivery

The utilisation rate of autonomously driven trucks will rise from currently 29 to 78 percent by 2030.

Source: strategy& 2018, Strategy& Truck Study 2018: Digitalisierung und autonomes Fahren halbieren Logistikkosten bis 2030

The delivery of purchases with drones meets with the consent of 50 percent of Germans.

Source: bitkom 2019, Großes Interesse an Drohnen-Lieferungen

Digitalized and automated logistics processes and delivery vehicles will reduce the logistics costs for standardised transports by 47 percent by 2030.

Source: strategy& 2018, Strategy& Truck Study 2018: Digitalisierung und autonomes Fahren halbieren Logistikkosten bis 2030

Fully autonomous goods road transport vehicles can be expected in public transport from 2025.

Source: Roland Berger 2018, Shifting up a gear Automation, electrification and digitalization in the trucking industry

40%

of all German truck drivers will retire by 2030 - creating a demand gap of 150,000 drivers.

Source: Roland Berger 2020, FreightTech Treiber für die Logistik der Zukunft – FreightTech-White Paper 2020

"By computerising all units involved in a logistics chain, Logistics 4.0 creates the basis for flexible positioning in situations such as the Corona pandemic, but also in everyday change."

02 Changes in logistics

According to the Global Connectedness Index, the world is more interconnected than at almost any previous point in time. While this global interconnectedness is a key driver of growth and prosperity, it also creates major dependencies in the field of corporate and city logistics. Since changes in environmental conditions can affect entire value and supply chains, these dependencies are becoming particularly important. To be able to guarantee efficient logistics chains, nevertheless, continuous, flexible and fast reaction together with an adaptation of the entire logistics is of great importance.

A current example that illustrates the relevance of this adaptability is the corona virus (SARS-CoV-2, Covid-19). The international spread of this virus poses a major challenge to every single logistics player in the procurement and delivery of goods. Established supply chains must react to production stoppages, regulatory uncertainties, new regulations, closed borders and increasing controls. Other aspects such as labour shortages, limited transport capacity and financial challenges faced by companies and cities also need to be taken into account. Quick reactions, flexibility and the best possible use of existing capacities are existential in these challenges. Many experts assume that the increase in online trade that is already taking place today will continue after the Corona crisis. Accordingly, new concepts are urgently needed for distribution centres and the entire distribution logistics sector in order to achieve the desired throughput and, for example, to limit delivery traffic in city centres.

By computerising all units involved in a logistics chain, Logistics 4.0 creates the basis for flexible positioning in situations such as the Corona pandemic, but also in everyday change. This means that Logistics 4.0 is not only driven forward by new technologies and their possible applications but is also in demand by individual participants in the global market and is a prerequisite for the future.

2.1 Trend towards smaller deliveries

Increasing urbanization, the rise of e-commerce, as well as rising customer expectations and growing demands on the flexibility of retailers, have enormous implications for the logistics industry. Today, it is already a matter of course for customers to have ordered goods delivered to their home quickly and according to their individual needs. Statistics show that the number of courier, express and parcel service (CEP) consignments in Germany rose by around **58 percent** between 2008 [2,230 million] and 2018 [3,520 million]. Forecasts predict that there will be around 4,430 million goods shipments in 2023, which would correspond to an increase of around 99 percent compared to 2008. **By 2035, we expect 8.5 billion shipments per year in Germany.** This is far more than double the current figure.

The rising expectations of ever-faster individual shipments lead to significantly more small-scale deliveries. The consequences of this development are dramatic and can be seen not only in the increasing long-distance traffic and countless delivery vehicles in the cities but also in the CO2 balance. Trucks now account for 19 percent of all polluting emissions on German roads, thus contributing significantly to the deterioration of air quality. Studies also show that urban flows of goods will cause an increase in the current transport volume from 3,747 million tonnes (2018) to 4,011 million tonnes in 2022. This would correspond to an increase of 7 percent and thus have a massive impact on the entire transport landscape and people..

By 2035, we expect 8.5 billion shipments per year in Germany.

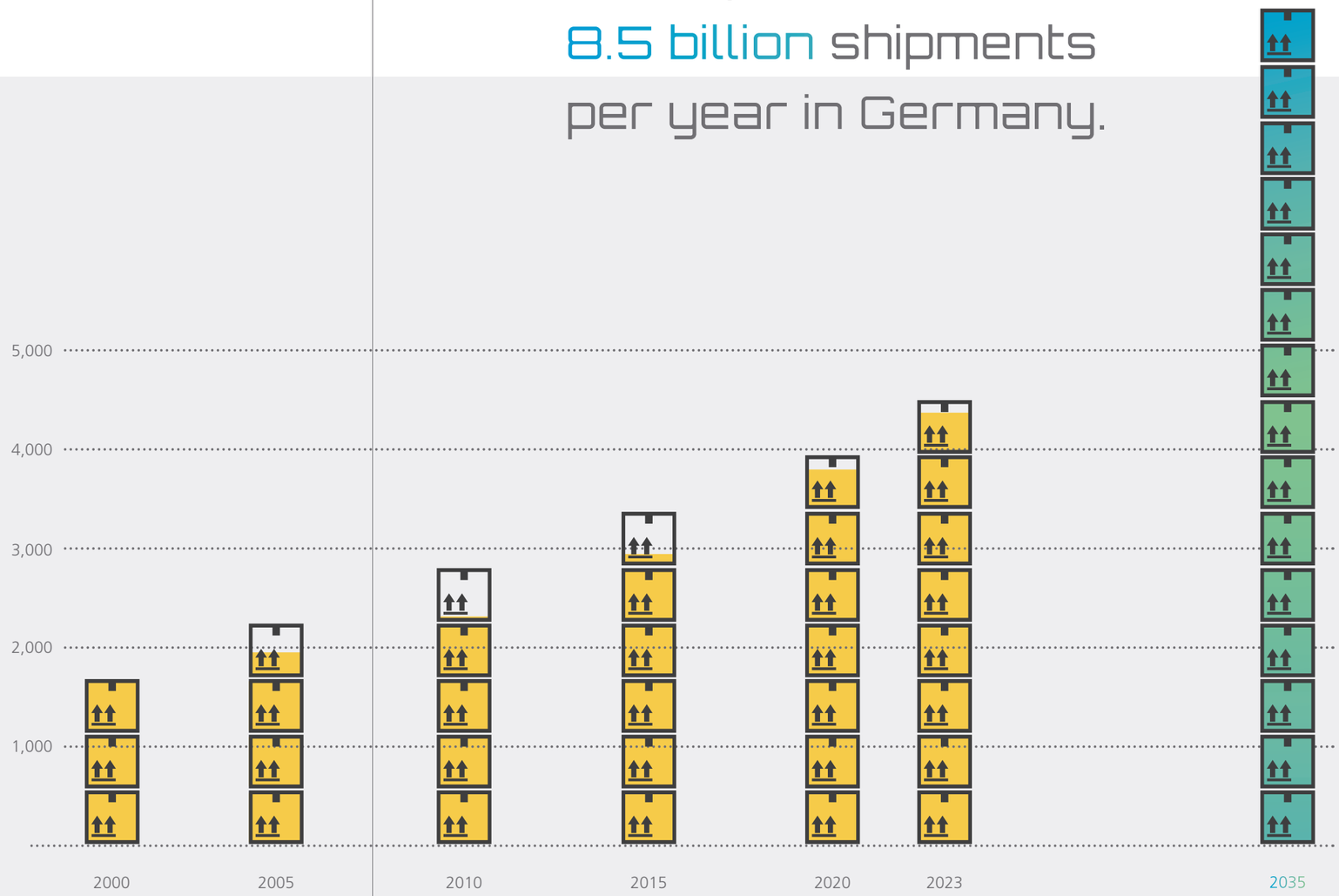


Chart no. 03: Development of consignments
Source: MHP // https://de.statista.com/statistik/daten/studie/154829/umfrage/sendungsmenge-von-paket-und-kurierdiensten-in-deutschland/

2.2 New requirements for city logistics

To be able to manage the increasing flow of goods in a controlled and coordinated manner, cities are also forced to establish new logistics concepts. In the future, tried and tested transport routes must be used more efficiently, for example by restricting the travel time for goods transport or bonus times. In addition, new innovative transport routes should be created. In this context, options such as underground transport routes, which have been used relatively little to date, are likely to become more important for freight transport. Air transport will also be more closely integrated than ever and will reduce the burden on road haulage. Especially in the early stages, cities will benefit from the autonomy and the numerically low level of disturbance in these two environments. With regard to land use, however, standards for innovative parking management and modularity in the subsidies must be defined. Along the existing transport arteries, 6G-supported applications will form the basic framework for the digital infrastructure. Platforms developed specifically for this purpose will be open to various modes of transport based on defined conditions of use and will have a higher degree of capacity utilisation. In companies, on the other hand, intralogistics will be revolutionized by fully integrated autonomous transport and process systems and smart devices. Existing job profiles such as buyers, warehouse workers or material suppliers will change drastically due to autonomy and automation.

The issue of sustainability will be much more comprehensively considered in the logistics landscape in 2040 than it has been so far. Ready-to-carry freight and empty transport vehicles will be brought together more quickly by using optimization software, the integration of forwarders and innovative load carriers - this will reduce the CO2 balance per transport. In addition, electrically driven trucks and ships with alternative forms of propulsion will communicate and interact with other transport components (e.g. ship with lock) so that they can transport goods autonomously too.

These examples give only a small foretaste of how excited the world is about developments in the logistics industry up to 2040. In the following, we explain concrete examples of current research projects in more detail and present possible scenarios along the supply chain - starting with the inbound process.

MHP Study: [5]
„Robots Wanted – The influence of digitalization on the workforce in the automotive industry"

In companies, on the other hand, intralogistics is being revolutionized by fully integrated autonomous transport and process systems and smart devices.

03

Inbound Process

"The fact is that the classic inbound and delivery process by truck will develop even more in the direction of intermodal transport in the future thanks to alternative transport routes and means."

In this section, we discuss the question of what the inbound process of a company will look like in the future. Will material increasingly be transported by drones? Or underground, comparable to a pneumatic tube system? Both concepts are already being investigated in pilot projects. The fact is that the classic inbound and delivery process by truck will develop even more in the direction of intermodal transport in the future thanks to alternative transport routes and means. Over the next five years, the manually controlled truck will be replaced by automated towing vehicles in defined, cordoned-off areas (on-site, e.g. on factory or port premises). This will be followed by a deployment phase of semi-autonomous vehicles that will drive independently in some areas and be controlled manually in other areas - e.g. by drivers called in via radio. By 2040, autonomous transport vehicles will be on the road in many areas of application.

3.1 Autonomous procurement process

Procurement is one of the first corporate processes to be almost completely digitalized and handled autonomously by 2035. Thanks to intelligent, comprehensive networking, material that has been used in production or removed from the warehouse is independently reordered from the supplier. The operational activities of purchasers and dispatchers will change significantly. The professional profile in this field will develop both internally and externally towards the interface manager. The demands on IT technical understanding will increase enormously, and the ability to analyse data will also come to the fore. Nevertheless, personal customer relationships, especially for non-standardised processes, will remain an important factor for the success of supplier-company relationships.

3.2 Changes in means of transport

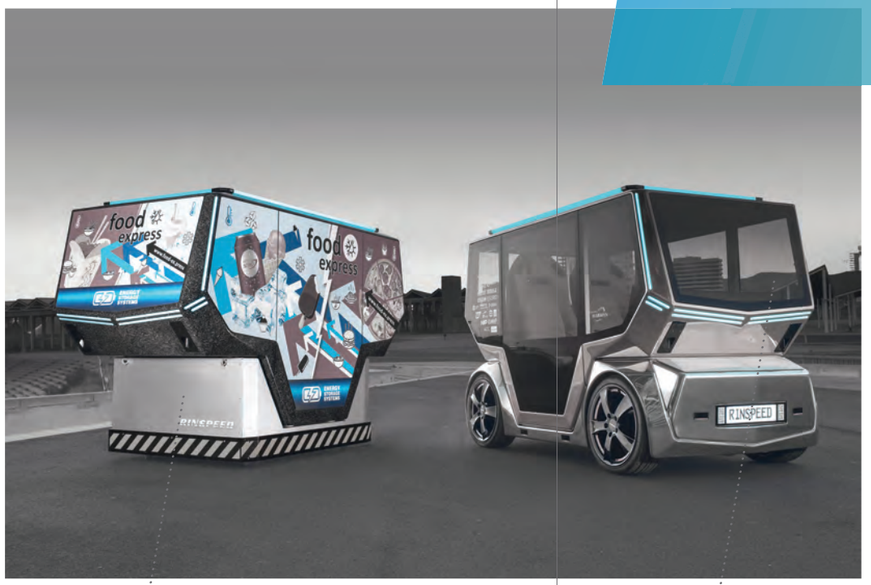
By 2040, conventional diesel-powered trucks are rarely seen on the roads - instead, they have been replaced by driverless, local and environmentally friendly means of transport. We see an increasing use of battery electric vehicles in the next few years for trucks with short driving routes, such as in conurbations. This will require a suitable charging infrastructure, including the corresponding network expansion. For long-distance trucks, hydrogen is used as a locally emission-free energy supplier and enables short charging times. As early as mid-2019, the first autonomous truck without a driver's cab was successfully tested on public roads in Sweden. Due to the lack of a driver's cab, this logistics concept not only offers space savings, but it also increases the capacity for freight transport. Such systems will be taken for granted as a transport system on the roads in 2040. As long as autonomous driving along the entire route is not yet possible, these vehicles will save energy through platooning and, thanks to real-time monitoring, deliver goods in a plannable manner and with a high degree of on-time delivery. This will also enable the integration of non-industrial goods such as private consumer goods - in an extremely environmentally friendly and efficient manner. In the course of the complete networking of means of transport, companies will in future be able to use real-time tracking to predict delays in the delivery of goods and react to them automatically. As a result, measures such as changing the production sequence can be initiated in production, production stoppages can be averted, and expensive express deliveries can be reduced.

3.3 Keyword intermodularity

Currently, in logistics, it is rare to find different uses of a mode of transport such as the transport of goods and people at different times. The idea of the fundamental separation of chassis and body is based on the idea of being able to perform different transport tasks with the same chassis in the future. Standing times and empty runs are reduced by this intermodularity. Whereas today a school bus usually has a free capacity between 8 and 11 a.m., by 2030 the passenger transport module of this bus could be replaced by a freight space module and transport goods in the time that is currently free. The decisive advantage is that this would reduce the number of transport modes on the roads and cut emissions by using high-priced vehicles that are locally emission-free. MHP is actively involved as a sponsor in such a vehicle concept of the future. "Rinspeed Snap Motion" and "Rinspeed MICROSNAP" embody this intermodularity and provide further impetus for urban mobility.

The efficient use of operating resources, transport routes and other infrastructure is being driven forward based on continuously rising demand. However, the legal and political framework is also becoming increasingly important.

Vehicle concept of the future: "Rinspeed Snap Motion" und "Rinspeed MICROSNAP"



Freight module

People module

3.4 Exploring underground potentials

Heavily congested traffic routes at rush hour with bulky articulated lorries and dozens of small transport vehicles are part of everyday life in many cities and traffic junctions. As already mentioned, it is only a matter of time before this state of affairs becomes even more acute as a result of urbanization - to the point of possible gridlock. Accordingly, there is no question that the means of transport used today will be supplemented in 2040 by new alternatives for supplying businesses and private individuals. Companies are already developing and specializing in the integration of underground transport routes in the logistics sector. Among other things, platform solutions are being developed to coordinate and autonomously manage the transport of goods underground. This concept can not only be applied to industrial flows of goods between suppliers and companies, but it also offers great potential in terms of intelligently networked city logistics. Through so-called hubs at the starting and end points of important transport routes, goods, parcels and other materials such as building materials are transported by elevator into the underground infrastructure. There, unmanned conveyors are available with networked wagons or fully electric conveyor belts with transport modules. It is conceivable, for example, that the first hubs will have been established in industrial conurbations as early as 2030 in order to supply as many companies as possible and reduce transport emissions through concentrated use. If this has a value-creating effect, it is also conceivable that in the next step companies with their own hubs on the underground infrastructure will connect up with various suppliers. Decisive advantages here are the low level of disruption to the environment compared with above-ground freight transport. The probability of delayed deliveries of goods or the resulting production downtimes could be significantly reduced. In terms of environmental protection, this concept also contributes to the preservation of nature, as no new additional traffic routes such as roads need to be built.

A Swiss company specializes in precisely this logistics concept and is planning a first underground section of approximately 70 kilometers between Härkingen-Niederbipp and the outskirts of Zurich. This is to be commissioned by the year 2030. The aim is to create strategically useful intermediate hubs between this connection - primarily in industrial conurbations. If this proves to be a success and makes economic sense, it is only a matter of time before the rest of Switzerland will be able to transport goods from A to B in an underground network.

3.5 Flying warehouses and unmanned boats

In addition to underground concepts, the logistics industry is also researching alternative means of transport for air traffic. Here, too, the aim is to be able to benefit from fewer disturbing influences. The possible supply by drones is already known and can be implemented according to current technical standards. Even though the drone manufacturers are in the starting blocks, numerous legal framework parameters still need to be clarified for this logistics concept. It is conceivable that by 2025 the legal situation in some countries will allow the first material deliveries by drones in daily operations. One US company is currently conducting particularly visionary research on a concept that literally functions as a warehouse in the air. A huge airship is to serve as a central warehouse, filled with materials or packages for companies and private individuals. Using autonomous drones, the last mile to the end customer is covered directly from the airship. In keeping with this concept, the first new buildings with an integrated drone landing place are already available in Ludwigsburg.

Compared to the flying warehouse, however, it is more realistic to expect that from 2035 onwards certain material deliveries to companies and cities will be handled by autonomous ships. As part of the transport route in the inbound process of an industrial company, shipping currently shows great potential with a previously low degree of digitalization. A five-year research project, which is to be carried out jointly by the Massachusetts Institute of Technology (MIT), the Amsterdam Institute for Advanced Metropolitan Solutions (AMS), the Delft University of Technology (TUD) and Wageningen University and Research (WUR), is currently examining the options for this logistics concept. [8] In Berlin, too, the „A-Swarm“ project was launched in July 2019 by the Schiffbau-Versuchsanstalt Potsdam, the Technische Universität Berlin and the Berliner Hafen- und Lagerhausgesellschaft. [9] The aim here is also to shift the transport of goods around Berlin more to waterways and to contribute to modern city logistics by using autonomous, connectable and electrically operated water vehicles. On-demand solutions such as variable bridges in cities could also be realized by such compact autonomous boats. It is therefore quite realistic that we will see the first autonomous goods transport on the water in 2030.

Through so-called hubs at the start and endpoints of important transport routes, goods, packages, and other materials such as building materials reach by elevator into the underground infrastructure. There, unmanned conveyors are available with networked wagons or fully electric conveyor belts with transport modules.

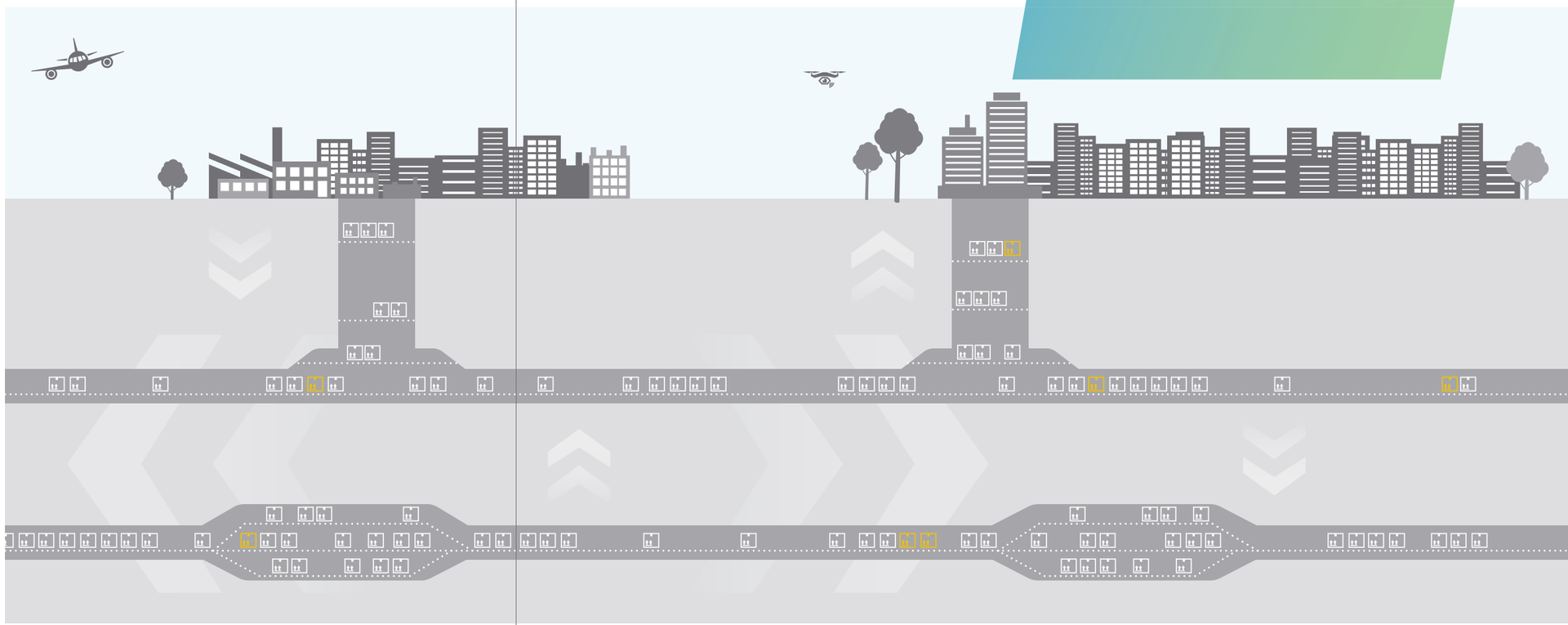


Chart no. 4: Cargo Sous Terrain Conzept [7] – Source: https://www.innofrator.com/cargo-sous-terrain-will-guetertransport-unter-die-erde-verlegen/

"Instead of rigid production processes, in future decisions will be made independently by the system during operation using algorithms."

04 Inhouse logistics

After presenting possible design scenarios for the future inbound logistics process, we will now look at vertical logistics in this section - also known as the in-house logistics of a manufacturing company. Higher working speeds, individual customer requirements and a multitude of new technical possibilities will change the industry's in-house logistics, in some cases massively, by 2040. Innovative companies will be fully networked. The exchange of information between components and departments will then be almost 100 percent autonomous. Fully automated processes such as the control of material and production will raise the question of whether there will still be professions such as shift supervisors and warehouse staff with their current range of tasks. Instead of rigid production processes, in future decisions will be made independently by the system during operation using algorithms. This algorithm-based production will replace the previously isolated solutions, as they enable more flexible, faster and more cost-effective production. In the following, we provide insights into potential logistics in-house scenarios. Current topics in the warehouse and in production are presented. In this context, MHP has gained valuable experience in numerous software implementations for warehouse management and transport management systems (e.g. SAP WM, EWM and TM) and has implemented efficient solutions for customers.

4.1 Warehousing of the future: Warehousing 4.0

Manual quality control and quantity checks of materials and their transport with pallet trucks or forklifts are a very common sight in warehouses of industrial companies today. In 2035, this will be carried out by autonomous transport vehicles on the factory premises, with the objects constantly exchanging information and identifying themselves via barcodes, RFID and active trackers. [16] Also, radio technologies such as Bluetooth, NB-IoT, UWB (ultra-wideband) or 5G are used in special areas to enable cross-warehouse communication with all logistics elements. The combination of sensor and camera-based technologies with intelligent load carriers will create the first fully autonomous, self-controlling supply chains. If one thinks this further, the load carriers could join together to form transport associations and communicate independently, position themselves, transport and - supported by artificial intelligence - also prioritize orders among themselves. There is also the chance that the existing system could be continuously optimized based on the collected data. In the field of auto identification, where RFID and active trackers are used in particular, we have established a special department in MHP that already supports almost all OEMs in this environment and can provide the appropriate IT integration.

4.2 Order picking: about 20 percent of the logistics effort

The ever shorter life cycles of products increase the number of materials required in companies. As a result, the time and effort required for storage and retrieval as well as order picking is increasing considerably and could affect competitiveness in the near future. Already today, order picking ties up about 20 percent of a company's logistical effort and represents a major cost factor. Numerous companies have recognized this and are researching new technologies - for example, a picking robot or new picking systems such as Pick-by-Watch. In addition, smart devices such as fully networked gloves with sensors as well as data glasses for scanning and checking labels are to be used across the board in the medium term and optimize this subprocess. MHP is also currently developing an innovative Pick-by-Voice system, called Voiceee. By using Natural Language Understanding (NLU), Voiceee recognizes voice commands in different languages and dialects almost without error, so that a system learning phase is no longer necessary. The goal is a commissioning that works almost without human intervention. Accordingly, due to its modular system integration, the solution can be installed at short notice and quickly connected to existing IT landscapes. Instead of high initial investment, Voiceee with a pay-per-pick approach only charges for the running costs. This opens up new possibilities for manual picking.

4.3 AGVs as the universal remedy

Today, modern companies already use driverless transport vehicles, or AGVs for short, on fixed and sometimes flexible routes. In the future, they will not only be used in modular production but also represent a flexible tool in the warehouse for the storage and retrieval of materials. Different types of AGVs, such as autonomous forklifts or towing vehicles for unit load carriers, which can be intelligently networked and integrated into a fully automatic route train, will reduce process time and increase flexibility within a company.

4.4 Smarter stocktaking

Even the manual inventory in companies, which has been widespread until now, will be replaced by drones and inventory robots by 2035. In 2015, a German company already started the test phase of an autonomous inventory robot. Using UHF RFID readers, it can scan an area of approximately 2,000 square meters in one hour with a detection rate of 99 percent. In addition to robots, autonomous drones are also suitable for carrying out inventories in warehouses. At present, this technology is about 25 percent mature and is expected to increase to about 85 percent by 2030. Numerous demo projects are currently running in companies. It is worth mentioning that inventory drones are currently only used in warehouses without employees. Nevertheless, advantages such as the simultaneous detection of two aisle sides, overnight inventory and the simultaneous use of several inventory drones in large warehouses are decisive for an establishment in 2040.

4.5 Drones as a logistic tool

Drones not only enable time and cost savings in stocktaking, but they also open up numerous other possible applications in industry. A pilot project is currently being conducted at a German metal company. In this project, samples are transported by drone from production to the laboratory at the other end of the factory premises. This saves travel time and the deployment of an employee for the transport. In addition, the drone is also attractive to manufacturing companies in other indoor and outdoor areas: for example, for package searches, the transport of time-critical parts, asset monitoring in production, fleet management or process monitoring. Statistics show that by 2018 there were already around 474,000 drones on the market - but only 19,000 of these were being used commercially. [11]

By 2030, a population of approximately 850,000 drones is predicted in Germany. The number of drones in commercial use is expected to increase to approximately 130,000. This would mean an increase of approximately 584 percent within twelve years. [12]

4.6 Algorithmic modular production

Industrial companies also have to rethink their production processes in order to meet the increasing market requirements. The first effects of the speed of digitalization are already being felt in the automotive sector, for example, and companies are facing major challenges in mastering the balancing act between innovation and day-to-day operations. Statistics in the automotive industry show that over the last 60 years, the number of units has increased by a factor of 30 and the number of variants by a factor of 50. [13] And this trend will continue in the future. Consequently, there is no doubt that as variants and quantities increase, companies will have to produce more flexibly and more cost-effectively in the future.

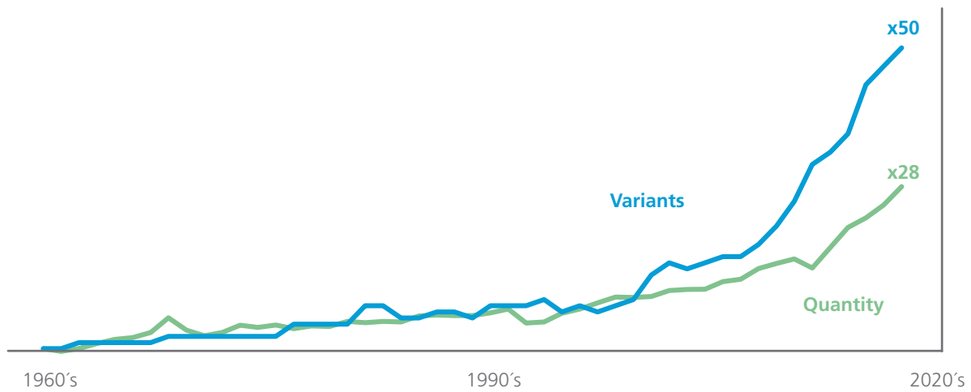


Chart no. 5 – Source: Paper 'Alternatives to assembly line production in the automotive industry'

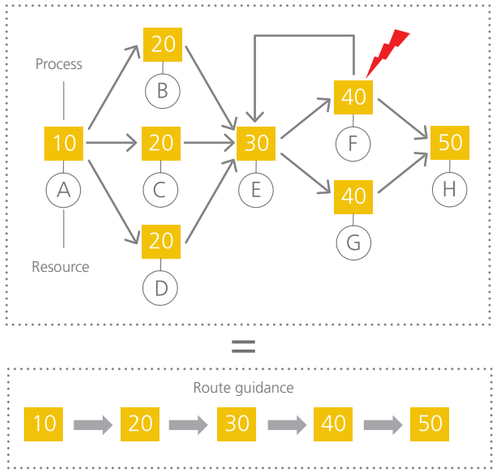
However, traditional production lines can only withstand this growth in variety for a limited time. One solution here is to switch from rigid island production to modular production. AGVs are the decisive logistical instruments here, and in 2035 they will be largely controlled by software programs and artificial intelligence. As already mentioned, the system makes intelligent decisions based on algorithms parallel to the processes taking place. This is because, in combination with the introduction of Smart Factory including [I]IoT technologies, companies are currently faced with the challenge of making complex decisions under various restrictions (e.g. the number of machines or AGVs), which, however, cannot yet be implemented in current control systems in terms of almost real-time-capable solutions (< 10 seconds reaction time). With MHP, we are working on an algorithm that can be integrated as a useful „optimizer" between production planning and operative execution on the shop floor. By linking machine data, AGVs and other shop floor reporting points, the algorithm can make an ideal short-term decision for the execution of the production program, such as loading orders into machines or assigning transport orders to AGVs. [14]

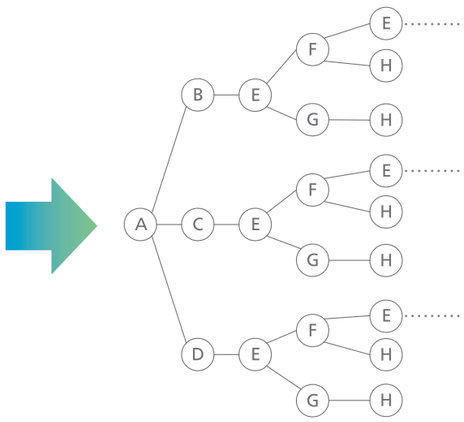
In summary, an algorithmically optimized assembly offers the following advantages:

- Savings of investments due to reduced number of stations and assembly tools
- Shortening of lead times for variants with low complexity
- Reduction of the cycle time spread

Audi recognized the advantages of modular assembly a few years ago and implemented an initial solution for this new assembly environment at its plant in Györ (Hungary) with its electric motor assembly. MHP provided consulting services for this project and integrated important system components.

Every decision increases complexity

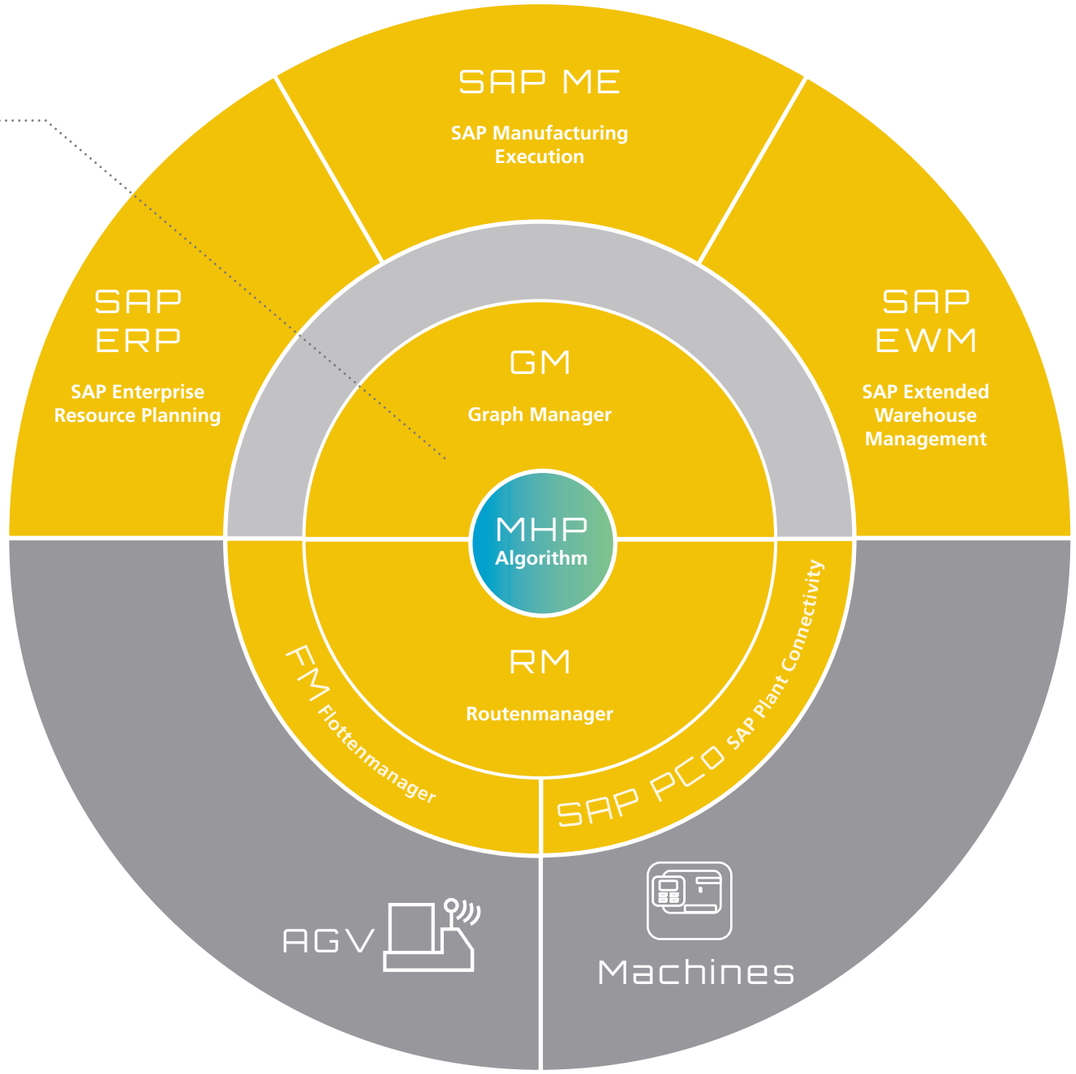




Shopfloor

"We want to become a digital car brand. The leader in digital transformation. With fully networked products from fully networked production, in which tools and machines control themselves intelligently" [15].

Prof. Dr.-Ing. Hubert Waltl,
former Board Member for Production at Audi AG



05

Outbound delivery

5.1 Location-Tracking

Analogue to the inbound process, there will be changes in means of transport and transport routes in 2040. In principle, it can be assumed that goods to the customer will be transported in the same way as materials from the vendor to the company. A considerable part of the total volume will then be transported via underground infrastructures, autonomous transport vehicles and drones - especially in large cities. [16] Significant changes will, however, occur with regard to the last mile. In the alliance between outbound logistics from the company and the future city logistics, new paths will be established with innovative logistics concepts.

5.2 Mega-City-Logistics-Hubs

In 2040, so-called mega-city-logistics-hubs will increasingly be seen on the fringes of conurbations or cities. The aim here is to bundle deliveries of goods to cities in a targeted manner and deliver them to the end customer in the city using environmentally friendly smaller transport units such as electric delivery vans and cargo bicycles or drones. In 2035, delivery to the hubs will also take place using underground infrastructure, environmentally friendly above-ground means of transport and/or autonomous ship deliveries. The city of Amsterdam is currently regarded as the pioneer in this respect. By planning a mega logistics hub on the outskirts of the city, it is laying the foundation for an optimal scenario. A 125,000 square metre logistics hub for goods deliveries to central quarters is to be built in the port of Amsterdam by mid-2021. The aim is to use the hub to reduce inner-city traffic and make deliveries as sustainable as possible. The ever-increasing urban flow of goods can thus be distributed in the city in a more controlled manner.

In 2040, so-called mega-city-logistics-hubs will increasingly be seen on the edges of conurbations and cities.

06

Summary and Outlook

Finally, it should be emphasized that although the [I]IoT transformation is a highly complex topic, it opens up enormous potential for an integrative approach.

6.1 Summary

In this white paper, we have identified approaches and ideas that are already in the first stages of implementation or will soon begin. It is visible that new technologies such as autonomous vehicles and business trends such as increasing online orders with rising volumes in parcel logistics are expected to bring major changes to the logistics industry. It is now crucial that companies set themselves initial targets for suitable development milestones. Otherwise, there is a risk of being overtaken and missing the necessary connection to technological developments.

With our comprehensive consulting portfolio and in-depth know-how, as well as our diverse project experience, we at MHP offer suitable support for the definition of the (IT) technical roadmap, including the implementation of all the topics outlined. In doing so, we can provide our customers with the best possible support in meeting the current challenges - both with our consulting and IT integration expertise on electromobility when starting to use autonomous logistics vehicles and with block chain used in the supply chain or end-to-end traceability through IoT and [I]IoT devices.

In summary, the following can be stated: Logistics will and must continue to develop until 2040 - especially in conurbations. It is important to focus on the core issues of the coming years. For us, the focus is on the development and integration of digital technologies, appropriate automation and greater use of logistics concepts aimed at greater efficiency and lower emissions.

Logistics 2040 is also a key component in the consideration of intelligent factories. Especially with regard to end-to-end processes and scenarios, logistics innovations contribute directly to the [I]IoT transformation, whereby the synergies can be generated not only on a divisional basis but also across divisions. An increase in the degree of automation, as well as efficiency and quality, underlines the necessity of the approaches.

6.2 Outlook

Detailed events of the development can only be hinted at this point. Accordingly, the present White Paper should not be regarded as a template, but rather as food for thought. In the last, five to ten years, simple and often manual activities, in particular, have been a characteristic of logistics. This is where the technological developments of the future will start and set new framework parameters. Digitally networked and fast-reacting logistics systems based on algorithms and with the help of the latest technologies will produce high-performance logistics in many areas of the industrialized countries, which have little more in common with today's processes than the actual transport of the goods.

In conclusion, it should be emphasized that although the [I]IoT transformation is a highly complex topic, it allows enormous potential for an integrative approach. Since the development cycles of software applications and innovative technologies will continue to accelerate, the management of an organization must also be approached anew. Especially the understanding of technical change and the changing tasks and roles of industry employees is becoming increasingly important.

With a clear focus on these key issues and with new technologies, resulting in optimized processes and holistic system architectures, we are quickly on the way to truly holistic, intelligent factories. We are ready for it!

07

Further Information

7.1 Authors & Contact Persons

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7.2 References

[1] https://www.iop.rwth-aachen.de/go/id/hhkc
[2] https://www.iop.rwth-aachen.de/go/id/hhkc
[3] https://de.statista.com/stattik/daten/studie/154829/umfragesendungsmenge-von-paket-und-kurierdiensten-in-deutschland/
[4] https://de.statista.com/statistik/daten/studie/205940/umfrage/prognose-zum-transportaufkommen-im-strassenverkehr-in-deutschland/
[5] https://sharepoint.mymhp.net/mi/blog/Lists/Posts/Post.aspx?List=1be87d6f%2D6325%2D4909%2D8ee8%2D6f60973b39da&ID=3&Web=dc5d7d22%2Dc028%2D4ee5%2Dadce%2D478d5bf3c273
[6] https://www.rinspeed.eu/de/microSNAP_50_concept-car.html
[7] https://www.innofrator.com/cargo-sous-terrain-will-guetertransport-unter-die-erde-verlegen/
[8] https://www.wiwo.de/technologie/green/autonom-auf-dem-wasser-amsterdam-testet-selbstfahrende-boote/14882480.html
[9] https://www.verkehrsrundschau.de/nachrichten/autonome-boote-sollen-auf-der-spree-erprobt-werden-2464477.html?utm_source=Newsletter&utm_medium=Newsletter-VR&utm_campaign=Newsletter-regular
[10] https://www.mhp.com/de/innovation/innovation-blog/post/2019/08/28/pick-by-mhp/
[11] https://de.statista.com/statistik/daten/studie/972524/umfrageanzahl-der-drohnen-in-deutschland-nach-verwendungszweck/
[12] https://de.statista.com/statistik/daten/studie/972642/umfrage/bestand-an-privat-und-kommerziell-genutzten-drohnen-in-deutschland/
[13] Grafic from the MHP DeepDive: Algorithmische Produktion auf Basis von FTF
[14] Grafic MHP Algorithmus
[15] https://logistik-aktuell.com/2017/03/09/modulare-fertigung-bei-audi/
[16] http://www.logistikweisen.de/wAssets/docs/Logistikweisen-Ergebnisse-zum-Logistikjahr-2019.pdf2

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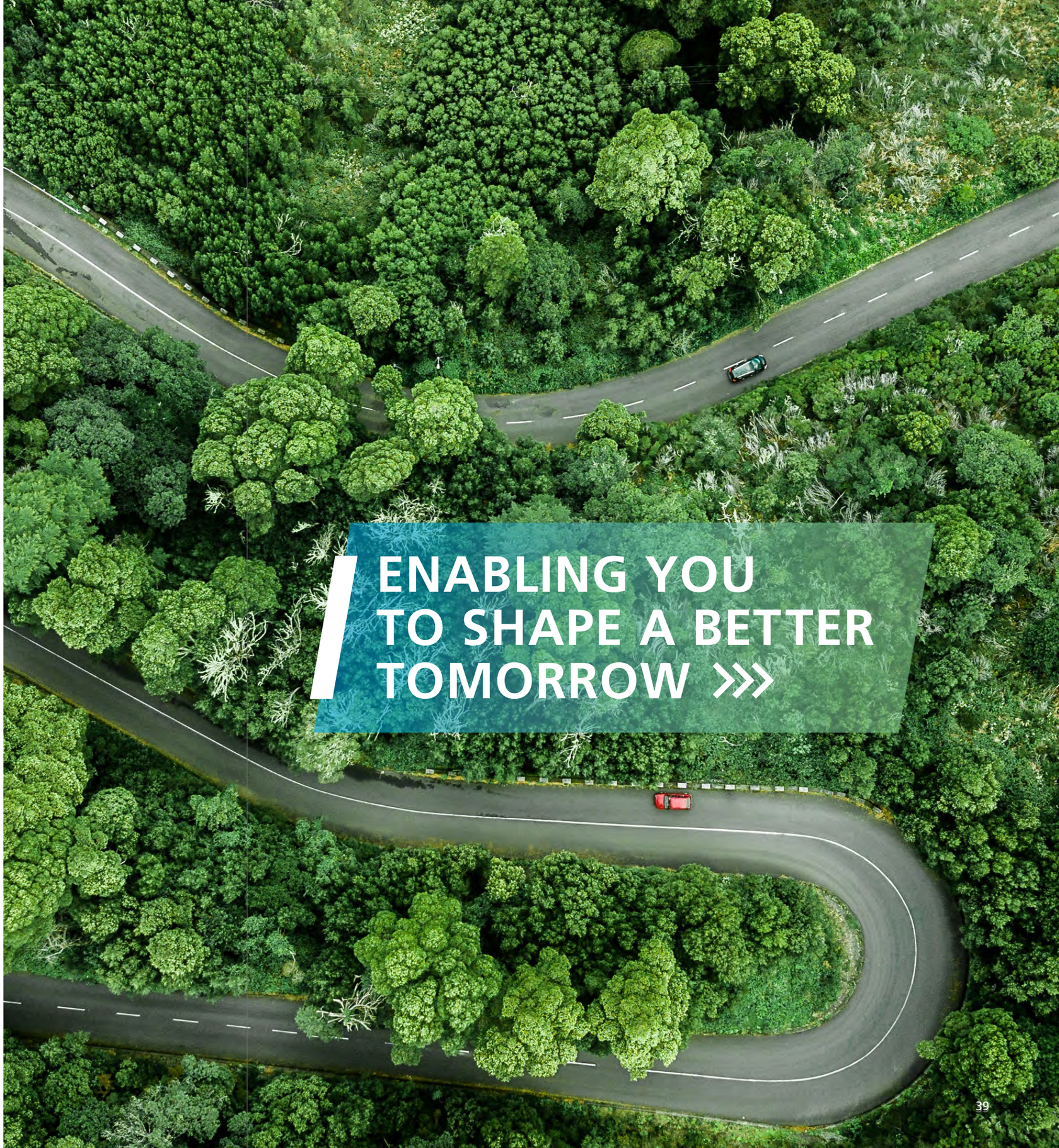

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