

## 4 FUTURE VISION

Throughout this report, we have seen many important improvements in robotics technology, along with clear evidence that robots are now starting to enter the world of logistics. In the preceding chapter, we explored the innovative new technologies that, with further development, could soon be ready for full-scale testing. So looking ahead, in this chapter we consider what will happen when these latest technologies mature and become widely available. The following is one possible snapshot of our future.

### 4.1 Distribution Centers

Compared with the distribution centers of today, the robotic warehouses of our future are likely to improve in almost every metric. These highly scalable facilities will be more flexible and faster to relocate; they will achieve higher productivity with increased quality.

New operations will incorporate different types of robot each with a specific job to perform such as unloading trucks, co-packing, picking orders, checking inventory, or shipping goods. Most of these robots will be mobile and self-contained but they will be coordinated through advanced warehouse management systems and equipped with planning software to track inventory movements and progress orders with a high degree of accuracy.

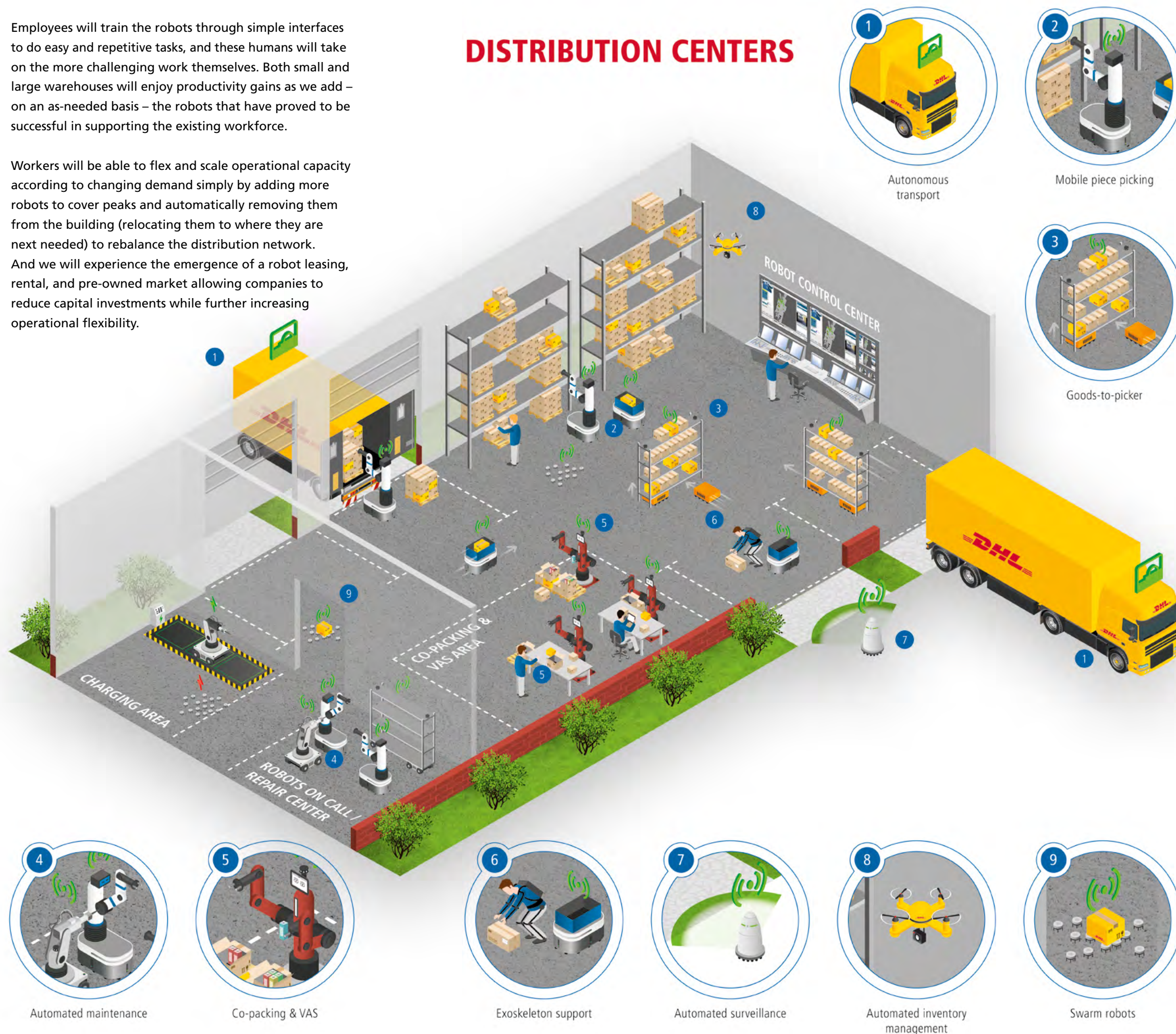
Overall reliability will increase because there will be fewer 'single points of failure' in each distribution center. As each robot acts as an individual unit, we will be able to quickly push it to the side if it breaks down and replace it with another unit from the robot fleet. Depending on the problem, we will be able to fix the broken robot on site or send it to a central repair facility. The new robot will be connected to the cloud so it will automatically download the knowledge needed to take over from its decommissioned counterpart.

Warehouse workers will be given more responsibility and higher-level tasks such as managing operations, coordinating flows, fixing robots, and handling exceptions or difficult orders. They will wear exoskeletons to help them lift heavy goods with less strain, fatigue, and chance of injury. When necessary, we will bring goods into a co-packing area where collaborative robots will work safely alongside highly skilled warehouse employees to transform basic products into new items customized for individual orders.

Employees will train the robots through simple interfaces to do easy and repetitive tasks, and these humans will take on the more challenging work themselves. Both small and large warehouses will enjoy productivity gains as we add – on an as-needed basis – the robots that have proved to be successful in supporting the existing workforce.

Workers will be able to flex and scale operational capacity according to changing demand simply by adding more robots to cover peaks and automatically removing them from the building (relocating them to where they are next needed) to rebalance the distribution network. And we will experience the emergence of a robot leasing, rental, and pre-owned market allowing companies to reduce capital investments while further increasing operational flexibility.

## DISTRIBUTION CENTERS





## 4.2 Sorting Centers

Unlike today, the sorting centers of the future will run continuously, 24 hours per day, to better align with the distribution centers that will also operate around the clock. Robotic warehouses and sorting centers will be just as effective on the last shift as they are on the first shift. Working in waves, the new supply chain will facilitate multiple shipments to end customers each day. By fully utilizing equipment across shifts, we will be able to lower logistics costs and, by processing multiple daily delivery waves, we will achieve faster service to end customers. Goods will be brought to the sorting center by self-driving trucks. These will arrive according to specific scheduled timeslots, and we will be able to efficiently control truck movements onto and around the yard using GPS and a yard management system.

When a truck arrives at the dock door, robots will unload it and sort the parcels according to final destinations. There are several possible approaches to accomplish this. For example, we could think of using a large number of mobile robots to transport the parcels from inbound dock doors to the appropriate loading areas. Each mobile robot would be loaded with parcels by a robotic arm; it would then group and sequence itself with other mobile robots to efficiently transport loads throughout the sorting center. When a truck arrives with dangerous goods, these will be automatically sorted, handled, and transported separately and securely. All of these tasks will be supervised by employees working in a robot-control center; these humans will address any issues, manage workflows, and make key operational decisions. Employees will also handle any exception parcels such as items that require repacking, relabeling, or a customs check.

When leaving the sorting center, most parcels will be loaded by robotic arms into line haul trucks which take them to the next sorting center in the network. Some items will be loaded into drones for airborne delivery to hard-to-reach addresses. Local delivery items will be loaded into mobile parcel robots which take them to individual homes in the surrounding area. And if the recipient is a high-priority customer, they will be able to send their personal self-driving vehicle to the sorting center; they can continue with their busy day elsewhere while their parcel is placed automatically into the trunk. It's clear to see that the advantages of these futuristic sorting centers – speed, flexibility, higher productivity, and more – will translate into better service for end customers, achieving faster delivery at a lower cost.

## SORTING CENTERS





4.3 Last-Mile Delivery

In future, the general public will interface with robots on a daily basis. We won't fear for our physical safety because these robots will avoid bumping into us using advanced sensors such as cameras, laser scanners, and proximity sensing skin. Using cloud computing techniques, these robots will provide high-quality customer service; they will be able to speak our language, react to our emotions, and access appropriate account information to ensure successful interaction. The first robots that we are likely to encounter are the ones at local parcel service centers. Here, a robot assistant may help us to ship a present to an old friend.

Another everyday occurrence could be the receipt of an email informing us that there's a small package for collection at a mobile parcel locker located outside a nearby store. How did it get there? Early each morning these lockers will be swapped out by self-driving trucks for lockers holding new parcels which have been preloaded the evening before by robots at the local sorting center.

What about larger items? They will still be delivered to our homes by human employees, but they will be using exoskeletons to safely lift heavy weights. They may be assisted by mobile robots carrying several items and following behind the human along their route. If you live in a large apartment building, a small mobile delivery robot may automatically take the elevator to your floor and, once outside your front door, call your mobile phone. You will simply open your door and enter a code into the robot; this allows a compartment to open, and you will be able to access your parcel. If you live in a remote area, a drone may message you from your driveway and require a similar access code procedure. In both cases, you will be able to preplan the delivery time to fit your daily schedule since this single parcel delivery vehicle will be sent only to you.

What if you are not home? Your own personal robot will be able to open the front door to accept the parcel on your behalf. It's more than likely that our homes, cars, and personal robots will all work together in the future, ensuring we always receive our deliveries safely and on time!

LAST-MILE DELIVERY



Automated door-to-door shipments



Service robot



Follow me vehicle



Exoskeleton support



Automated aerial delivery



Pick up robot



Automated sorting



Mobile parcel station



Trunk delivery



2-man-handling



Parcel box loading and unloading