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# The Warehouse of the Future

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**Abstract:**

From flying drones to robots to pick, pack, and sort items without human intervention, technology and innovation will dramatically impact the warehouses of the future. In another decade, we may see fully automated warehouses. In this article, we will find solutions to several problems in the process of organizing warehouses of the future.

**Keywords:** Warehouse, filling, system, logistics, operation, cargo flow, transport, cargo, product, cargo order, pricing, security, innovation, technology, technique.

## Introduction

When I set out to write the first edition of this book I didn't think I'd be following it up with a second edition so quickly. The continuing challenges faced by companies including omnichannel retailing, significant reductions in order lead times, and environmental and staffing pressures have suppliers, users, and academics looking at ways to overcome these challenges. New technology is continually being introduced and, as Mark Strand says, the future is now in many respects. Concepts such as fully automated warehouses, carbon-neutral buildings, hybrid trucks, robotics, voice operations, and optically guided picking are all in their various stages of development.

What of the warehouse of the future? One revolutionary product or process is 3D printing – what effect will this have on the warehouse of the future? This section will look at the likely role of the warehouse in the supply chain in the future, what it might look like, and the new technology which will potentially have a significant effect on warehouses in the future.

## Context

First, we need to put things into context and be aware that warehousing in the future will be affected by many factors, such as:

- Globally we have a growing but ageing population. This means that land will be at a premium but also there are likely to be labor shortages in key areas, which suggests a potential growth in automation but also the need for elder-friendly workplaces.
- The growing economies of not only the BRICS countries (Brazil, Russia, India, China, and South Africa) but also those of the developing world where consumerism and the growth of the internet will put even greater pressure on consumer product manufacturers and their warehouses. Consumer awareness and demand for new products and services will continue to increase.
- As economies grow and the population gets older there will be greater competition for staff. Warehousing has not been a career of choice for many people because of its image according to a recent PWC report (2012) and companies are going to have to market themselves better to become more attractive to today's youth.

- Sustainability will play a significant role in supply chain operations in the future. The green lobby will look to the supply chain for initiatives in terms of alternative energy use, reduction in CO2 emissions, reduction in waste, reduction in water usage, and the use of alternative forms of transport. This will include intermodal transport initiatives as well as fuel-efficient MHE. Consumers and retailers will also be encouraged to source local products, leading to an increase in demand for neighborhood warehouses.
- Fuel and energy costs will continue to rise as fossil fuels continue to decline. Companies will look to warehouse automation and the use of greener vehicles whilst developers and warehouse operators will be encouraged to consider solar panels, wind turbines, and the use of waste products for energy production.
- The potential introduction of government taxation initiatives to encourage companies to reduce their impact on the environment.
- An increasing pressure on companies to collaborate and share resources. Many warehouses and, for that matter, transport modes are underutilized, so pressure from the green lobby and also continued pressure to further reduce costs will encourage companies to collaborate.
- Technology will continue to improve, evolve and become more affordable. As has been proven time and again, the next big idea is likely to be just around the corner.

Generation, The post-90s generation has entered the market, as both consumers and employees. Having grown up using e-mail, social networking, and communications technology such as mobile/smart phones, MP3 players, laptops/tablets, and game consoles, they have never known a world without them. Adept at switching between multiple platforms, formats, and devices, they expect to utilize the technology they are familiar with in the work environment, accelerating the prevalence of Bring Your Device (BYOD) in industries heavily reliant on the timely transfer of data, such as logistics.

**Views of the future: the landscape**

Capgemini (2010), writing about the supply chain, see the characteristics of the 2016 future supply chain as follows:

- The future model will be based on multi-partner information sharing amongst key stakeholders: consumers (the originators of the demand signal, either from home or from a store), suppliers, manufacturers, logistics service providers, and retailers.
- Once produced, products will be shipped to collaborative warehouses in which multiple manufacturers store their products. Collaborative transport from the collaborative warehouse will deliver to city hubs and regional consolidation centers.
- Warehouse locations on the edge of cities will be reshaped to function as hubs where cross-docking will take place for final distribution. Non-urban areas will have regional consolidation centers in which products will be cross-docked for final distribution.
- Final distribution to stores, pick-up points, and homes in urban and non-urban areas will take place via consolidated deliveries using efficient assets.

As we can see from Figures 17.1 and 17.2, warehouses will remain a vital cog in the supply chain, becoming consolidation centers, regional hubs, and shared-use facilities for a variety of manufacturers and products.

Although there are many shared-user operations currently in place, including retail consolidation centers, Capgemini's vision of collaborative warehousing takes it to another level.

They see the key point being that both retailers and manufacturers collaborate even more closely by extending the consolidation center premise to cover multiple retailers, thus ensuring greater warehouse utilization and full truckload deliveries in all directions. This is borne out by recent surveys such as those by Kewill, Savills, and others who cite collaboration and shared user warehouses as being one of the future solutions for cost reduction and the shortage of labor.

To succeed, this concept will require high levels of trust and commitment among manufacturers, retailers, and logistics service providers, but This is likely to be one of the main stumbling blocks and it will require third-party logistics companies to play a greater role by being more proactive and brokering agreements between all three parties and also taking some of the risk.

**Views of the future: the warehouse**

What of the warehouse itself?

I'm certain that those of us who grew up in the sixties and seventies would not have predicted that mobile phones and computers, although I use the terms loosely in this context, would have had the impact on communications that they have today. Nor that such powerful devices could be packaged into such small units.

The other phenomenon has been the internet and the effect it has on the way we do business today. This leads me to the role of the warehouse in the future.

Some would argue that there won't be a requirement for stocked warehouses as companies will manage their supply chains so well that cross-docking or transshipment will be the norm and therefore warehouses will become transit sheds, parcel, and pallet hubs.

Secondly, with the growth in e-retailing, there will be more fulfillment and returns centers as opposed to warehouses. In addition, with the increase in fuel costs, there may be an argument for production becoming more localized, and therefore warehouses will become an extension of the production plant once again. This should lead to a more just-in-time method of order fulfillment.

For those of us who subscribe to the view that warehouses will still exist some time into the future, what function will they perform and what will they look like?

The current trend seems to be towards greater centralization of warehousing, with retailers building bigger sheds with more automation, replacing smaller regional centers.

Others argue that the rising cost of fuel and customer demand for shorter lead times will result in a greater number of local warehouses.

These centers will act as replenishment centers for stores, and continued growth in e-retailing will increase home delivery significantly. On this point, orders to the warehouse will grow appreciably but the number of lines and items per order will be small. Thus where individual items are ordered by consumers over the internet there will be a greater need for technological solutions and quicker, more accurate methods of order picking and despatch.

Automation will play a big part in the warehouse of the future and we will likely have many types of robots crisscrossing the floor, collecting and depositing pallets, cartons, and totes wherever they are needed, with very few humans in sight.

Conveyors will abound and robots will move both horizontally and vertically, making full use of the cube of the warehouse. Radiofrequency sensors will be placed strategically throughout the

warehouse to ensure that there aren't any breaks in transmission and to guide the various automated equipment.

We humans will no doubt still be involved in some capacity but mainly as IT and equipment service engineers. Skilled pickers will still have a place on the warehouse floor where goods-to-picker systems will continue to play their part. Staff will also be required for various value-added tasks such as re-packing, gimballing, and kitting.

For this to work efficiently, everything will need to be uniform. Pallets will need to be the same size – no combinations of UK, US, euro, or print pallets, for example. Cartons will also need to be standardized. Alternatively, goods will be moved in plastic, returnable and recyclable totes.

As for the building itself, it is likely to be built with sustainability in mind.

The warehouses will operate 24 hours per day. From an environmental standpoint, the warehouse roofs will have solar panels and the yards will be full of wind turbines, not only to run the warehouse but also to produce energy to recharge the electric vehicles which make the deliveries. The equipment will be regenerative and all operations will benefit from energy-efficient lighting and heating.

The majority of warehouses are likely to be high bay (at least 12-meter eaves according to the BNP Paribas report) with some lower height warehouses or sections of warehouses to act as cross-docking operations. The continued growth in third-party logistics and shared-user warehousing is also likely to see larger warehouses with the potential for sub-division.

The increase in product lines could also see greater use of mezzanine floors. As for location, port-centric logistics is increasing in popularity together with the increased use of rail transportation which suggests coastal locations or those linked by inland waterways and rail.

Finally, there will be a requirement for greater flexibility with shorter lease terms. The following are potential scenarios for the future of warehousing. Scenario one looks at the use of technology to its utmost whilst Scenario two suggests that we humans will continue to play a significant role in warehouse operations.

***Scenario one***

As a vehicle arrives on site its RFID tag will be read and the vehicle guided to the relevant loading bay. On reaching the bay its roller shutter door will open, as will the loading bay door, and the rails within the trailer will connect to rails within the warehouse. The conveyor will be activated and the pallets will be unloaded. Each pallet will move through a portal where each pallet and item tag will be read and the data sent directly to the WMS. An AGV will take the pallet to its relevant location, be it the despatch bay for cross-docking or into deep storage. If the products are destined for the pick section they will be de-layered robotically and each layer of product placed into a tote for onward delivery to the mini-load AS/RS storage area. Suppliers will be informed of any discrepancies and their payments adjusted accordingly.

The system will control all of the movements within the warehouse with no requirement to print pick lists, communicate with PDAs or send voice instructions to us humans. The paperless warehouse should become a reality (unlike the paperless office which has been much heralded but never achieved). All items are RFID tagged and are tracked throughout the warehouse. Once an order is received the mini-load system will send the tote containing the product(s) to a pick station and a robot with suction pads will read the RFID chip or compare its image with that of the order, pick up the item and place it into another tote or carton for despatch. This task may be done by a human if the robot's dexterity is called into question.

The tote will be placed on a conveyor, a lid fitted together with a destination label and it will be loaded onto a waiting vehicle.

The problem will be how to manage complexity. The requirement for individual items to be picked from cartons will continue to pose problems for a fully automated warehouse. The growth of internet shopping and orders for individual items will continue to pose challenges to warehouse operators, so human intervention will still be a fundamental requirement. Robot dexterity may be improved but this could be at the risk of slowing down the operation as a whole. It may be that robots, conveyors, and AGVs will bring the products to the operator but the actual act of picking and packing could well remain with the operator.

***Scenario two***

There is an argument that people will continue to be used for specific operations within the warehouse. For example, people are currently able to pick individual items faster and more cost-effectively than a fully automated system. The following is an example of how the present and the future are coming together with most of this technology in place individually but not yet combined into a single operation.

This is a concept system called Aria put forward by LXE, a leading manufacturer of mobile computers. We have also incorporated Jungheinrich's RFID warehouse navigation system. The concept covers both inbound and outbound operations and is heavily reliant on the introduction of RFID technology. The arrival of the delivery at the security gate triggers a message to the warehouse operator from the WMS via their headset, which is attached to a mobile computer worn on their arm, belt, or installed on their lift truck, to 'Go to dock door 34. The door opens and the RFID reader on the lift truck automatically reads the RFID transponders in the floor and takes the truck and driver to the correct location. A tag on the dock door confirms that they are at the correct location. The RFID reader then automatically reads the pallet tag which contains a unique EPC code associated with the pallet and the shipper. The WMS retrieves the electronic ASN referenced by the RFID tag. Based on the ASN data, the WMS issues any QC instructions (damage checks, case counts, etc) to the operator via either the mobile computer screen or headset.

After the operator validates that any QC tasks are complete, the WMS does an auto-receive of the pallet. The WMS then tells the operator via voice to take the pallet to aisle 07 and deposit it at the pick-and-drop location. This repetitive movement can be replaced by an AGV. A message is sent to the very narrow aisle truck operator that there is a pallet awaiting put-away. The RFID reader on the truck follows a particular path set out by the WMS to arrive at the correct location. Upon arriving at the pick and drop point in aisle 07 the RFID reader on the operator's truck auto-confirms the operator's location by reading an RFID tag embedded in the rack.

When the pallet is deposited in the location, the RFID reader notifies the WMS that the task has been completed correctly. The WMS completes the transaction and updates the inventory location record.

Once completed, a further message is sent to the operator to retrieve a pallet from aisle 07 location 0105, and take it to pick location 012101. A member of the picking team receives a message via their headset to go to pick location 012101.

A laser-guided truck is despatched from the outbound bay, having collected an empty pallet, to meet the picker at location 012101. On arrival at location 012101, the RFID reader on the operator's arm and the truck auto-confirms the truck and operator's location by reading an RFID tag embedded in the floor or on the rack.

The operator is instructed to pick three cases. The warehouse operator then places three boxes on the pallet. The RFID system confirms that the correct product has been picked in the correct quantity. If the wrong product or quantity is picked, the system immediately communicates appropriate corrective action at the pick location where the problem can be resolved with minimal disruption and expense.

The picker and the truck continue to the remaining locations on the pick list. Once completed, the truck departs for the despatch bay while the picker awaits the next instruction.

The advantages of such a system include the following:

- high levels of accuracy;
- driving to the wrong location is eliminated;
- reduction in order-picking mistakes;
- greater operator comfort;
- less stress for the driver;
- up to 25 percent higher pick rate;
- higher order-picking quality;
- distance and time optimization;
- saves energy;
- distance optimization means energy optimization; and
- reduction in lighting within aisles is possible ('pick by light on the truck').

**Other advances**

Technology that is just around the corner includes Knapp's optically guided picking system. The picker wears a camera and is guided by the system to each required pick location using superimposed arrow symbols directly in the field of vision of the operator via a head-mounted display. There is a countdown in terms of the meters left to travel. At the pick location, the goods to be picked are identified for the picker and the camera reads barcodes, lot numbers, and serial numbers to confirm the pick without any further human intervention. A digital display will show the number of items to be picked.

Once established, it is thought that the system will prove even more accurate than voice, and the head-mounted equipment will be the same weight and design as a normal pair of glasses.

As with voice-directed picking, training is quick and allows operators to keep both hands free for the picking.

One other piece of technology I want to share with you is 3D printing or additive manufacturing.

3D Printing was originally developed as an automated method of producing prototypes. Although there are several competing technologies, most work is based on building up layers of material (sometimes plastic, ceramics, or even metal powders) using a computer-aided design. Hence, it is referred to as an 'additive' process; each layer is 'printed' until a three-dimensional product is created.

A report by Transport Intelligence suggests that 3D printing 'is already very good at producing products (even with moving parts) which previously would have required the assembly of multiple

components', and that by 'eliminating the assembly phase there will be huge savings for the manufacturer in terms of labor costs'. 3D printing-based production could also reduce or eliminate storage, handling, and distribution costs.

People will be able to print a required item at home providing they have the scanned image or the blueprints of the product itself. The report goes on to say that 'A major new sector of the logistics industry will emerge dealing with the storage and movement of the raw materials which "feed" the 3D printers. As 3D printers become more affordable to the general public, the home delivery market of these materials will increase.'

Global and national parts warehouses as well as forward stock locations will become unnecessary. At present billions are spent on holding stock to supply parts to products as diverse as cars and x-ray machines. In some cases, a huge amount of redundancy is built into supply chains to enable parts to be dispatched in a very short timescale to get machines up and running again as fast as possible.

The Service Parts Logistics industry will be either transformed or decimated by 3D manufacturing – or perhaps both! With small 3D Printing machines available, operations in remote locations – or even in an engineer's van – will only need electronic libraries of designs available to them on a local computer. They can then call up the design of the spare part required and immediately print it. Obsolete parts could simply be scanned in 3D, fixed in the computer's memory and the new part printed. The implications for inventory are clear.

**Summary and conclusion**

Warehouses in highly developed countries will no doubt adopt the latest technology, and companies whose products can absorb the high initial capital investment will be at the forefront of warehouse automation.386 Warehouse Management However, as discussed previously, automation is not for everyone, and warehouses will continue to hold stock and employ staff to receive, put away, pick, and despatch products.

It is hoped that this book has given you, the reader, an insight into warehouse operations in the 21st century. Although investment in technology will improve and speed up operations, changes in processes, attitudes and improved communication both internally and externally are the stepping stones. These need to be firmly in place and cannot be bypassed under any circumstances before any thoughts of automation.

The growth in e-commerce will continue to challenge warehouse managers globally and the change in profile from full-carton and full-pallet picks to individual-item picks will have equipment manufacturers seeking the holy grail of pick systems. Whatever that may be. One thing is certain: we cannot afford to stand still. US Rear Admiral Grace Hopper (1906–92) once said, 'The most damaging phrase in the language is: "It's always been done that way."'

This is a statement I have heard many times in my career and therefore I hope this book has given you some new ideas to think about hopefully you will be able to implement them and they will help you improve efficiency and minimize costs.

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