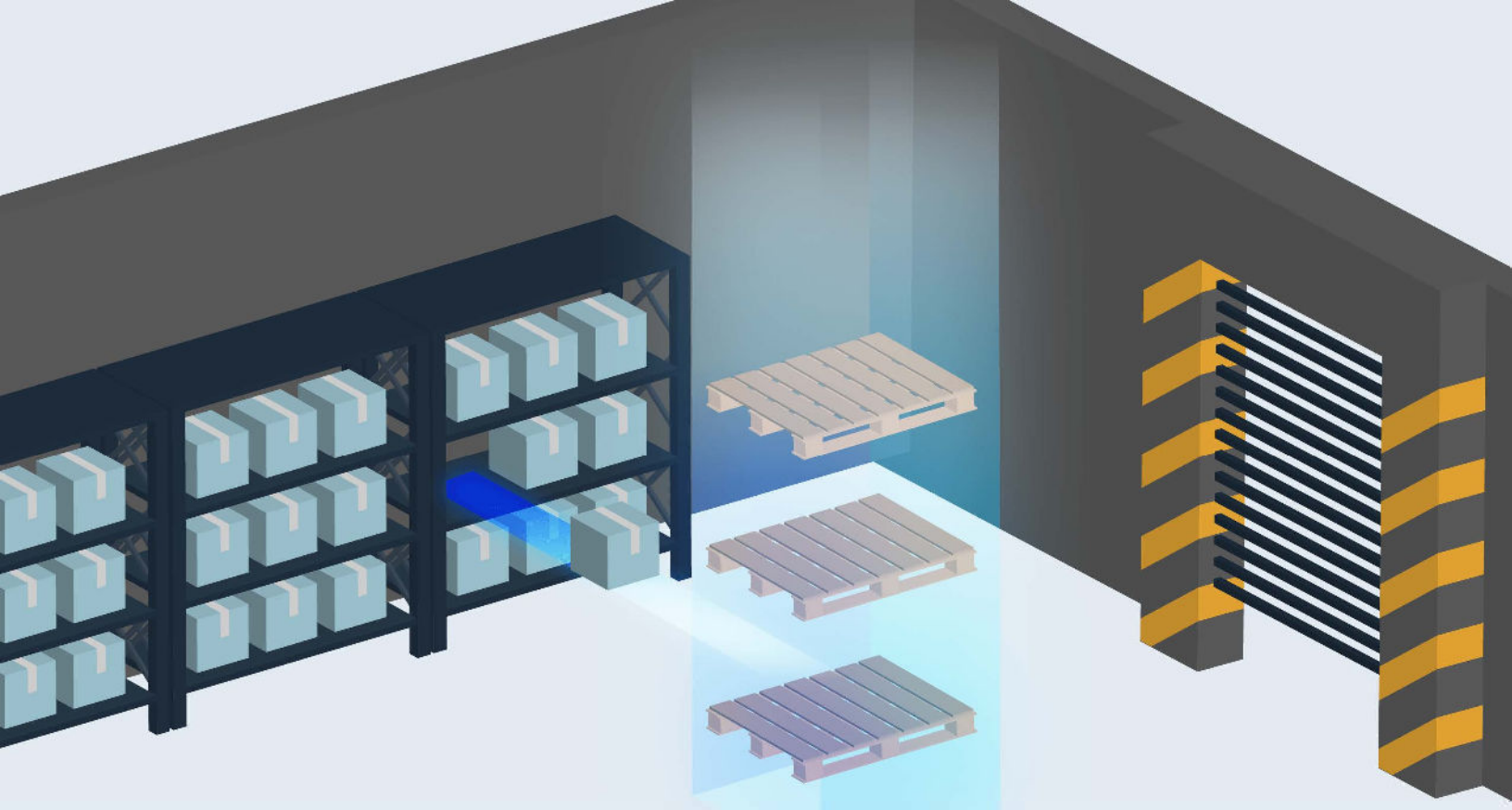
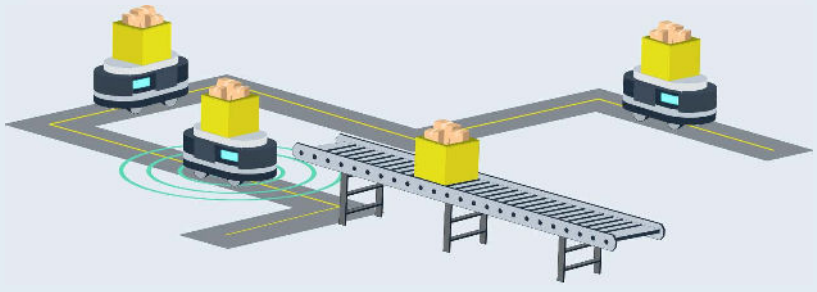


PLAN YOUR NEXT MOVE BY C3

HANDBOOK

Solving for Retail



BY C3 Solutions

In this handbook we will review the 5 major technologies that have been re-shaping the Retail Industry.

Along with better Yard and Dock Management, we will be discussing how you can use the following technologies in your efforts to create a more efficient, effective and sustainable supply chain for your organization.

- ✓ Machine Learning Analytics
- ✓ Retail Distribution Center Automation
- ✓ The Emergence of 5G
- ✓ The 3 Warehouse System Softwares
- ✓ Benefiting from IoT Data

A constantly evolving Supply Chain means that your operations need to evolve as well.

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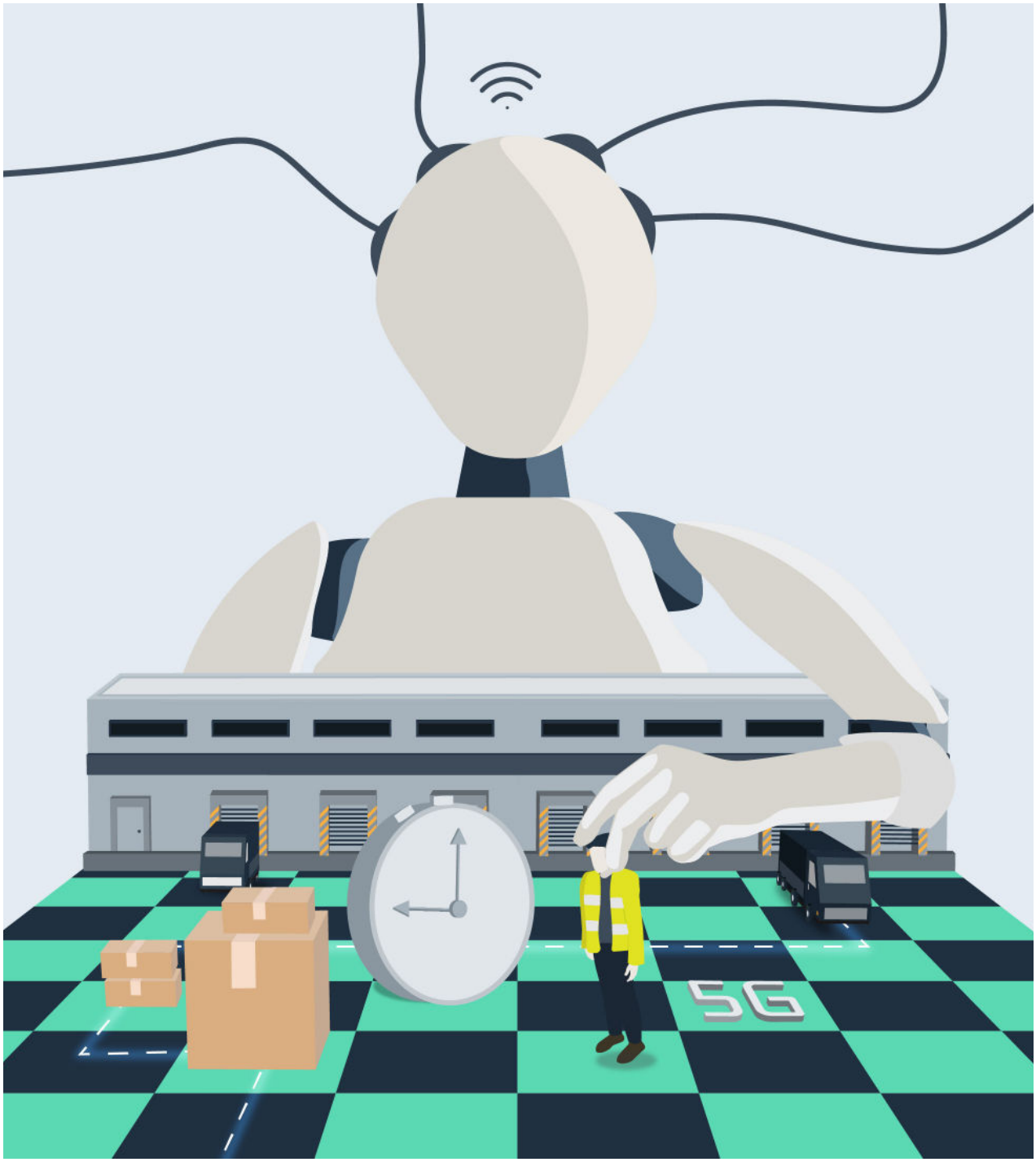
PLAN YOUR NEXT MOVE

BY C3

Artificial Intelligence

Making Machine Learning Analytics Work for Your Retail Operation



SOLVING FOR RETAIL

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> If you aren't thinking five moves ahead in today's high-stakes game of retail chess, you'll find your business outmaneuvered and backed into a corner. The key to winning this game is being able to decide on the right technologies to leverage in the fight.

Just as a chess master must choose whether to zig and zag like a knight or make a laser-straight run with a bishop to outsmart the opponent, selecting the right tool to optimize retail operations will depend on a lot of factors. In this paper, we will look at the various challenges facing retail today and then focus in on a technology that many are choosing as a solution.

This time we'll be considering artificial intelligence (AI) as a promising new tool to solve retail challenges and drive bottom-line results. Although it's been around for a while, AI is just now coming into its own as a supply chain tool. As you'll read below, it's got tremendous promise as a means to streamline operations by improving processes like routing and by making autonomous driving possible.

Once those technologies become the norm, you will be challenged to keep up without modernized practices. That's why we at C3 Solutions want to share what we've learned about AI and how it fits in the retail supply chain.

One of the ways we see future success is through the proper application of technology like automated yard and dock management. Once those automated trucks start rolling, being able to seamlessly manage operations at the dock doors will be an even more critical function than it is now.

We hope you find this exploration of AI interesting and helpful as you plan for the continued and future success of your retail operation.

Challenges

Did you know that delivering 25 parcels by road could offer **15 septillion** possible route options?[1]

Home deliveries seemed like a simple process – send the truck out, let the GPS guide the driver and a few hours later everything's delivered.

But with parcel deliveries topping 87 billion in 2018[2], and 2,760 shipped every second of every day, that's a lot of permutations and calculations being made around the world to get them to their final destinations. Even 15 years ago we did not have the computing power or capability to crunch numbers on this scale.

All this activity is being driven by e-commerce and customers' increasing demand for fast-as-possible deliveries. Known as the "**Amazon effect**", thanks to the e-commerce giant's ability to fulfill orders quickly and accurately and the resulting inflation of customer expectations, **it has fundamentally shifted the retail marketplace from one where price was a differentiator, to one where delivery speed makes the sale.**

Alongside Amazon's dominance, the technology in customers' hands also plays a huge role.

> On Cyber Monday in 2018,
>
> **54%** of shoppers were using mobile devices
>
> **30%** of actual purchases were completed by mobile
>
> **netting**
>
> **US$ 7.9 billion**
>
> **in revenue for online retailers.[3]**

The growing penetration of mobile into retail means customers are perpetually ready to shop, very well informed, and are able to make purchasing decisions on the fly. **Retailers are now challenged to keep up with that trend and make sure they can stay one step ahead of the always-on customer.**

On the operations side, the need for speed creates multiple challenges. It means traditional suppliers are being forced to step into the last-mile delivery game, turning themselves into retail omnichannel operations. It means a greater emphasis on flexibility and gaining the ability to adapt to changes in demand. It means having to implement stronger returns and reverse logistics practices. It means having a pinpoint-accurate inventory control system and demand planning in place to prevent **stockouts, which in the world of e-commerce almost always means a lost sale.**

Failure to meet these challenges has disastrous consequences, as the staggering number of retail bankruptcies and closures in the past few years demonstrates.

> In 2019, the third week in September, 8,500 stores were closed in the United States alone, and a forecast suggested 12,000 might be the final tally by the end of the year.[4]

That represents those shuttered due to bankruptcies and downsizing.
But at the same time, the U.S. retail industry is expected to report growth in the range of 3.8 percent to 4.4 percent by the end of 2019, thanks largely to e-commerce.[5]

Clearly retailers need a new way to understand and execute business processes if they are going to survive and thrive.

What is AI ?

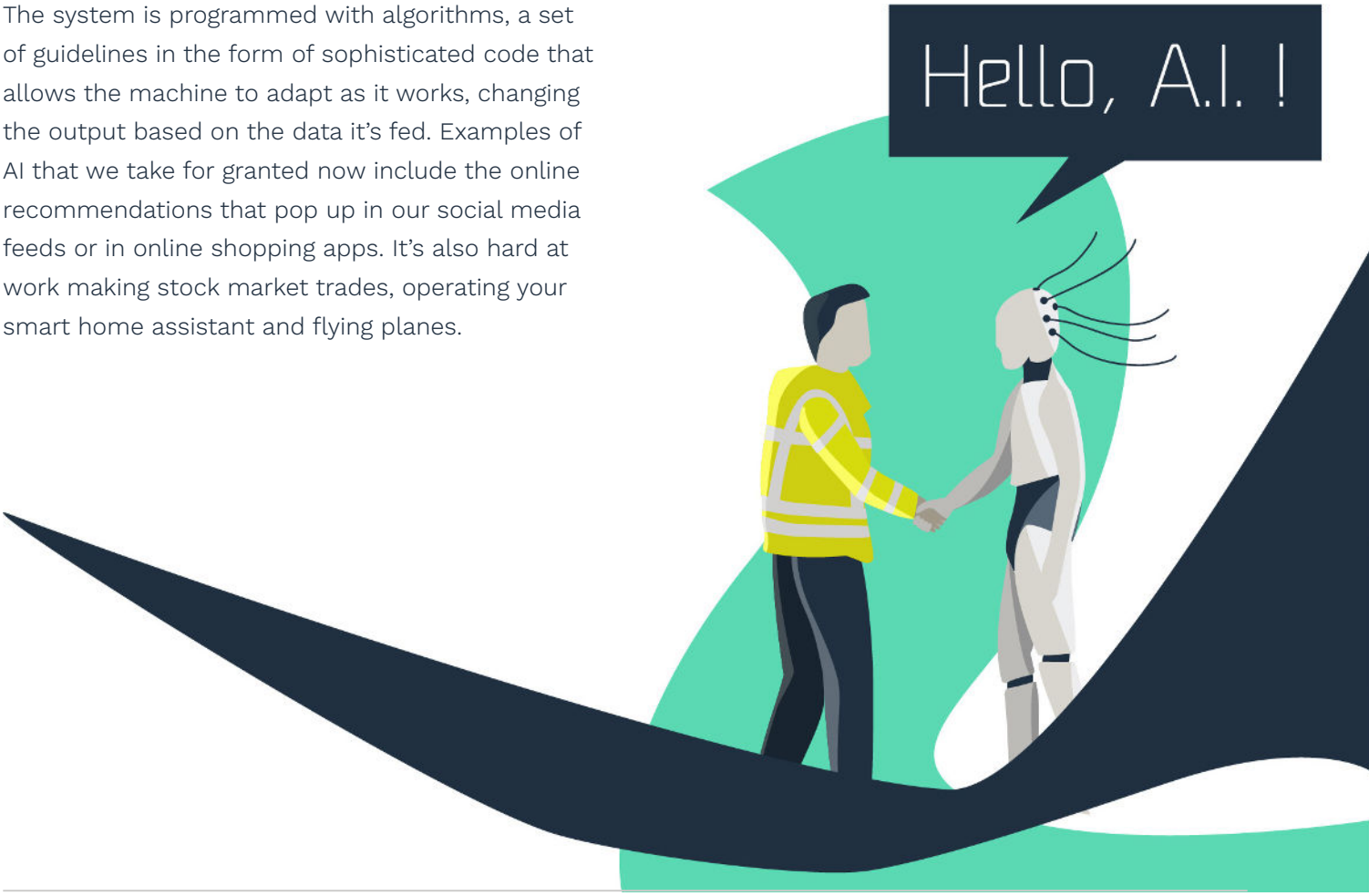
Staying alive in this environment requires fast thinking and a sound understanding of the technologies that can keep your business in the game. Artificial intelligence is one of the most interesting new game changers in the retail landscape. It's been described as **"the single biggest technology revolution the world has ever seen".**[6]

Actually, AI is larger than one single technology. It is a collection of systems that allow a computer to "sense, comprehend, act and learn".[7] Rather than relying on coding that anticipates binary decisions to make a process happen, AI allows the computer to figure out how to act by analyzing data instead.

The system is programmed with algorithms, a set of guidelines in the form of sophisticated code that allows the machine to adapt as it works, changing the output based on the data it's fed. Examples of AI that we take for granted now include the online recommendations that pop up in our social media feeds or in online shopping apps. It's also hard at work making stock market trades, operating your smart home assistant and flying planes.

Adoption of machine-learning technology – another term for AI – has the potential to resolve issues of time, resources and cost. Analytics is the branch of AI that will do the most in this area, as it represents the ability to crunch the numbers in vast quantities of data where humans can no longer keep up.

AI is set to make a dramatic impact on business around the world. **One estimate places its economic impact at US$15.7 trillion by 2030 – that's an uptick of 14 percent in global GDP.** Of that, about $6.6 trillion will come through productivity gains and the rest from consumption.[8]



Many are pinning their hopes for business success on it. **Numerous surveys have asked executives about their plans for AI adoption, and the number who say they plan to use it tracks as high as 75 percent.**[9] The retail and consumer goods segment of the global supply chain analytics market alone is expected to grow from US$1.2 billion in 2019 to $2.5 billion in 2024 – that's an annual growth of 16.2 percent.[10]

In general it's expected that AI will affect three areas:

1. Productivity gains through automation of processes (including automated vehicles and robots)
2. Productivity gains through application of AI to assist the existing labour force;
3. increased demand thanks to the ability to increase product personalization.[11]

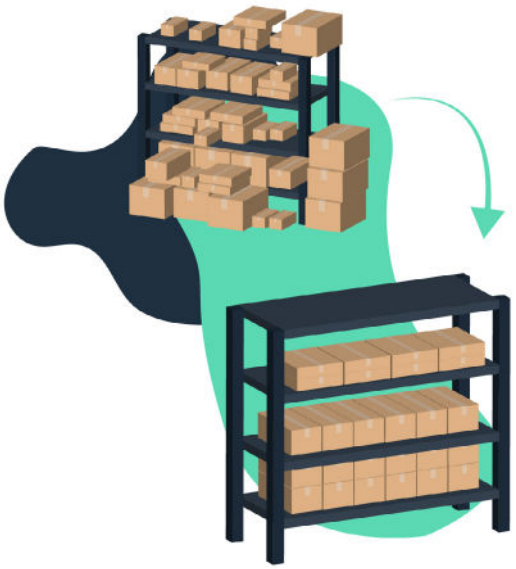
What can AI do for Retail Operations?

Retail operations stand to benefit from AI in many ways, and in ways that have yet to be envisioned or realized. However, for the moment AI is seen predominantly as a means to streamline inventory control and profit by improving processes.[12]

Crunching the vast amounts of data being generated from observing e-commerce shopping habits, **Internet of Things** connected objects, and sales information can yield reams of actionable insights.

> **But retail operations will also be influenced by the use of AI in the service sectors it relies on. AI in transportation and logistics, for example, will have a huge impact on how retail operations will need to function. AI applications that improve routing – as we noted above – as well as load matching, and in the not-too-distant future autonomous trucks, will all contribute to a faster, more efficient transportation system.**

In the meantime, here are some of the top AI applications that are proving to have a direct and beneficial impact on retail.



Inventory optimization

In the cutthroat retail world, inventory optimization is a key survival tool. One of the ways that AI can help is by providing accurate predictions of future sales. **Demand planning is now part of the analytics tools that AI can provide, and will allow retailers to reduce excess inventory** by only buying what these predictions indicate is needed. The other benefit is that the amount of space needed to store inventory may be vastly reduced if the quantities needed are foreseen accurately.

This does present a risk on the flip side, however, if demand exceeds predictions and the retailer is caught short. Overstocks cost retailers US$470 billion in 2015, while out-of-stocks caused a US$630 billion hit, globally, according to one study.[13] But with the increased accuracy, and continuous learning that AI affords, both types of inventory miscalculations may eventually be remembered as headaches of the past.

Delivery optimization

Going back to the route-planning problem noted above, **AI is already being employed to ensure packages get delivered with the maximum efficiency**. A major parcel delivery specialist has been using such a system since 2013, and now employs it on 10,000 routes. It uses fleet telematics and advanced algorithms to provide drivers with optimized routes. The technology figures out the most efficient way to deliver and pick up packages within a set of stops defined by start time, committed delivery time, pick-up windows and special customer needs. The system relies on customized online map data to calculate miles and travel time to plan the most cost-effective routes.

For the delivery company's retail partners this means e-commerce parcels will be delivered faster and for less cost. It also means that those same retailers will feel even more pressure to step up the speed and efficiency of their own operations.

DC process improvement

AI is being used by third-party logistics (3PLs) suppliers to predict when customers will need orders and then organize their distribution centres accordingly. If you know when a pallet will be needed it's possible to stage orders so that they can be most efficiently picked and loaded onto waiting trucks.[14] AI is taking old-school analysis of fast-moving SKUs versus slow moving product to a whole new level, based on order history and factors such as seasonal demand and even weather patterns, in the case of cold storage suppliers handing items like ice cream and frozen treats. And for the company in this example, it's paid off with a 20 percent improvement in efficiency.[15]

End-to-end supply chain planning

AI will be able to enable planning across the supply chain from raw materials right through to the end retail consumer. In the best case scenario, it will entail being able to better plan everything from how much of a sourced material will be required and the precise moment it needs to be delivered to the manufacturing plant, through to knowing when demand for that product will peak and then being able to suggest it to the right customer and have it delivered the same day.

This will reduce costs all along the supply chain by reducing delay, avoiding wastage in manufacturing, eliminating unwanted inventory and the extra touches and storage it requires, and minimizing the cost of lost sales due to stockouts. If done correctly, AI has the promise to deliver benefits all the way along the chain.

Avoid AI Pitfalls

While numerous large retail companies are making productive use of AI – Amazon being the prime example – it is still very much a technology, or suite of technologies in relatively early development. This means retail leaders taking a look at introducing AI to their operation need to proceed with caution. There's a lot of hype, inflated claims and hucksterism to be wary of as numerous developers seek to promote their – largely untried – solutions.

Here are some recommendations to help prevent an expensive AI misstep:

Use AI for the right reasons.

Using AI because someone in senior management has read about the competition using it is not a good reason. Instead, **leaders should ask what technology will drive the most value for the bottom line.**[16] For example, you might ask which areas of the business have lower profits than they should, or what tasks employees are doing that are unpleasant, or where the most errors are made.[17]

Adopting AI might be the answer to solving these challenges, but it just as easily might not. **As always, with new technologies, asking the right questions will hopefully reveal the realities of your needs and the areas where new solutions may be practical solutions.**

Ensure the right leadership

With IT capabilities so central to retail success, it comes as no surprise that for many organizations the ownership of IT projects has been fragmented across numerous departments. With IT budgets increasingly spread across the enterprise, AI implementations can become pet projects of a single department, without general oversight. This often leads to stalled progress or failure since important considerations like regulatory compliance, data management, security and more may be overlooked.[18]

It is therefore extremely important to keep oversight of AI projects within the purview of the company's chief information officer. AI is complex and requires careful integration of many functions and data from across the enterprise. It will require planning and input from across the enterprise, with guidance from IT and senior management. Preventing departments from going rogue with their own AI experiments will reduce the risk of wasted time and costs.

It's all about the data

Before AI will work, you have to have the data to feed it. If you are operating in an e-commerce or **omnichannel environment** already, you have access to reams of information. Information from your e-commerce sales, logistics processes, inventory control, marketing, and so on may all be valuable fodder for an AI system to interpret.

The key is identifying exactly which data will be useful for your AI project and making sure it is captured and stored in the right format.

The good news about AI is that it can tolerate data that's not completely "clean". Data with duplicate records or even outdated and incomplete information can still be used by AI systems thanks to their ability to learn and fill in gaps.[19]

Get the right people

Part of solving the data question will involve finding staff with the skills to implement and maintain AI systems. This is a serious challenge. In fact, lack of AI talent is seen as a major barrier to the technology's adoption by many enterprises.[20]

There is a huge shortage of data scientists – the people who will manage AI systems – around the globe. Their skills are so valuable that numerous acquisitions of AI startups have been fuelled by the need to gain the talent behind the technology, more than the tech itself. It's estimated that graduates in the discipline will increase by seven percent a year, but demand will outstrip supply, with a 12 percent annual growth rate.[21]

Retailers seeking to make an AI breakthrough need to consider the cost that hiring these skilled practitioners – whether directly or through outsourcing – will add to the cost of their project.

Real Intelligence

The amount of data created from digital sensors, virtual reality applications, and smart mobile devices doubles every three years, and while the ability to store it has expanded proportionately, the cost has dropped dramatically.[22]

AI allows the utilization of the vast quantities of data – also known as Big Data – made available by e-commerce. It also creates an opportunity for the retailer to be constantly connected to their customers, leveraging the data that online shopping creates, to stay top of mind and make tailored offers. In fact, for now marketing and sales applications are the most common uses of AI in the retail sector, with supply chain applications ranking in second place.[23]

However, as we have seen, AI for supply chain is really still in its infancy. And this creates an opportunity for retail businesses that want to take advantage of AI technologies in the near future. Because AI capabilities are still in their formative stages, now is the time to look at how the information and process improvements it can afford will affect other processes and systems that the business relies on.

For companies with retail distribution operations, this means ensuring you can keep up with the increased velocity of orders coming and going from your distribution and fulfillment centres, as well as being prepared to shift on the fly as you learn more about future demand.

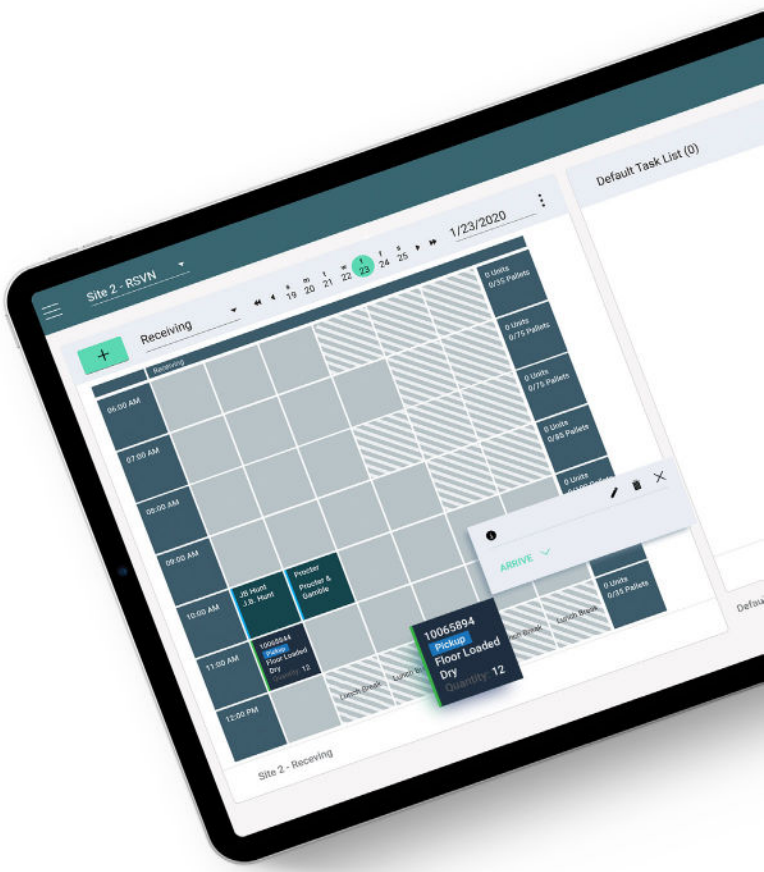
That's where C3 Solutions' best-of-breed scheduling system comes in. If you want to leverage the powers of artificial intelligence to speed up your operations you need to ensure that all areas will be able to keep up. **You cannot afford to have bottlenecks and congestion slowing down the arrival and departure of goods and orders at your dock doors.**

Implementing a dock scheduling system will allow for the smooth arrival and departure of trucks, and help ensure that your inventory is where it needs to be at the right time. It will be a key piece of the plan when it comes time for your operation to step up to the improved speed and accuracy that AI will bring.

Think about it this way: AI will mean pinpoint accuracy in the delivery of goods for replenishment. If your docks aren't ready at the moment that inventory needs to be delivered, then what's the point in having the precision of AI to know that those SKUs are needed? Likewise, on the outbound side, whether it's a parcel truck arriving for last-mile delivery pick-ups or a full-truckload going out to replenish a bricks-and-mortar location, **if they are forced to loiter in the yard waiting for the load**, then you are wasting the capabilities that you've paid for by implementing AI analytics.

But if you have a scheduling system in place, you'll be able to make sure that loads match up with time slots at the docks and you'll be leveraging your AI investment to its intended result.

By using the latest in C3 scheduling technology to coordinate your dock equipment and labour with the other fast-moving parts of your retail supply chain you will be able to maximize the ROI on your IT investment.



Dock Scheduling with

Reservations

A cautious gambit

Artificial Intelligence should be on your radar if you play on the retail chessboard. Just as AI can play the game of chess better than a human chess master, it will also be quickly learning how to master retail operations. That may be a little fanciful, since AI won't do anything without human creativity to do the initial programming, but once this technology evolves and matures to the point where it's commonly employed and no longer solely at the disposal of IT-native retailers or the very large, it will be a fundamental game changer.

Those that are not feeding the data they collect from their operations into the big computer brains will be at a serious disadvantage. They will be slower, less accurate, unable to predict with precision, and will lose sales.

Just as in chess, the game relies on being able to think many moves ahead, retail success will likely soon come down to the ability to leverage AI to its best advantage. Ignore it and you may find your operations in checkmate.

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PLAN YOUR NEXT MOVE

BY C3

Retail Distribution Centre Automation

Using Technology to Stay in the Game

SOLVING FOR RETAIL

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Retail is moving at a pace we've never seen before. Not only is e-commerce creating an onslaught of orders, but the choices of solutions available to fulfill those orders is also multiplying rapidly. It's a high-speed, high-stakes game and you need to be thinking many moves ahead.

Today's retail operations superstars are the ones who know where and when to employ not only the newest, fastest technologies but also the tried and true. For companies seeking to survive and excel in the current 'retail apocalypse', understanding the right technologies to employ in their supply chain operations is critical.

In this paper, we will look at this changing environment and the challenges it presents, and then show some of the automation options retailers are adopting in their distribution centres as a means of building the velocity, accuracy and efficiency it takes to thrive on the retail battlefield. The information we present here is intended to help inform your decision-making in the context of the massive challenges facing retailers. At C3 Solutions we think it's important for those considering different technologies to have as broad a perspective on the options as possible.

This paper is not about what we do; it does, however, explain how automated yard and dock management fits into the bigger picture of available DC automation. Ultimately, we hope that you'll take away a new perspective on technology and what it can do for your retail operation. As the saying goes, knowledge is power.

Challenges

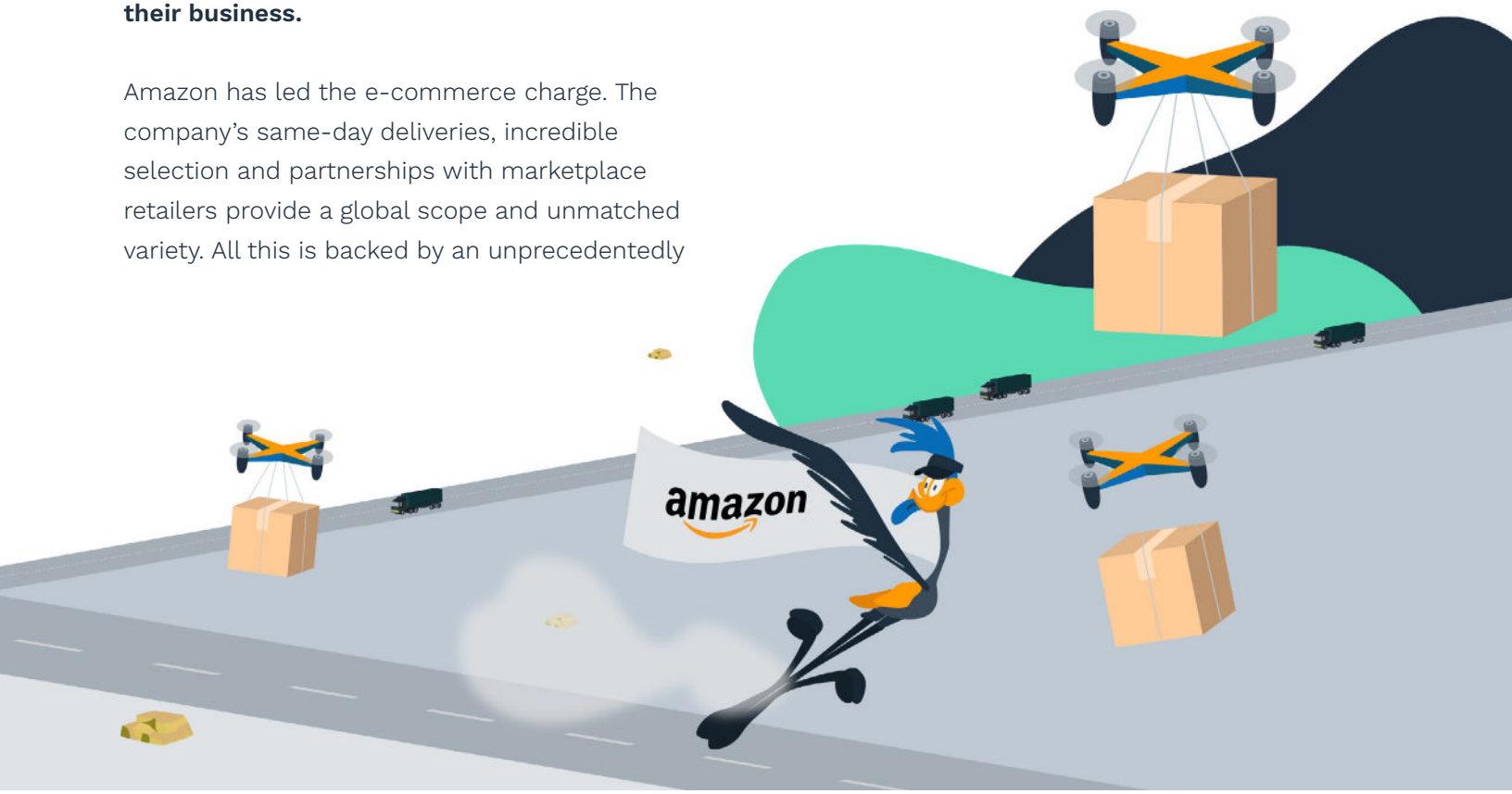
E-commerce has become so big it's almost incomprehensible.

It's estimated that in 2019 the global e-commerce market will climb by almost 21 percent to US$3.53 trillion. That represents 14 percent of the world's overall retail sales of $25.038 trillion.[1] To put that in perspective the United States' gross domestic product (GDP) for 2019 is forecast to reach $21.439 trillion.[2]

Retail has always been competitive, but with e-commerce taking over such a large share of the market, the level has intensified. Consumers are no longer bound by loyalty or geographic necessity in their purchase decisions. Any retailer that has the item they want and can deliver it promptly, for the right price, can win their business.

Amazon has led the e-commerce charge. The company's same-day deliveries, incredible selection and partnerships with marketplace retailers provide a global scope and unmatched variety. All this is backed by an unprecedentedly huge supply chain operation, with almost 200 fulfillment centres in the U.S. alone, covering about 100 million square feet. Those DCs operate with 33 percent less inventory than conventional retailers and work towards a standard of orders being picked and packed within two hours of the customer clicking the 'buy now' button.[3]
The appetite for online commerce has also changed where people shop, with grocery, pharmacy and other categories like furniture and power tools becoming increasingly sought after by e-commerce customers. That's putting new pressure on retailers in these categories and expanding the scope of the retail apocalypse.

To put it starkly, the expansion of e-commerce and ever-faster, ever-cheaper delivery is the new standard. Retailers that don't keep up lose out and often fail.



Consider the options

E-tailers facing this crisis need to find a way to speed things up in their order fulfillment process. **Customer-facing technology is one piece of the puzzle**. With consumers using their smart devices to make more and more purchases, retailers need a robust and always-on interface that makes shopping easy and fun and transmits the order information to the **fulfillment centre** as quickly as possible.

> In order to secure that order, the retailer has likely offered a very quick turnaround time and probably free delivery as well. That doubles the pressure to move things along in the DC, as well as create efficiencies to keep delivery costs down and also to offset them by saving costs in other areas.

Labour

One obvious way to accelerate operations is to add labour. If you can add more pickers and packers, then surely you can move more orders out the doors.

However, consider that a one million square foot e-commerce fulfillment centre may need up to 4,000 workers[4]. And with distribution centres popping up like mushrooms, as Amazon's burgeoning network demonstrates, competition for workers is intense. With low unemployment, workers will jump ship for an extra dollar or two an hour, or for benefits.[5] It was estimated that in 2018 and 2019 the U.S. would need over 452,000 more warehouse workers.[6]

And even if you can find the workers, throwing them out on the DC floor does not automatically solve the problem. One Toronto Ontario-based e-commerce operation tried it, but found that too many people in the aisles were leading to collisions between pickers, and actual traffic jams at corners. Far from speeding things up, it was slowing them down and causing personal injuries.

Adding a shift might help, but then you need people who don't mind working overnight. Those are hard jobs to fill. That goes double for cold storage warehouses, where the new surge in **online groceries** and meal kits is creating a huge demand for their services and pushing them into e-commerce fulfillment operations more than the old pallet-in, and pallet or case out model. Working in freezing temperatures for an eight-hour shift is not the ideal job for too many people.

Rethink Network Design

If adding labour is not going to work, then perhaps moving to a larger facility or one closer to the customer base is under consideration. It may make sense to increase the footprint when SKUs proliferate and volumes go up, and when free delivery is almost a requirement, getting closer to the customer can help keep those costs under control.

However, the commercial real estate market may tell you otherwise. Vacancy rates have plummeted, and the space available for newbuilds is getting scarcer and more expensive.[7]

As warehousing requirements have increased, the most desirable lands just outside city cores that are close to transport arteries have been snapped up. This forces those seeking new industrial space further afield, which hardly meets the objective of getting closer to the customer.

Distribution Centre Automation

But there is another option. Automation can improve both the labour scarcity problem and the requirements for space in the DC.

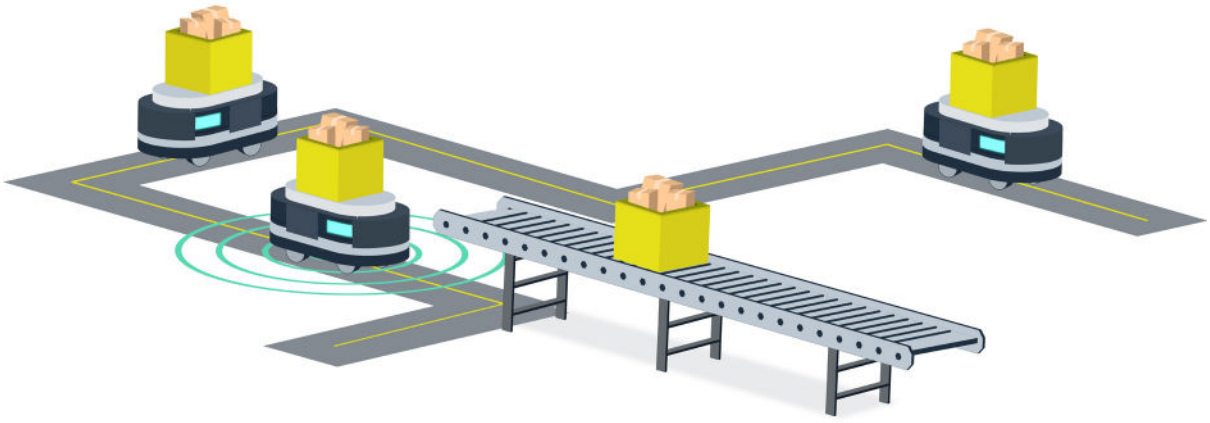
Automation for the retail fulfillment centre can take numerous forms. In this instance we're going to talk only about physical automation, not the decision-making automation that is exemplified by Warehouse Management Systems, **Warehouse Execution Systems** and **emerging technologies like AI**.

The technologies available in this segment have been growing – almost as quickly as e-commerce itself has bloomed. They range from gigantic automated storage and retrieval systems (ASRS) that store millions of items, to goods-to-person robotics, to automated guided vehicles (AGVs) and down to technologies that help humans do their jobs.

Each one is designed to meet a particular order fulfillment or inventory storage challenge, so it's important to understand the scenario where it will work the best.

Here's an overview of the different technology types you might consider:

- ASRS Robotics
  (Automated storage and retrieval systems)
- Autonomous Mobile Robotics
- Automated Guided Vehicles
- Conveying Systems
- Picking
- Human augmentation technology



ASRS Robotics

Automated storage and retrieval systems are not new technologies. But they have made leaps in technological prowess in the past few years, so that they are now extremely sophisticated tools for e-commerce fulfillment.

An ASRS is basically a box that contains a mechanism to store and retrieve items as they are needed. Beyond that core, however, there is a great deal of variation in their size – from an entire building down to as small as a display case – in how they work, and the item-unit that they work on. They allow for a much greater use of real estate, by allowing dense storage that doesn't require human intervention to place and remove items from storage.

For the purposes of e-commerce an ASRS will usually present goods to the order picker at an item level, while the in-feed may be at the pallet or case level depending on what you are storing. Examples of such systems are increasingly found for grocery operations. Takeoff Technologies, for example, builds small scale, self-contained ASRS units that fit into the backroom space of a retail store, and fulfill orders for pickup or local delivery.

On a larger scale, the Ocado system, pioneered by the UK e-commerce grocer, fits into a large DC footprint and is being adopted by grocery retailers in North America. In Canada, Sobeys has been the first adopter, with two of the robotic cell facilities under development[8], while in the U.S. grocery giant Kroger has exclusive use of the system.[9]

For traditional retail models it's pallet-in or case-in, and case-out in most instances. Canadian discount retailer Giant Tiger has recently adopted large-scale automation made by Symbotic in a new distribution centre. Its 90,000 square-foot ASRS is fully automated, inducting cases at a rate of 1,750 an hour with depalletizing robots. The cases are moved to a storage location in the 15-level high structure by shuttle bots that can move at 28 mph, and when they are needed to build a store order they are delivered to one of two smart palletizing robotic cells that create the outbound pallets one case at a time. They do this at a pace of one every two minutes using algorithms that ensure the goods are organized on the outbound pallet according to where they need to go on store shelves.[10]

ASRS systems can also be a lot simpler, consisting of dense racking equipped with shuttle units that simply run from back to front. Usually palletized, loads are inducted by a forklift onto the shuttle and are moved to an available storage location. For retrieval, the process is reversed and the pallet is delivered to the front of the racking face for pickup by the forklift. In cold storage applications, this system is particularly useful as it eliminates the need to chill air in aisles where it is not needed.

ASRS units are also being deployed by retailers for e-commerce order pick-up, with kiosks appearing by the entryways of stores like Walmart, Canadian Tire, and dozens more. While these standalone have to be filled by humans, they are designed for attendant-free pickup by customers who use a special code to access the correct order.

Autonomous Mobile Robotics

Autonomous mobile robots (AMRs) are robots that can navigate through the distribution centre on their own. They don't need external guidance systems to find their way to specific locations but rely on vision and sophisticated programming –known as SLAM, or simultaneous localization and mapping – to make decisions about where to travel.

AMRs are still very much an emerging technology, but with numerous start-ups working hard to perfect the technology[11], they will no doubt gain in popularity for retail DC applications. With their ability to travel independently AMRs are very flexible and allow DC operations to easily realign to shifting priorities.

Automated Guided Vehicles

AGVs or autonomous guided vehicles are very similar to AMRs but do not have the smarts to maneuver on their own. They travel throughout the DC following prescribed routes that are set out with magnets or tape on the floor. In an e-commerce fulfillment centre they are typically used to pick up orders from human pickers on the floor – typically gathering totes at the ends of the picking aisles – and deliver them to packers who put everything in a box for delivery to the final customer.

Amazon deploys thousands of AGVs to bring goods to pickers, to deliver prepared parcels to the correct mail sorting area, and more. It's one of the ways it stays at the front of the e-commerce pack.

Conveying Systems

Automated conveying systems have been employed for decades in DC operations. They are highly customizable and can move product extremely quickly. From pallets to single items, automated conveyors can be designed to fit any retail distribution operation. Conveyors offer sophisticated sortation capabilities, making them ideal for retail e-commerce applications, for example sorting cases to pickers in a goods-to-person model, then returning them into storage once a pick is made. They can be speeded up and down depending on requirements.

Although modular conveyors are now available, making them more flexible, a drawback to some legacy systems is that once installed they are quite static, making them less adaptable to a quickly changing e-commerce fulfillment operation.

Picking

Automated picking is a technology on the cusp of widespread adoption. Advances in robotics have made it possible for collaborative robots (cobots) to physically select items from a disparate assortment. This is a complex task that is easy for humans but requires a finely tuned combination of sensing, gripping and movement capabilities from a robotic cell. To further complicate the scenario, these robots typically need to work with a human counterpart, and thus must also be programmed to not injure their human partner.

Several developers have been able to meet this technical challenge, and cobots are at work in a few distribution centres. New offerings are coming to market, for example combining picking robots

with automated storage and retrieval technology[12], offering the promise of fully automated warehousing.

Human Augmentation Technology

While these fully automated DCs may appear in the future, for the moment humans are in no danger of losing their jobs in retail fulfillment. In fact, augmenting human labour with automation is one of the principal ways that operations managers are planning to add automation[13].

Some of the technologies that are currently in use or being developed include pick-to-light, voice picking, vision picking and augmented reality, along with tried and true RFID scanning and barcode reading. What these all have in common is the ability to make humans more efficient in their order picking (or putaway) activities. These technologies reduce errors, reduce unnecessary touches, minimize travel and also can enhance worker safety by improving ergonomics.

They are also the least capital-intensive automation implementations and offer a very quick return on investment, often as quickly as six months.[14]

The Gains

In 2016 it was estimated that only 10 percent of US warehouses were employing automated technologies.[15] With the e-commerce boom, however, that number is accelerating, and **the market for automation products and services is expected to more than double from US$13 billion in 2018 to $27 billion in 2025.[16]**

Retailers are realizing that some level of automation is the answer to meeting omnichannel e-commerce challenges. When you need to retool your processes from simply fulfilling store orders to meeting direct-to-consumer demands as well, a complete refit of the DC may be in order. But you may also be able to keep up by applying less capital-intensive options, like the human augmentation technologies noted above.

Automation provides numerous benefits:

- It reduces labour costs by streamlining work processes, and also by reducing the need for temporary or overtime labour to meet high demand periods.
- It improves labour retention by making jobs easier and less physically demanding.
- It can improve order and inventory accuracy through the automation of data collection to reduce misplaced stock. This accuracy also helps with regulatory compliance and internal audit processes. When errors are made, they are also much easier to track down.
- It can save costs by reducing the real estate footprint needed for the DC.
- It can reduce energy consumption by using a smaller footprint, and also by enabling lights-out operation in places or implementing on-demand power-up for various components.
- It improves flexibility by allowing process improvement through programming changes instead of needed a refit of physical layouts.
- It speeds up order cycle times.

The cost of order picking can represent up to 55 percent of a warehouse's operating costs,[17] while travel time for workers manually picking from a traditional warehouse eats up between 50 and 65 percent of labour.[18] If you minimize travel by automatically bringing the goods to the picker, you stand to save massively, while also making workers' jobs easier. Studies have shown that automation can net 99.999 percent order accuracy[19], allow for 85 percent space savings and reduce operational costs by 65 percent.[20]

Making it All Work

Deciding to automate is not a decision to take lightly. It can make or break your business, and needs to proceed on a foundation of research and understanding of the risks and benefits. **You need to know what you want to achieve before deciding on the technology to apply.** It will take a thorough analysis of your current and future operations, looking at which technologies will best deliver the productivity, space, throughput, accuracy and ergonomic gains you are striving to achieve.

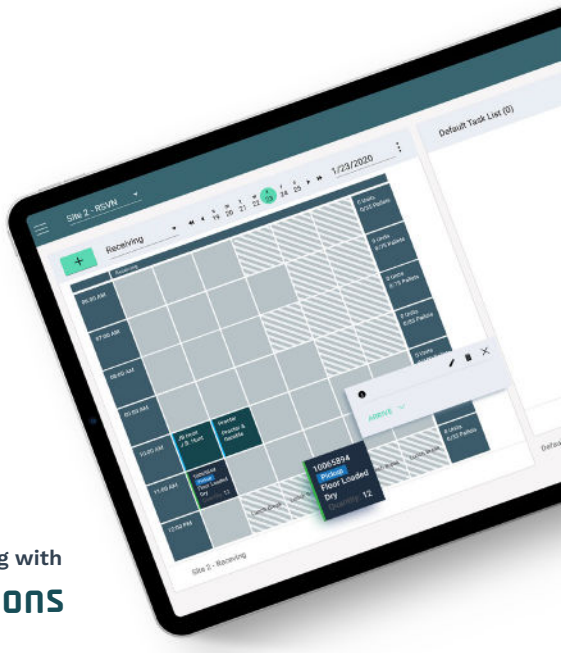
And you will also need to assess how the new technology and processes inside the DC will interface with the outside. How will automation impact your transportation requirements and scheduling of loads? Will you be able to receive product more quickly? Will your volume increase so that more trucks are arriving at your docks? Ensuring that these variables are taken into account will help to maximize the return on your automation investment. You may need to increase the number of dock doors as you automate; you may need a larger yard, and you may also need to automate your dock scheduling so that you can keep up with the increased velocity of arrivals and departures.

> With higher volumes of trucks, it may no longer be possible to keep up using manual processes. The old spreadsheet and phone call method isn't compatible with highly automated, fast-moving systems, and with trucking companies imposing hefty detention charges, you can't afford to keep them waiting, either.

Dock scheduling provided by C3 Solutions can help. By putting the process in the hands of the drivers, appointments are simply made and can be adjusted on the fly. And because it can link up with your WMS system, it's primed and ready for exactly what's about to arrive. Storage locations can be pre-defined.

When your staff knows a truck is inbound, they can be ready to receive without confusion and in an organized fashion. The dock area will be clear, equipment at the doors ready. That means there's less chance of an inventory error as pallets or cartons are scanned in, which translates into greater accuracy for the orders on the way out.

Knowing when a load is coming also means you can deploy your labour doing productive tasks until that truck arrives instead of waiting around on the docks for something to happen. You'll save labour costs this way, and have happier, more productive staff who know what they are meant to be doing.



Dock Scheduling with Reservations

Don't overlook the **importance of a scheduling system** when you consider your automation needs. With the unprecedented speed of retail operations and the ultra-competitive world of e-commerce fulfillment, you need every advantage you can find.

And it's that advantage, that edge over the competition, which will mean success in this challenging retail environment. From efficiency gains and accuracy improvements, to labour savings and cost reductions, automation offers many irrefutable benefits to a distribution operation. **At this point, it's not really a question of *if* you implement automation, but *when*.**

And then the task becomes very detailed and exacting as you map your processes and plan your future operational strategy to maximize an investment in the technology you choose. You'll be rewarded by taking a big picture view, looking inside and outside of your fulfillment centre, and considering all the moving parts before you make a decision. **The future of your business depends on making the right moves.**

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PLAN YOUR NEXT MOVE BY C3

Emerging Digital Technologies for the Retail Supply Chain

Strategic Advantage or Big Question Mark?

SOLVING FOR RETAIL

Table of Contents

> Everybody wants a strategic advantage in today's retail supply chain. The intensity of competition, the speed with which orders arrive and must be fulfilled, and the constant pressure to innovate are motivating the development of new technologies.

Digitization is one of the biggest umbrella concepts being touted at the moment. If you do any supply chain reading you'll know that digital technologies are the proposed answer to every challenge. There is a new solution for every problem.

And it's no surprise that this is where the best minds are taking innovation. We live in the digital age, and after all, it is digital commerce – e-commerce, omnichannel retail – that's driving the charge.

So, if the future is digital we thought it was time to look at some of the cutting-edge innovations that are on the market or close to fruition to help you understand the landscape and where we may be in the next few years.

We chose three technologies to discuss:

- ★ 5G
- ★ Digital Twins
- ★ Blockchain

All three are rapidly evolving and all three have demonstrable benefits for supply chain operations. These tools may not be right for your organization yet, but understanding what they are and their level of development will be a piece of the strategic puzzle that will help you make the right moves in the retail chess game.

Our piece of that puzzle is the interface between the distribution centre and the outside world. A best of breed automated dock scheduling system from C3 Solutions ensures that you are in control of the inventory coming and going from your facility. That's a foundation piece in the retail supply chain – without it you are operating in the dark.

As these new technologies add a layer of complexity, what we do helps to simplify, streamline and enhance your operation.

Our objective with this paper is to help you make decisions that will drive your organization forward.

Read on for an overview of 5G communications, digital twins and blockchain and how they may – or may not – become a useful part of your supply chain technology inventory.

5G is Coming

5G is the fifth generation of the international cellular communication standard and it is expected to propel the advance of numerous technologies such as **AI**, **robotics**, **Internet of Things (IoT)** and virtual reality. If you've been reading our C3 retail whitepaper series, you'll know that each of these technologies is playing a significant role in supply chain modernization.

5G is expected to deliver much faster data speeds – roughly 20 times faster than today's 4G optimum – and also reduce the delay time, known as latency, as a device receives and responds to a message.[1] Another benefit is network slicing, which divides the signal among numerous clients, whether they are systems or devices.[2]

Blazing Speed

The 5G promise is huge, according to the 2019 State of Logistics report:

> **It will be so fast that you can download 20 videos in the time it takes for one today; it will be so efficient with network energy that your sensors' batteries will last 10 years instead of one; it will connect up to one million devices per square kilometer with 100 times more capacity than today..."** [3]

Cellular providers are beginning the 5G rollout and a recent survey from Gartner says businesses are eager to adopt it.[4] The survey found that activating Internet of Things applications is the most common objective, with the end goal of increasing operational effectiveness.

However, while some service providers already offer limited 5G capabilities, the technology will not be widely available until the 2025 timeframe. Gartner is predicting that only 45 percent of global communications providers will be offering the technology by then.[5]

That timeframe may give retail operations managers plenty of time to assess how 5G might improve their business; but it's not too soon to start investigating. One analyst suggests that if you are only beginning to consider 5G now, you need to get moving quickly or be left behind the adoption curve.[6]

So, what are the applications that will have an impact on future retail operations? As noted above, IoT will be a big one. With its ability to split the signal for millions of devices, 5G will make IoT possible on a much larger scale. Many more items will be able to be monitored in a smaller area, making the IoT warehouse feasible on a scale that large retailers with millions of SKUs, for example, will be able to leverage.

The IoT-enabled distribution centre is already being brought online.[7] And with commercially available 5G technology not yet ready for widespread dispersion, many large enterprises are planning, or building their own networks to get ahead of the trend.[8]

Not only in the DC but throughout the supply chain, a 5G-enabled IoT will open the door for much greater visibility into inventory, delivering a truly seamless and real-time image of where product is and how fast it's moving.

Retail supply chains will also benefit from the application of 5G in autonomous vehicles. Both over-the-road trucks and last-mile drones will be able to achieve new heights of sophistication using 5G's ultra-fast communications speeds. Although pilot projects for both types of driverless vehicles are proceeding, with success after success, experts agree that 5G will provide a boost that will speed up commercial viability.

The faster speed of the 5G network will give autonomous vehicles the capability to make decisions much faster than they have to date. This will enable them with the kind of "reflexes" that humans have[9], and make them even sharper – and ultimately safer – than human operators.

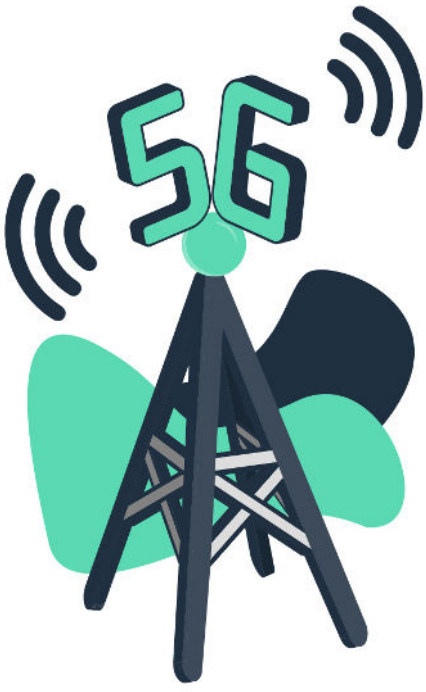
These benefits will also apply to the development of robotics technologies inside the DC. The 2019 CSCMP State of Logistics Report asserts that 5G will be a game changer for DC operations. It sees the wireless capabilities of 5G as enabling greater flexibility in the use of robotics, as well as increasing the speed at which **DC automation** can operate.

Among some of the bleeding-edge technologies the report highlights are real-time supply chain orchestration, video that captures items being shipped in real- and full-time, pinpoint temperature control, and more.[10] If they come to fruition, each of these has the potential to create significant efficiencies and cost savings in the retail supply chain.

Not So Fast

While 5G is a very exciting technology that promises huge gains in automation for logistics operations, there are still some challenges to be worked out. First, the final standard will not be published until March 2020, so there are details still being worked out. Second, in many cities, the network will need an infrastructure upgrade, which will require a major investment and will take some time.[11] Third, some analysts are calling 5G hype, and assert that the service promised may not be exactly what users end up getting.[12]

So, as with any brand new technology, a wait-and-see approach may prove to be a good risk-management strategy. On the other hand, if 5G turns out to be as advertised, fortune may favour the aggressive early adopter, providing you can get the service!



Digital Twins

Digital twins are coming. A digital twin is a digital copy of a thing, process or being. Digital twins rely on sophisticated algorithms and artificial intelligence to parse information coming from sensors placed in and around the real object, along with historical data. They monitor and recreate the real-world item or process in real-time, creating a visual representation of what's going on. Engineers can then change parameters in the simulation to see how the real thing will react, but without having to put it at risk.

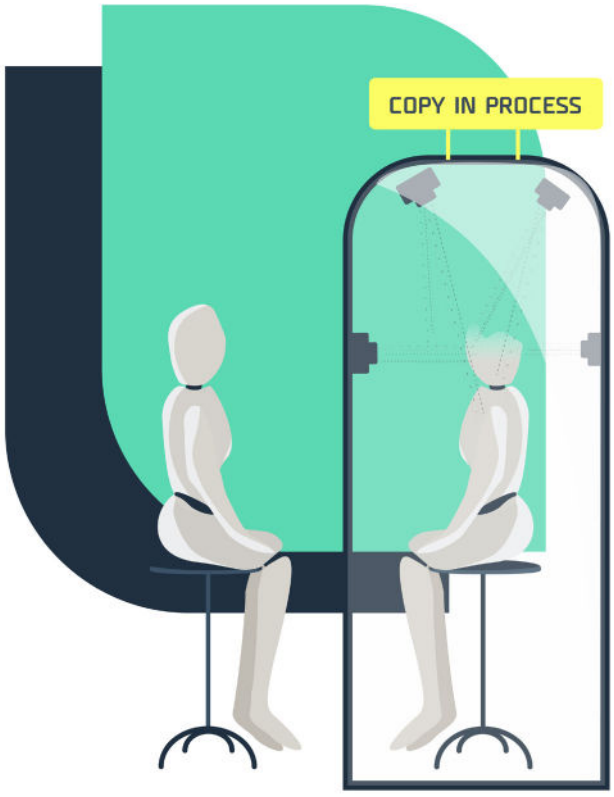
While the term was coined in 2002[13], in fact, this concept has been around for a lot longer than that; with NASA famously using a ground-based model of the Apollo 11 capsule to figure out how to resolve critical issues in space back in 1970.[14] In 2002, the McLaren Formula 1 team was using a digital twin simulation to predict performance, but it was around 2015 that the idea really started to become feasible with the advent of Internet of Things technology.[15] Major manufacturers like GE have been using them since then to derive significant gains in manufacturing and maintenance.

In the supply chain, twins are relatively new kids on the block. Only in the past couple of years have digital twin solutions for logistics operations been made commercially available.

A digital twin is the logical, modern extension of the engineering prototype. Where engineers once modeled in clay, then moved to mechanical models and eventually to computer aided design, now they can create a digital copy of a real-world item or system or process and manipulate it to see how it reacts under different circumstances.

Magical Twin Powers

In general terms digital twins offer numerous benefits, including improved reliability, reduced risk, lower maintenance costs, more efficient production and faster return on investment.[16] In an industrial example, using digital twins GE was able to improve a customer's reliability from 93 to 99.49 percent in less than two years, and cut reactive maintenance by 40 percent in just one year. A digital twin also saved a customer US$360 thousand by predicting a power outage.[17]



In logistics, analysts see tremendous potential for digital twins to drive efficiencies. Keeping tabs on distribution packaging, for example, could yield insight into how to make more **sustainable packaging** as well as helping track the millions of reusable containers in the transport system. **Likewise, a digital twin of an entire shipment may give transportation planners the capacity to plan loads more efficiently and may turn out to be an incredibly effective tool for AI-enabled load matching services.**

The trucks themselves offer a huge opportunity to streamline communications. Because they are now effectively rolling computers, they are sending data to various systems like maintenance, driver logs and fleet management but they send it multiple times in various formats. If each truck had a digital twin, which contained all the data, sent via a single channel, these other systems could access the twin and get the information they need.

> **The traditional approach wastes effort and resources because the data is overlapping and redundant.**
>
> **Additionally, it's very complex and expensive to establish a new channel for every new application that needs to access the data."** [18]
>
> said W. Roy Schulte, Distinguished Vice President Analyst at Gartner.

In the complex and fast-moving environment of a retail distribution centre, for example, a digital twin would enable operations managers to adjust for different scenarios without having to take the risk in real time. A new putaway process, for example, could be tested. Or new automated picking equipment could be specified and tried out to see how it would integrate with existing processes and equipment. **The whole change can be tweaked and perfected, before the change is implemented in the real system.**

All this is not fantasy or hype. Dematic has recently released a product that lets users explore a distribution centre environment before it is built to look at factors such as labour productivity, inventory movement and the effectiveness of material handling.[19] The twin reduces risk by letting the DC's systems run in virtual reality before you commit to expensive capital outlays, making sure that it does what is expected and needed. According to Dematic, their system can be as specific as letting you know what happens if a barcode doesn't scan properly.

In theory, an entire supply chain could be modeled this way, enabling adjustments from raw materials procurement right through to delivery to the final customer. In fact, the entire city-state of Singapore has been modeled into a digital twin by engineering firm Dassault Systèmes. It's being used to make decisions about infrastructure and how to manage possible emergencies like major fires or floods. The model is connected to traffic systems, climate data and transport vehicles.[20]

Sounds a lot like a supply chain, doesn't it? Geographic information systems connected with autonomous vehicles will be able to deliver enormous amounts of data that can potentially fuel end-to-end supply chain twins. Add products to be tracked and you are pretty close to the elements that would be needed to replicate – and manage – an entire supply chain ecosystem from end to end.

Applications specific to retail operations are also coming. In addition to tracking inventory throughout the supply chain, twins technology is being used to model actual retail stores with the objective of guiding shoppers right to items on the shelf, as well as using the **data on individual customers** to create models that may be able to predict shopping behaviour. [21]

Double Trouble?

Digital twins are very compelling. They offer many new opportunities thanks to the creation of digital sensors, the data they collect and the development of artificial intelligence to analyze and act on it all.

However, just because there are examples already in action and new models being developed as we speak, does not mean that digital twin technology will suddenly become the norm for assessing and streamlining operations, in spite of predictions. Back in 2018, Challenge Advisory predicted that by 2020 up to 60 percent of manufacturers would be monitoring product performance and quality with digital twins.[22] A 2019 survey by Gartner put the brakes on a bit, suggesting the adoption rate would be more like 62 percent of the only 13 percent of organizations already using IoT technologies.[23]

A few hurdles will need to be cleared before we see the birth of a digital twin for every application. First is the challenge of integration. Most digital twin applications within the enterprise require the twins to achieve some level of integration with each other. According to Gartner, this remains a significant technical hurdle.

> **"The ability to integrate digital twins with each other will be a differentiating factor in the future, as physical assets and equipment evolve."** [24]

Further, for the grand, overarching, end-to-end supply chain model to come alive, numerous jurisdictional, regulatory and cooperative hurdles will need to be overcome. Just as we now struggle sometimes to communicate effectively between supply chain partners, this fragmentation of the logistics industry will also militate against effective twinning.

Data will need to be shared amongst numerous partners, with resulting concerns about security and proprietary and competitive information. It will take a lot of work for standards to be developed that all can agree on. And further down the road there will need to be agreement on how the massive amounts of data collected will be managed and owned.[25]

Blockchain

Blockchain is also known as distributed ledger technology. **It is a system whereby every transaction, every move of an item in the supply chain is tracked via a digital ledger**. All the parties can see every entry in the ledger and changes cannot be made without signoff from all involved. Ownership of the data is decentralized; it is available to all, but the chain of custody is crystal clear.

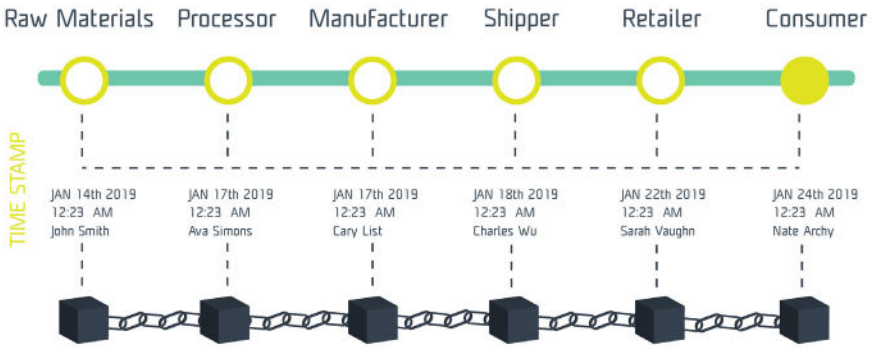
Originally conceived as a means to secure crypto-currency transactions (Bitcoin and the like), in the past couple years **it gained a lot of traction in the leafy greens supply chain** as a means to combat food-borne illnesses like salmonella by being able to ensure the provenance of food items is known. Walmart led the charge to implement blockchain, requiring greens suppliers to sign onto an IBM-designed platform.

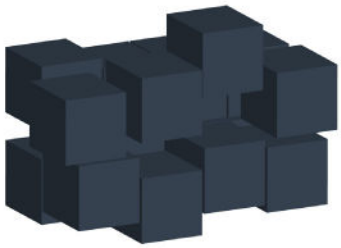
This initiative is not alone: TradeLens, Global Shipping Business Network (GSBN), Blockchain in Transportation Alliance (BiTA), Digital Container Shipping Association (DCSA) and other associations are testing the waters for blockchain in the shipping industry. In agriculture, the world's four largest companies have banded together in a project to digitize the grain trade.[26]

Block Party

Blockchain promises great strides in overcoming supply chain inefficiencies. IBM estimates that global trade could see a 15 percent boost if blockchain were widely implemented.[27] Because it is fully transparent it should be able to show where items come from. For example, tracking provenance was key in the adoption of blockchain in the leafy greens initiative. It should show what's next in the trip, thereby making hand-offs and border crossings simpler and faster, and it can provide real-time tracking. **Eliminating paperwork is one of blockchain's chief promises**[28], an objective that many in supply chain have been working towards for years.

For retail, it's suggested that aside from the track and trace benefits outlined above, it also has potential on the customer-facing side to improve trust and authenticity for brands and products.[29] Blockchain-authenticated goods, like fair-trade foods, or child-labour-free clothing, allow retailers to prove that they are on the side of good corporate citizenship, rather than just making the claim. Likewise, blockchain offers retailers and brand owners the ability to reduce the penetration of counterfeit parts and final products into the retail chain.[30]





Putting the Block on Blockchain

However, recent surveys suggest that while blockchain is on executives' radar, it's not at the top of their must-implement lists. In one study only five percent ranked the technology as a game changer,[31] while in another, it ranked lowest among 11 emerging technologies in use today and only eighth in supply chain execs' estimation of what technologies would be adopted in five years.[32]

The problem seems to be that the return on investment for blockchain initiatives is opaque. While companies considering a blockchain project cite cost savings, traceability and transparency as the top benefits, 92 percent of organizations that were already involved in implementation said that their inability to measure ROI was the main challenge.[33]

Blockchain faces two main hurdles. First is a lack of awareness and second is the problem of sharing proprietary and competitive data with supply chain partners.

In a recent call for blockchain research to support initiatives in the U.S. food and beverage industry, Information Services Group (ISG) director Alex Manders identified the problem:

> **Based on my observations, the top challenges facing the food and beverage industry are incomplete awareness and understanding of blockchain technology vendors, solutions and business-to-business collaboration models; a lack of established industry and governance frameworks, and markets influenced by supply chain participants with a disproportionate pool of resources."** [34]

Indeed, the question of collaboration among supply chain partners is the most frequently cited barrier to blockchain adoption. For blockchain to become a truly useful tool, it requires the cooperation of every party in the chain. And that's a big hurdle for many companies.

Not only would they have to modify their digital systems to join a common platform, they also have to figure out how to scrub the data that is shared so that company secrets are not revealed, and at the same time ensure that data meets the needs of the ledger's recordkeeping. Lots of work is being done at the intergovernmental level right now to educate corporate players about the benefits of blockchain[35], but the fact that its success will depend on the intervention of governments, global trade organizations and the like, is a sign that the technology's widespread adoption may be years away.

The End Game

One thing is clear in the world of emerging technologies and the retail supply chain. There is no single miracle move that will save the game. 5G is coming, but when? Digital twins offer the possibility of real gains, but come at a cost of tremendous complexity. Blockchain can tell us everything about where an item comes from, but do we want to trade our own data to get that information?

What we do know is the pressures that are making us examine these new technologies are not changing. **The retail supply chain is getting faster every day, and competition is intensifying. In this environment, how do you choose the right solution to meet the challenge?**

Let's take it right back to the distribution centre. All the solutions we've described in this paper are very high-level. They have far-reaching objectives that, if they work, have the potential to impact the entire supply chain.

> But there's one place where you can gain an advantage, given that you choose the right technology: and that's at your dock doors. Trucks come, trucks go. They will do that whether your DC is running on 5G or not. They will do it if you are blockchain enabled and they'll still arrive and depart if someone is monitoring them as a digital twin.

The dock door, as simple as it is, can be a great source of efficiency. **Take a look at your scheduling system. Could it be improved? Chances are the answer is yes**. That's where C3 comes in. Using our cloud-based dock scheduling could give your retail DC the boost you are looking for in new technology, without the cost, implementation headaches and months of research. [Click here to see a video >]

Simply allowing drivers to make an appointment allows you to allocate labour and equipment, ensure there is no wait time, and eliminate repetitive, and error-prone manual processes. Even more, imagine if your appointment process could be automated by configuring your business rules into our system and allowing carriers / suppliers to take care of the booking via an online portal. With this one effective, simple addition to your technology repertoire you can increase efficiency in the DC, keep up with retail orders and look like a hero.

So, instead of staying up at night trying to figure out how blockchain will help you, or when 5G will be available, why not investigate, right now, the strategic advantage of scheduling?

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PLAN YOUR NEXT MOVE
BY C3

Warehouse Software Systems

The Brains Behind the Operation

SOLVING FOR RETAIL

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There is a bloody battle taking place in the world of retail sales. It's a fight to the death to win customers. Whether you operate in cyberspace trying to attract e-commerce buyers, or are focused on getting warm bodies into bricks-and-mortar stores, the struggle is intense.

The radical transformation of the retail environment over the past several years is leaving no room for complacency or **inaction**. E-commerce is a juggernaut powered by Amazon's dominance and it's changed just about every aspect of retail operations.

Not only has e-comm speeded everything up, with consumers now expecting same day or next day deliveries, it has also driven the demise of many a traditional retail outlet. Stores are closing, and retailers are facing massive costs to keep up with the demand for home delivery.

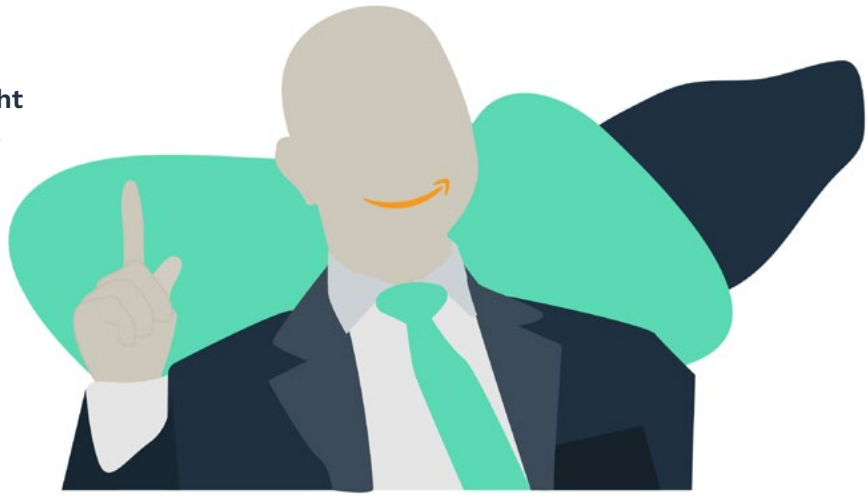
Amazon itself admitted that it will spend US$1.5 billion MORE than anticipated to up its delivery game from two days to one[1]. As Amazon CEO Jeff Bezos said in explaining the move,

> **It's a big investment. And it's the right long-term decision for customers." [2]**
>
> **-** Jeff Bezos

If Amazon is taking a hit bigger than the GDP of many countries so that it can meet consumer demands, how are smaller retailers supposed to survive? It's not easy, that's certain.

Upping your technology game is key to survival. If you've been reading our retail series, you may have already seen our papers on **Automation**, **Emerging Technologies** and **Artificial Intelligence.** Choosing the right technology is the recurring theme in the battle for retail survival. It's like knowing which piece on the chessboard will make the move you need to stay in control of the game.

This time we are going to look at the absolutely fundamental importance of the software systems that underpin DC operations: Warehouse Management Systems (WMS) and the newer Warehouse Execution Systems (WES) and Warehouse Control Systems (WCS). These systems are the brains that help retail operations stay ahead of the competition, by enabling the addition of new automated systems.



As the DC becomes more complex and moves more quickly, that's where yard and dock automation plays a key role in ensuring that your DC operations can keep with the increased speed of automation. Being able to plan the arrival and departure of key inventory can make the difference in the success of an automation project – and our systems integrate seamlessly with operating software.

That's why we want to share this overview of the developments taking place in warehouse operating systems with you. As the complexity grows, so does the need to understand your options.

Read on to find out how the latest systems may work for your retail operation.

Warehouse Management Systems

WMS has been around since the ancient Egyptians needed a way to keep track of their grain crops. Their system – records written on papyrus – served to manage food supplies to prevent starvation in poor crop years. [4]

But it was really the development of innovative material handling systems in the mid-20th century that prompted the need for ways to keep track of more densely stored goods and higher levels of inventory. With the concurrent innovation in computing technology, inventory tracking systems were created that could generate automated reports.

The first contemporary WMS system on record was installed for a retailer – JC Penney – in 1975. In the 1990s systems proliferated and the industry experienced a mini-boom. Companies began to use rudimentary WMS to manage inventory and order fulfillment. At the turn of the century the first WMS supplier achieved revenues of US$100 million and offerings were enhanced for the first time with add-ons like transportation management systems (TMS). [5]

But WMS only really came into its own after the 2009 recession, as the economic rebound prompted the beginning of the **e-commerce boom** and renewed consumer spending. Demand for faster, more accurate order fulfillment required new solutions. At that time WMS was seen as one of the top technologies operations managers were considering to add to their arsenal. [6]

Managing Complexity

Warehouse management systems are designed to manage the many moving parts in a warehouse or DC. Usually integrated with a company's ERP. (enterprise resource planning) system, they organize the complexity of the interactions between the storage equipment, mobile machinery, humans and the transactions that make inventory move. And with the growth of e-commerce and **digitization**, these are just becoming more complex.

Consider just a sampling of the tasks – from the mundane to the intricate – that take place in the average warehouse or DC: Monitoring storage conditions; cleaning and getting rid of garbage; keeping the aisles clear; ensuring heating and ventilation are correct; maintaining security; inventory quality control; ensuring product is properly stored; keeping inventory counts up to date; scheduling cycle counts; ensuring safety stock; updating location labels; scheduling workers; ensuring safety; managing incoming and outbound loads; the list goes on and on [7].

WMS helps to manage the four main tasks of a warehouse:

Its role is essentially to optimize the movement of goods through the DC by making choices that are too complex for old-style paper-based systems. They receive information from auto-ID systems like RFID code readers and **IoT enabled** items as well as from information transmitted by vendors about inbound loads.

As distribution requirements become more complicated in an **omnichannel retail environment**, with both direct-to-consumer orders and store orders being fulfilled from the same location, the WMS needs to become more sophisticated. **The WMS serves the executive function of the warehouse, looking after its business requirements, while also maintaining vast amounts of data such as order info, inventory positions and past performance records**. The WMS churns away in the background, processing information and establishing objectives for each day's handling needs. [8]

This set of requirements is then communicated to the people or technology tasked with meeting those objectives.

The WMS ensures the best possible usage of every precious resource – time, labour and equipment – in the distribution centre. [9]

Warehouse Execution Systems

WES are an offshoot or evolution of WCS, and can encompass all the functions that might be controlled by both WMS and WCS. They are being born out of the need to better coordinate resources for omnichannel fulfillment.[13]

While it's said that WES software is being built as a more off-the-shelf solution than WCS, which is usually quite customized,[14] there is no standard set of tasks that WES performs. Each vendor is developing its own WES suite that either complements or supersedes the control systems and even sometimes WMS functionality.

An example of WES functions includes: workload planning, dynamic order allocation and release; shipping management; replenishment management; system balancing; real-time notification of order allocation, inventory and automation equipment status; business intelligence and reporting on warehouse operations.[15] These functions are not exclusive to the WES, and this is how the system may integrate with or replace the WMS or WCS.

Warehouse Control Systems

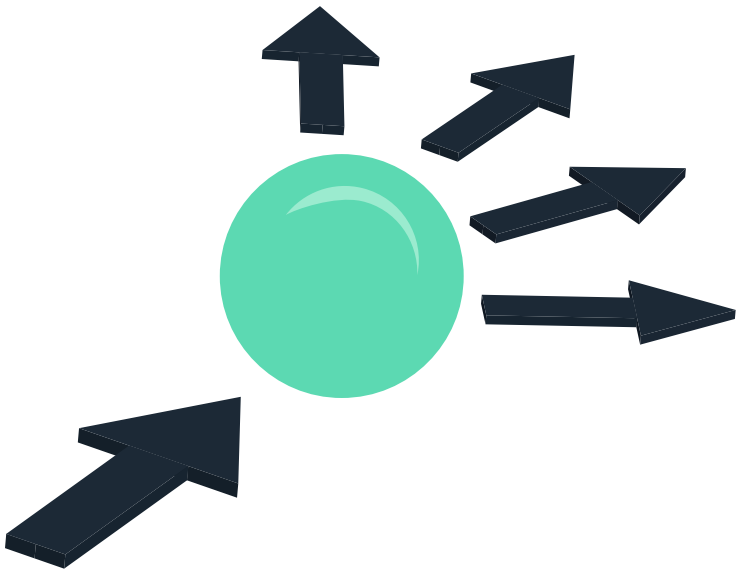
A WCS is the software interface between the WMS and **automated technologies such as AS/RS** (automated storage and retrieval systems), conveyors, palletizers, and automated guided vehicles (AGVs) or automated mobile robots (AMRs). Its role is to coordinate the activities of all these subsystems and ensure that everything is running optimally to produce maximum, accurate throughout. When the WMS determines what needs to be done it's the WCS's job to allocate the resources at its disposal to make things happen.

Using data on products, order lines, volumes, priorities and dispatch deadlines, the control system's tasks include allocating work to the equipment to keep systems in balance and avoid bottlenecks, and directing human operators and automated material handling equipment to stage product correctly for order fulfillment.
This entails performing specific tasks such as sending cartons to order pickers based on defined algorithms, allocating or reallocating floor space, and maintaining inventory control processes like first-in first-out (FIFO), and more. The WCS also generates reports that are communicated to the WMS, and collects information on its own performance. [10]

In an omni-channel DC the WCS may also be tasked with balancing order picking across the channels so that both e-commerce and store orders can be managed at the same time and in the same space. As well, when picking e-commerce orders the WCS may have the capability of directing orders to the correct carton size. These higher-level functions are what are known as add-on capabilities that let flexible WCS software accommodate new technologies in the DC.

Some WCS – when applied with voice-picking technology, for example – can track individual workers' productivity, as well as identify zones where picking is not performing at an optimal level.[11] Real-time data like this allow managers to shift labour to where it's needed and will be most productive, thus helping to keep costs under control.

One of the chief benefits of a WCS is the speed with which it controls activity in the DC. Microseconds matter with e-commerce fulfillment, and the control system is able to use the data from devices and the instructions from the WMS to make decisions and adjustments on the fly. [12]



Speed is of the Essence

Whether your operation is using a WMS, WCS or WES, or even all three, the table stakes for retailers trying to win in the omni-channel world is speed. **From the time an order is placed by the customer, to the moment it arrives on their doorstep or gets picked up at a retail outlet, every second counts.**

All the steps in between that order's receipt and final fulfillment are manageable through these iterations of warehouse management software. It's a sophisticated, highly orchestrated process that links together information about inventory levels and locations, order details like destination and shipping speed, and starts making decisions about how that one order fits in with all the rest being processed at the same time. For Amazon, that means keeping track of almost 120 million different products[16] and being able to sell and fulfill more than 100 million items in a 36-hour period on Prime Day 2018. [17]

The WMS Gap

While nobody compares to Amazon and no other retailer has the infrastructure to compete with the **e-commerce juggernaut**, you have to put resources behind your own e-commerce efforts to stay competitive. Yet, it's amazing how many distribution operations are running without the benefit of even a basic warehouse management system.

In 2018, estimates suggested that a third of businesses still had not implemented a WMS. The Warehousing Education and Research Council (WERC), which made the calculation based on its own research, noted that trying to run a DC without a WMS would make implementing automated processes impossible.[18]

Many companies are

> **operating in a no-man's land between knowing that consumer omnichannel shopping is really starting to affect them and recognizing that their store-centric supply chains and supporting systems will need fundamental modernization, "**
>
> says one analyst.[19]

As they come to this realization, it appears that WMS adoption is set to increase. Recent research predicts that sales of WMS will increase by about 16 percent a year, on the back of demand for cloud-based services.[20] Cloud-based WMS – like other **software as a service models** – will grow in popularity because of its ease of implementation and lower upfront costs.

But although it may be obvious from picking errors, poor customer satisfaction or even declining sales that an upgrade is needed, figuring out what to choose can be just as daunting. The number of options available is huge, and each has to be evaluated on what it can deliver and how much it will cost to implement – both in terms of the time it takes to transition, and the financial cost.

On the other hand, allowing your operation to continue being hamstrung by poor processes when there are solutions available is a questionable business decision. Taking the plunge and **making the investment in a proper software system** is nothing short of a necessity for retail distribution.

As one retail operations manager succinctly put it:

> **To achieve a high service and at the same time not tie up cash with too much stock or empty locations, is not done by best judgment. It's optimum all the way through the supply chain these days."** [21]

Achieving Optimum

Optimizing your retail distribution operation should be a priority. You need to be able to manage the speed, order volume, SKU proliferation and omni-channel challenges that come with 21st century sales. Are you filling orders from the DC, from the store, from the DC for in-store pick-up? **How are you keeping on top of it all?**

Let's assume that if you are not already operating a WMS-enabled DC, or a more sophisticated system, you are considering one. And if you are running with automation already, have you considered all the areas of the DC that might benefit from a sophisticated, digitized approach? We're talking about the key gateway that goods pass through to enter and exit your facility – the docks. All the functions we've explored in this paper depend on you having inventory on hand when you need it. Not a day late, not hung up on a truck that's **waiting in line for an open dock door**, and not early, either, when you're not ready!

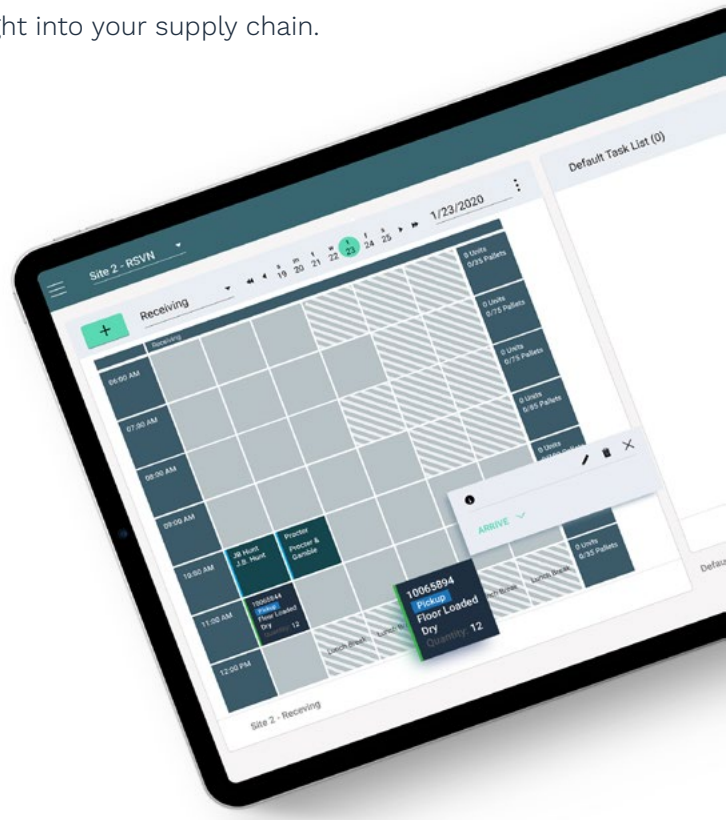
Eliminate Bottlenecks

The best way to enhance the performance of the docks – this key interface with the rest of your distribution chain – is to implement a dock scheduling system. Sure, you may be making appointments with carriers using a spreadsheet, following up with phone calls. **But how does that really work with the speed and accuracy you need to fulfill e-commerce orders?**

When the truck doesn't show up your workers are left loitering with nothing to do and you have to shift them around on the fly to keep them busy. Or multiple trucks show up at the same time, complaining about traffic tie-ups and you get dinged with **detention charges** because you can't unload them all at once.

These are not optimized operations. But you can do better. A **C3 Solutions dock scheduling suite** can eliminate the bottlenecks at your dock by allowing truck drivers to make their own appointments based on door availability via an online portal.

You control the rules that govern the schedules and you get the feedback and information about how you and your partners perform. The appointment scheduling system can be integrated with your WMS or ERP and TMS to ensure even more accurate tracking and giving you even more insight into your supply chain.



The beauty and simplicity of the scheduling system should not mask its value to a high-volume retail fulfillment centre. And it can help you at your bricks-and-mortar outlets as well, where space may be at a premium and time of the essence in ensuring that stores have the stock they need to fill e-commerce orders.

Just remember that while a good WMS will be the overseer of all your DC operations, you also need to make sure that the moving parts – like dock doors – are being directed to their best advantage.

A scheduling system will give you pinpoint accuracy for the docks, and allow you to get all the other pieces in the right places to ensure success.

Dock scheduling will work to streamline operations whether you are all in with automation in your DC or are still at the assessment stage, trying to figure out the best way to integrate software controls and automated equipment. It can be adapted to your operational needs to ensure that product moves in and out of the DC efficiently, ensuring you have the best capabilities to meet e-commerce demand.

Fight the Paralysis

Just as you have to pick the right piece to win the chess game of retail, you also need to keep moving. Standing pat will get you backed into a corner and left with no maneuvering room.

Don't be intimidated by the tough choices ahead. Instead embrace the agility that you'll gain by making a choice that's right for your business model.

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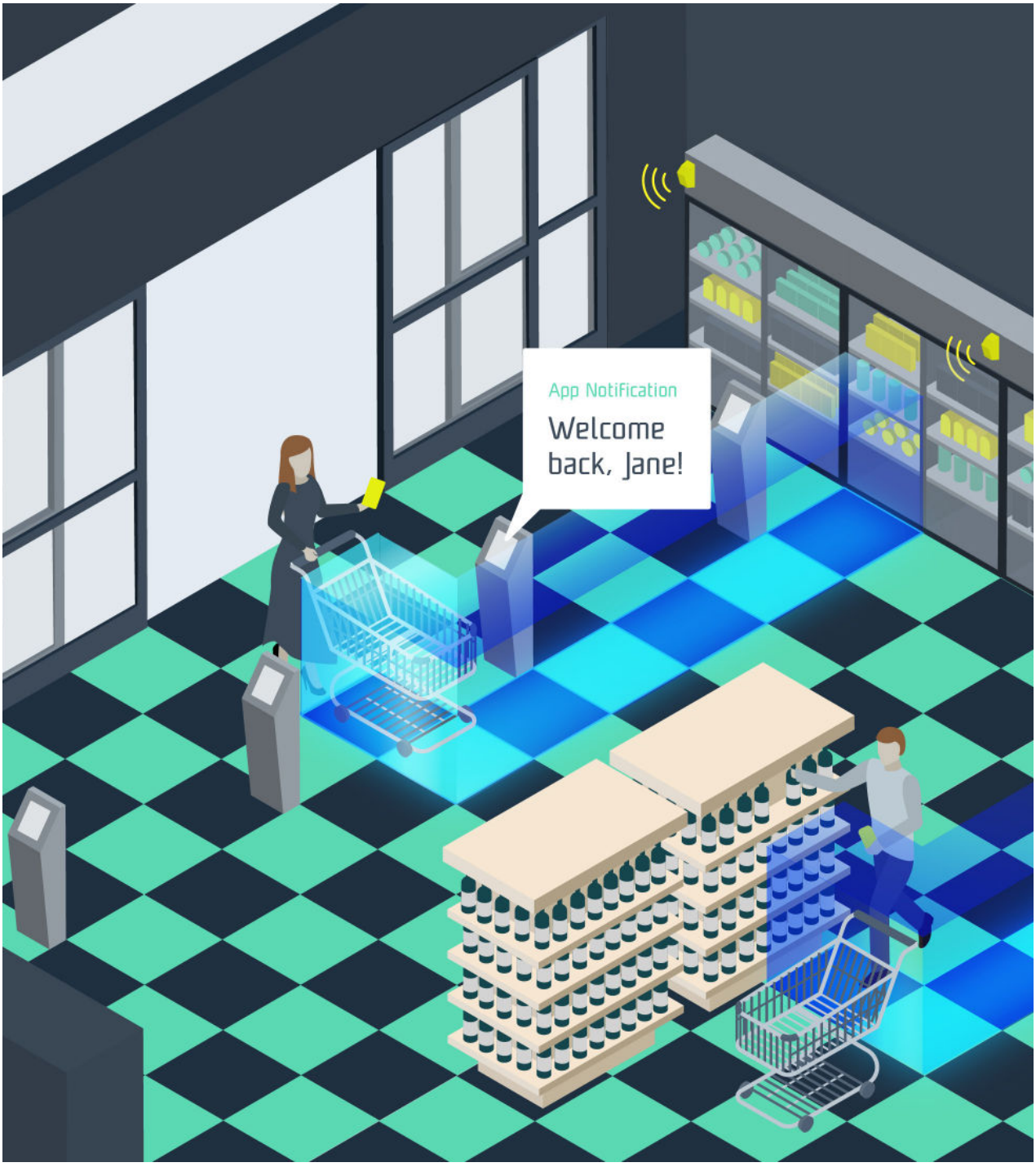
PLAN YOUR NEXT MOVE

BY C3

The Internet of Things: How Iot Is Reshaping Retail

The Deal Is in the Data



SOLVING FOR RETAIL

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From a term that came into use in 2009, the Internet of Things (IoT) has come a long way in 10 years. You've no doubt heard about it and likely use it on a daily basis if you own a fitness tracker or smart home gadget of any kind. It refers to the ecosystem of physical objects that are connected to the Internet and use it to communicate.

As with many new technologies the IoT has been the subject of much hype, lots of grand ideas and, inevitably, somewhat less return than initially promised. For an in-depth look at IoT and the "endless opportunities", it was offering a few years ago, see our Whitepaper, **The Internet of Things and the Modern Supply Chain**. Right now, in the context of the retail Armageddon, we thought it was time to offer a reality check on IoT and how it may play out in the retail sector. **What we discovered is IoT does have numerous applications for retail operations, but not necessarily where we thought they might be a few years ago.**

What's interesting is how the use of IoT technologies to track inventory throughout the supply chain can dovetail with the kind of visibility you gain when you implement a **best-of-breed dock scheduling system**, like the one we've developed at C3 Solutions. IoT lets you know what's on an inbound trailer, for example, and our solution lets you make sure that the right trailer gets unloaded, at the right door, at the right time.

It's a beautiful, coordinated sequence that lets you keep all the pieces in play for better efficiency. **Read on to learn more about IoT, its scope and potential retail use cases. It's a fascinating technology, and it's here to stay.**

IoT explained

The Internet of Things refers to the network of connected items that use the Internet to communicate. They are connected electronically via sensors that collect data like location, motion, temperature, light levels and so on. The communication is two-way; meaning IoT-enabled devices monitor their environment, collect and send data and can receive instructions, and take action based on the information they collect and receive.[1]

IoT-enabled things are generally thought of as items that would not 'normally' communicate via the Internet, thus smartphones and computers are excluded from the IoT. Examples of IoT-enabled products include appliances, automobiles, trucks, numerous components and parts, as well as personal consumer items like clothing, mattresses, toys and smart home devices like locks and light bulbs.

In 2015 predictions for IoT adoption were extravagant. Top analyst firm Gartner estimated that there would be 26 billion connected items by 2020, while Frost & Sullivan suggested the number would be more like 50 billion.[2] Cooler heads have prevailed now, though, and Gartner's best guess was in 2019 there would be 14.2 billion connected items, growing to 25 billion by 2021.3 Other research is even more conservative, placing the 2018 estimate at seven billion (not including the computers and phones noted above) with growth to 11.6 billion by 2021.[4]

Whatever the correct number turns out to be, it's clear that there may have been some unrealistically high expectations for IoT four or five years ago.

IoT evolution

Regardless of the exact number, countless factors are currently influencing the direction and growth of IoT. You can't talk retail without mentioning the 800-pound gorilla, so here's where Amazon rears its head once more as a **retail disruptor**. The online retailer is moving into bricks-and-mortar stores with its Amazon Go self-checkout concept, and has plans to open 3,000 of the small footprint outlets by 2021. Equipped with cameras and sensors everywhere to capture what shoppers have in their baskets, this is seen as an important driver for the IoT market, as other retailers are likely to try to follow suit. The value of the IoT market in retail is predicted to jump from US$10 billion in 2017 to around $35 billion by 2024.[5]

Other factors supporting the growth and attractiveness of the IoT are significant cost reductions in the costs of the technologies that make it possible. The average price of sensors has fallen from US$1.30 in 2004 to $0.38 in 2019, for example. Likewise, the cost of data transfer dropped from $0.47 in 2014 to just 4 cents in 2019.[6]

The anticipated arrival of 5G communications technology is also expected to give IoT a boost by allowing for faster data transfer, bringing new use cases to light and bringing it into the mainstream. Here, it is anticipated that the consumer will be the main beneficiary; as they will have access to more data, faster, enabling more comprehensive comparison shopping.[7]

Inside and Out

A handy framework for understanding where IoT can be applied is to understand the external and internal benefits it can deliver to the business.

In retail, that breaks down into how IoT can improve the customer experience to drive revenues – the external use case – and how IoT can be applied within the organization to create efficiencies.

Driving revenue

As noted above, providing more information to consumers is the primary method by which IoT will deliver external benefits. And it's in the **bricks-and-mortar outlets that most of the benefits may be realized.**

For example, this can include improving the in-store experience for shoppers by enabling location-based services such as an app that allows them to summon a clerk to their location, or request another size of an item from inside the changing room. Wearables offer retailers the ability to readily identify VIP clients, and in the case of Disney amusement parks, which hands out enabled wristbands to visitors, to monitor lineups and deploy staff to speed things up when necessary.[8]

Beacons are used to ping consumers in their immediate vicinity with special offers, and can also offer navigational aids within the store or mall environment.[9] Digital signage promises to inform customers with real-time price changes, specials or information like the number of parking spots available and on which level in a parkade.

The customer experience is also being enhanced through the use of heat maps to analyze traffic in stores and position products better where shoppers naturally seek it out.[10] Foot traffic analysis can also be applied across malls to optimize the shopping experience.

A perfect fit for fashion

Fashion retail, particularly, may stand to benefit from the use of these technologies, as clothing is mostly all tagged already. Adding the sensors and the ability to use the location data they provide is the remaining piece of the puzzle.

Men's shirt retailer Untuckit recently developed a pilot project in which RFID tags placed on “try-on” shirts in its retail outlets collect real-time data on merchandise movement from showroom to fitting room (and back). Using a combination of the chip data, overhead traffic counters and point of sale data, sales managers can identify which exact sizes and styles are being tried on and bought.

This data shows which SKUs are bestsellers so store managers can optimize inventory levels in real-time based on shopper behaviour. It also suggests which sizes or styles can be reduced in volume due to low demand, reducing inventory cost and allowing for Untuckit to redirect their investments toward more popular SKUs, or new offerings.

The pilot also included beacon-based traffic monitoring to count, observe and measure the traffic paths of shoppers and store associates. They can also gather data on when shopper-associate interactions occur, how often, in what duration, and how they impact shopper behaviour. With its high-touch approach, understanding how associate behaviour influences shoppers is a valuable training and service insight for Untuckit.

> **When people ask about examples of IoT in retail, I talk about this pilot. We have the ability to "upgrade" the physical store in a way that captures the same kind of data we get during online interactions,"**

said Keith Sherry, COO of SATO Global Solutions, which partnered with Untuckit.

> **"Retailers looking to compete in brick-and-mortar have more tools than ever to understand shopper behavior. The key is then applying these insights to align the customer experience with expectations across all channels." [11]**

For e-commerce, IoT payments are poised to gain a huge share. For drive-through applications or in-home shoppers, smart devices such as Amazon's Alexa can be enabled and authorized to transfer payment information via voice commands. Due to their speed and increased convenience, these transactions are expected to boom in the next four years; going from 56.5 million transactions made by payment-enabled smart speakers virtual assistants by the end of 2019 to 1,554.6 million in 2023.[12]

Driving efficiency

While most of the external benefits are seen in the retail space, the benefits that help keep costs under control are largely invisible to the customer. There are exceptions to that generalization, however, with IoT-enabled inventory counting increasingly being employed in retail outlets. From smart shelves that transmit inventory positions to stockers to robots that roam around taking counts, IoT is already being employed by numerous retailers trying to keep inventory numbers in real-time to prevent stockouts.

Inventory control inside the retail DC is not typically done with roving robots, although Walmart did try drone-based stock-taking in the warehouse a few years ago.[13] **More typical is sensor-based tracking using RFID on pallets or cartons to count and locate stock within the DC**. Active tags are also enabling the continuous tracking of loads in transit, from origin to destination, giving operations managers insight into where their goods are at all times and when they will arrive.

The benefits of having real-time visibility into on-hand and in-transit inventory is obvious. First, it saves the costs associated with counting things – time and labour. Second, the accuracy affords better planning and reduces the need for safety stock. Less stock means smaller warehouse footprints are possible, saving land and infrastructure costs. In the high-speed e-commerce and omnichannel retail, this also means there is less chance of losing customers to the competition because of out-of-stock situations.

The equipment and assets that operate the supply chain, from trucks and containers to forklifts and conveyors are yet another area that IoT is being applied. **The use case for asset tracking and predictive maintenance is a strong one, and it's been done for many years with solid results**.

It's almost routine now for forklift manufacturers, **AS/RS builders** and other material handling equipment suppliers to have IoT enabled maintenance communications built into their machines. Not only does it help keep their users' distribution centres running smoothly, with lower maintenance costs and less unplanned downtime, it also affords the manufacturer a potential new source of income from the diagnostic and maintenance service.

Specialized applications have also been tried, to ensure that material handling equipment is not inadvertently damaging product during the putaway and picking process. GE Appliances developed an IoT-enabled basiloid for appliance handling whose sensors will alert the user and back office to potential problems like excessive G-forces or pressure. **Ensuring the product you sell doesn't receive invisible damage on your own DC premises means more satisfied customers and fewer returns**.[14]

Bringing the outside in

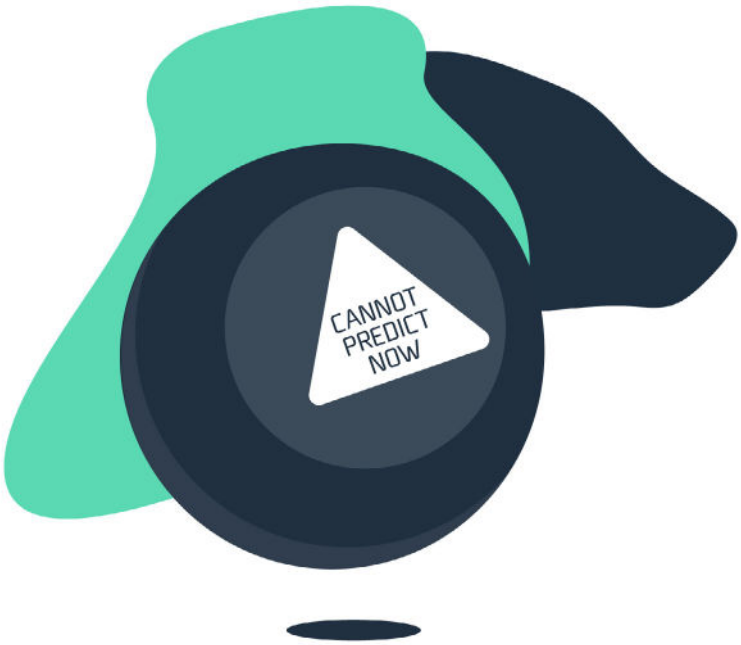
When you net the benefits that IoT can provide, both inside and outside the organization, you are essentially looking at the perfect, streamlined, transparent supply chain. Consumer data provider Nielsen refers to this **as "frictionless commerce", or giving shoppers "zero resistance from discovery to assessment to shopping to payment to fulfillment."**[15]

It encompasses the external blandishments being offered to consumers to entice them to buy – from the cashier-less Amazon Go shop, to the beacon that delivers personalized marketing messages, to the in-store experience that ensures no need goes unmet – and the back-end supply chain benefits like automated inventory control, shipment tracking, real-time inventory visibility and quality control. Meshing in-store data with full supply chain visibility gives the ability to use predictive analytics to optimize inventory flows.

> **Speed and convenience will drive behavior – and every millisecond reduced is a battle won,"**
>
> Nielsen says.[16]

Miles to Go

In spite of Nielsen's optimism, IoT still has a long way to go before it becomes mainstream technology and that perfect supply chain is realized. It's not the retailers aren't interested; **in fact, they strongly believe that IoT will have a dramatic effect on business in the next three years**, and 72 percent in a recent North American study said they were interested in IoT based automation, sensors and analytics.[17] It's just that half of them don't know how they'll use it in their own business.[18]



> **The biggest barrier to the IoT is that most enterprises do not know what to do with the technology,"[19] says Gartner Research Vice President Mark Hung. Even now, IoT seems to be a solution searching for a problem to solve. While the tech is "clearly past the early innovator phase...now we need to find out how to get it more mainstream," said Bill Hoffman, president of Object Management Group, a not-for-profit technology standards consortium, speaking at an IoT conference in October 2019.[20]**

"3PLs need to come to us with proposals on the kind of automation and IoT solutions that are going to noticeably counter rising costs while increasing visibility. We hear of solutions in R&D labs but we do not see the case studies of success stories implemented at scale. Nobody wants to be the guinea pig," Intel's global logistics procurement director Greg Christensen told the authors of the *2019 State of Logistics Report*.[21]

Where's the ROI?

It's understandable that companies don't want to take the risk on technology that has yet to demonstrate solid ROI numbers. Retail has the lowest margins of any sector, at .5 to 3.5 percent, making the investment hard to justify, especially when the use case is primarily in brick-and-mortar stores, which have been suffering under the e-commerce onslaught.

The few scaled-up implementations are being undertaken by retail giants – Amazon, Walmart and supermarket giants, primarily in dense markets like the United States and Europe. But for most retailers, IoT may not be that compelling.

Gartner suggests that the strongest business cases for IoT focus on finding **cost savings in fuel, energy consumption and labour – delivering shorter ROI times and higher paybacks.** The best candidates in their estimation are asset-intensive industries – so-called heavy industry like energy production and mining.

Gartner said in its “Leading the IoT” report.[22]

> **Here, industrial mechanical devices with high cost and complexity, critical asset value and remote geographic location realize IoT benefits such as remote asset monitoring and predictive maintenance that maximize asset utilization and minimize critical failure unplanned downtime,"**

It's about the data

Going back to the internal versus external framework for analyzing IoT applications, it appears that retailers need to keep their eyes on the real prize: the data. In a recent report, RSR Research claims that IoT for retailers is not at its heart about saving costs, although that is a side benefit of the inventory accuracy and information IoT delivers.

> **Its ability to bring about accuracy and efficiency to both inventory and inventory-related tasks absolutely has a cost-benefit component. After all, a needless task wastes human capital, and retailers have long been clamoring for smarter ways to reduce time wasting efforts – and the dollars associated with them,"**
>
> the research firm suggests.[23]

What retailers really stand to gain is the data, the information that is generated by the billions of smart devices in stores, and in the products they sell. With better quality information – not to mention more of it – retailers are able to take more informed action on their inventory positions. They'll be better equipped to decide where to allocate a product in the store to help it sell, when to put it on sale when its time is nearly up, where to position it in the distribution network to speed up fulfillment and lessen the pain of returns. When the information is that good, retailers can also share it with their customers to improve communication and further strengthen the relationship.[24] It creates a positive feedback loop where the retailer and customer join together in an IoT ecosystem that ideally finds a perfect balance.

Keep it Simple

We've talked a lot here about bricks-and-mortar stores. Usually the focus is on retail distribution and how to make the background operations as seamless as possible to ensure perfect order fulfillment. And ultimately, that's what we are still talking about.

Understanding where and whether to use IoT in your retail operation is a strenuous exercise, requiring a thorough understanding of your own operation and the potential business benefits you might gain. We can't tell you if IoT is right for your business, but we can explain how what we do will support you; regardless of the IoT decision you make. Successful retail distribution depends on having the right inventory in **the right place at the right time**, and it needs to be moving fast to keep up with today's pressures for same day delivery. That's the bottom line, regardless of how you get the inventory data you need to fulfill orders.

So, when you think about that higher function, also take a moment to consider how the moving parts of your distribution centre might be made more efficient. Take the dock doors, for example. In this fast-paced environment are you still using a spreadsheet to keep track of what's coming and going? Do you have a frustrated, harried co-worker whose job it is to track down truck drivers and find out why they didn't show up when they said they would? Maybe that person is you!

It doesn't have to be that way. The technology is at your fingertips to manage and control those dock doors, so you don't have to. **Dock scheduling from C3 Solutions** frees up the time of that scheduler and lets them do more productive work. It allows truck drivers to set their own appointments at the dock door, using a mobile app. It integrates with your system software – ERP or WMS – so you have visibility into the inventory inbound on those trucks.

Smoothing out the operation of your loading docks could just be the simplest, most effective change you make. Imagine how much more efficient the DC could be with inbound loads arriving on time, as expected, with staff at the ready to unload quickly and efficiently. **Carriers will love you** because you make and ***keep*** **appointments, and they don't get stuck waiting, wasting precious driver time.** You'll save money on **detention charges** too.

It sounds simple, doesn't it? We make it that way so that you have time to ponder the really big questions, like whether IoT is right for your business. But, just as a fully IoT-enabled retail operation succeeds on the successful analysis of reams of data, a C3 scheduling solution puts the complicated calculations and algorithms behind the scenes.

All you and your carriers see is the effective interface that keeps traffic at the docks flowing.

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