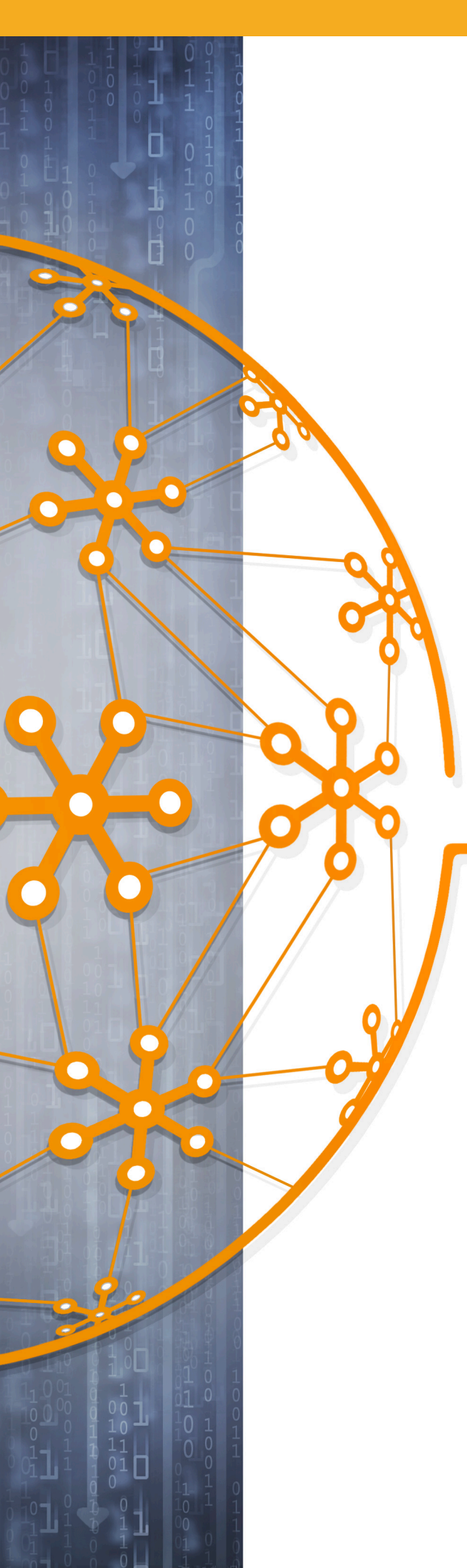

Intralogistics 4.0

invata intralogistics

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The dawn of the fourth industrial revolution is here, and that will result in a paradigm shift in intralogistics, the art of automating, integrating, managing, and optimizing the logistical flow of material goods with the flow of information within the walls of a fulfillment center, distribution center (DC), or warehouse.

The next stage of the industrial revolution, dubbed Industry 4.0, offers tremendous opportunity for businesses to tap its potentials to improve efficiency, transparency, and productivity in the supply chain. By intelligently networking elements in the logistics system, logging massive amounts of data, learning from conditional results, and adapting system behaviors, companies can use their supply chains to attain leading technological positions in an increasingly competitive marketplace. As Industry 4.0 evolves, so too will the importance of what is being is referred to as Intralogistics 4.0: The optimization of the systems and operations within the physical infrastructure of existing and new supply chain nodes.

Massive changes in macroeconomic factors coupled with an accelerated rate of technological innovation are what's driving the shift to Intralogistics 4.0. In this position piece, we take a closer look at both the macroeconomics at play as well as the technological innovations that are accelerating the rate of change.

The Macroeconomics of Intralogistics 4.0

Each of the previous three industrial revolutions brought about momentous changes in the macroeconomic output of goods and services, as well as in work activities. That will certainly be the case with the fourth industrial revolution. The growth of e-commerce, mass personalization of products, the growth of urbanization, the practice of sustainability, a shortage of highly skilled workers, and dramatic advances in technology are coming together to push the transformation to intralogistics 4.0.

The Growth of E-Commerce

E-commerce represents a significant macroeconomic shift in consumer purchasing behavior. In 2016 online shopping totaled $327 billion or around 10 percent of all retail sales, according to estimates from Forrester Research. And e-commerce is only expected to grow as consumers buy more products off the Internet rather than in physical stores. What's driving the growth of e-commerce are two factors: the increasing use of mobile devices, and traditional retailers making greater investments in omni-channel distribution systems. In this regard, demand and supply are both feeding and playing off one another to increase the size of the e-commerce market.

As of 2016, it's estimated that 77 percent of all Internet users in the United States made a purchase on the web, and all signs point to that percentage increasing in the coming years. Fulfillment of all those e-commerce orders will be challenging on at least three fronts:

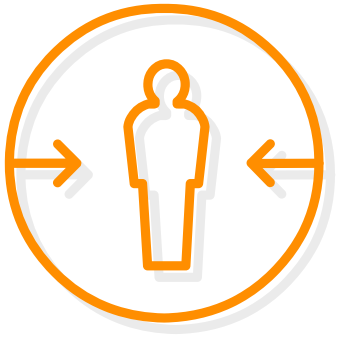
- First, direct delivery of products to consumers necessitates fast order fulfillment. The time to pick, pack and ship will be in minutes rather than hours, demanding greater levels of efficiency in the

fulfillment process than ever before.

- Second, filling direct-to-consumer orders requires handling individual items rather than cases or pallets. Handling individual items continues to be very labor intensive and complex, meaning companies will need to find new ways to improve efficiencies in the e-commerce fulfillment process.

- Third, for omnichannel retailers that want to meet e-commerce customer demand, sophisticated inventory planning will be needed to ensure there is enough product to meet consumer demand across different fulfillment channels without creating excessive safety stock levels that would tie up a company's capital.

Mass Personalization



Beginning 20 years ago, some producers devised ways to customize certain products within a mass production framework so goods could be sold for a much lower price than traditional customization would have allowed. Today mass customization has reached the point where customers now expect to have any product anytime they want it, anywhere they want it, and any way they want it. And there is no reason to believe this trend toward mass customization will abate. The number of mass customized products will continue to grow especially as producers adopt new technology like additive manufacturing or, as it's more commonly called, 3-D printing. Along with product individualization, personalized services will grow as well, including those for logistics and product delivery.

By 2025, the intralogistics industry must be capable of supporting a highly diverse set of order and distribution channels in keeping with mass customized products and delivery methods. Customers will want to order with their mobile devices and traditional retail will exist only for a customer experience. In the future customers will expect

deliveries of customized product anywhere at any time, placing fierce demands on DCs for faster throughput.

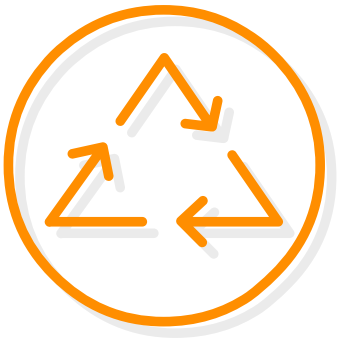
Urbanization

The rate of urban growth in the United States beginning in 2010 exceeded suburban growth rates for the first time since the 1920's. This macroeconomic trend has continued for the last five years and is expected to continue until at least 2050. Presently, 50 percent of the world's population lives in densely populated urban areas and the United Nations has projected that to increase to 64 percent by 2050.

Urbanization creates a number of issues for supply chain systems that provide consumers with goods. On one hand densely populated areas provide economies of scale for deliveries. On the other hand, land costs are higher in such areas, upping the expense for operating last-mile distribution centers. Urban consumers tend to purchase smaller quantities per store trip due to a lack of household storage. They also have lower levels of vehicle ownership and rely more on public transit, increasing demand for home good deliveries. Urban populations are often more demographically heterogeneous, creating a greater demand for a higher variety of products.

Sustainability

The importance of energy efficiency, environmental concern, and care for the workforce will continue to be factors in the transition to intralogistics 4.0. As far back as 2011, the tagline for the CeMAT fair in Hannover, Germany was "Sustainability of Intralogistics," an acknowledgment that industry growth would not come at the expense of future generations. The fair's directive to the intralogistics practitioner was focus on three pillars: economy, environment, and



social responsibility and to strike a balance between the three. Specifically, it called for companies to develop efficient products and systems, become more frugal with resources, and take into consideration the welfare of the people involved in these processes.

One company that's already committed to a sustainability in intralogistics is Nike, which in May 2016 released its vision for the Supply Chain of the Future, featuring an expanded logistics campus in Antwerp, Belgium. The campus sources energy from five locally generated renewable energy sources, including six 150-meter high wind turbines, and solar panels equivalent in size to three soccer fields. The campus recycles 95 percent of the waste generated onsite. Transportation routes to and from the campus have been optimized to reduce CO2 emissions by 30 percent. And the intralogistics technologies in use were selected for alignment to the overall vision and deployed in a highly efficient operating concept. Although the Nike logistics campus represents one of the first embodiments of that 2011 CeMAT vision to date, it certainly won't be the last.

For Millennials, also known as the "green generation," delivering sustainable solutions is a requirement. Millennials place sustainability as a priority on their shopping list and are willing to pay more for it. This means that Industry 4.0 and subsequently Intralogistics 4.0 stands to defy free market trends of the past in that quality, price, and convenience won't necessarily be the only determiners of product success. Because millennial consumers place more emphasis on value over price, they are willing to pay more for what feels right. And as Millennials gain greater control over the business world's financial resources, they will reward the intralogistics brands that establish a reputation for environmental stewardship and social responsibility.

Workforce Scarcity

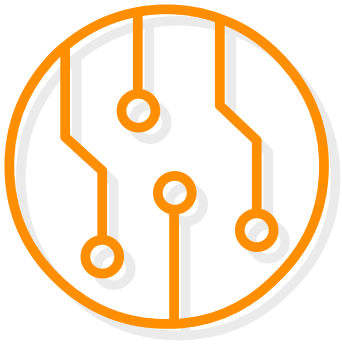
One additional macroeconomic trend that is also behind the transition to Intralogistics 4.0 are changes in labor force demographics. According to the US Census Bureau, 60 million "Baby Boomers" will exit the workforce by 2025, while only 40 million new workers will enter the job market. The cost of finding, training and retaining increasingly scarce labor is about to reach a tipping point. With labor being a substantial portion of operating budgets, escalating labor costs have a significant impact on margins.

In addition, there is considerable concern whether the existing and future workforce will have the skills needed for employment. The rapid rate of technological change inherent to today's market requires workers to regularly acquire new skills to stay relevant. But it's not just technology skills that are cause for concern. Skill gaps in much of the workforce include problem-solving abilities, situational response expertise, abstract reasoning, and even basic work ethic. And there is no indication these trends will reverse themselves any time soon.

The Evolution of Technology

As has been the case with the past three industrial revolutions, advances in technology play a major factor in driving macroeconomic changes in the way goods are produced and services are rendered. Technological evolution will alter the operation of the supply chain as businesses adopt new technology to minimize costs and maximize profits.

In particular, five key technologies are expected to play an important role in Intralogistics 4.0 for the following reasons.



- Mobile computing will enable constant communication and knowledge access for on-the-go consumers, managers, and workers.
- Industrial and humanoid robots will supplant human workers for routine, manual tasks in intralogistics.
- The Internet of Things (IoT) will provide constant monitoring of the intralogistics center and supply chain network.
- Big data analytics will harvest insights from piles of information for operational improvements.
- Additive manufacturing, aka 3D printing, will enable the quick construction of products or parts to unique buyer specifications.

Technological Innovations Accelerating Intralogistics 4.0

While macroeconomic factors play a major role in driving the transition to Industry 4.0 and Intralogistics 4.0, the rate of change in technological innovation is playing an equally important role in accelerating the advent of Intralogistics 4.0.

Both macroeconomic factors and the rate of technological innovation go hand-in-hand in this scenario as each feeds on and plays off the other. Technological innovation is driving macroeconomic change, but its adoption is occurring sooner because of macroeconomic change. And vice versa.

Below we take a closer look at advancements in technologies that will drive the rate of change to Intralogistics 4.0.

Mobile and Wearable Computing

Advances in mobile computing means that people no longer have to be connected to stationary computing devices to access knowledge and information. Mobile computing allows individuals to access information stored in cloud computers from almost anywhere. Consumers with imbedded global positioning systems in their smart phones can know where they can locally source products and track their delivery. Constant connectivity means purchasing is no longer limited by time or geography, and therefore DC operations are now 24/7 operations to serve customers who are everywhere and buy at any time.

Mobile computing technology for use in intralogistics includes optical head-mounted eyeglass computer displays, which support augmented reality applications to enhance warehouse worker productivity and convey non-verbal information. This technology leverages a human trait: people tend to remember what they saw and did, and often don't remember what they read or heard. Augmented reality provides a solution for applying

non-verbal communication to the workplace. It does this by offering visual cues to direct workers to pick locations or in packing items.

Fitness trackers used by consumers also have potential for application in distribution operations. Because these trackers measure steps, distance, calories, and custom activities, this technology could be applied to enhance both productivity and worker safety in the distribution center. The tracker could provide a deeper level of granular data on warehouse worker activity for use in Labor Management Software Systems.

Robotics and Automation

The use of robotics in Intralogistics should expand as distribution operations turn to this technology to automate pick, pack, and ship activities. The International Federation for Robotics reports that in 2015 the global population of industrial robots totaled 1.6 million units. And the IFR predicts that the number of industrial robots deployed worldwide will reach 2.6 million by 2019. Although industrial robots are primarily used in manufacturing, they are becoming more viable for material handling and logistics in the future. DCs will increasingly use industrial robots to automate order fulfillment and provide 24/7 hours of operation to meet around-the-clock product demand.

Still, industrial robots are really machines that perform automated tasks and not the humanoid robots found in sci-fi books and movies. But companies are working on humanoid robots that will find their way into Intralogistics. Rethink Robotics has taken a step in the direction of a humanoid robot with its product, Baxter, which has a camera face and two mechanical arms. Humanoid robots could be used to address the challenges inherent to single-item picking and provide efficiency. Before humanoid robots see application in a warehouse, they will require the development of fine motor skills for selecting a variety of items along with sophisticated visions systems to distinguish object characteristics. Increases in computer power, software intelligence, vision systems, and sensors make the development of humanoid robots a question of when, not if.

While humanoid robots may take years to perfect, existing robotic technologies already in use in retail fulfillment applications will continue to see expanded usage for moving inventory to and from storage. Mechanized conveyance vehicles, or "bots," popularized by Amazon Robotics, improve labor productivity by bringing goods to workers for picking and packing as do robotic shuttles used in automated storage and retrieval systems. Equipped with telescoping load handlers that mechanically deposit and retrieve cases and totes from static storage shelves, shuttles will continue to be a key component in advancing goods-to-person technology going forward.

Driverless industrial trucks that will use robotics technology are on the horizon as well. Self-operated, robotic forklifts are likely to be deployed in increasing numbers to improve warehouse productivity in the near future, displacing sales of electric and internal combustion engine (ICE) units. In 2015, the Industrial Truck Association said nearly 65,000 electric rider units and 76,000 ICE units were shipped, and it's likely that at least half of the annual shipments of rider forklifts will be replaced with autonomous vehicles in the next 10 years, offering significant benefit to the logistics industry. Given that the majority of rider forklift trucks are being driven by an operator two shifts a day, replacing those forklifts with robotic forklifts represents a potential $40-80 billion in annual labor savings.

Sensors And The "Internet Of Things"

All kinds of industrial and consumer equipment and facilities will be outfitted with sensors and computing devices to collect and exchange information such that the Internet of Things (IoT) will consist of 50 billion networked devices in 2020. Each year, manufacturers are creating smaller and smarter devices that can talk to other devices without human intervention. These devices will be used for an array of functions and activities in the supply chain and intralogistics center. The standardization of communication protocols will further spread adoption, especially as businesses will seek to collect data from these sensors anywhere at any time.

In the future, the IoT will be widely used inside the intralogistics center to track inventory allocated to a single order in the same way that packages on delivery routes are tracked today. With delivery windows for orders placed on the Internet growing shorter and shorter, DCs will need this ability to track in real time to ensure prompt fulfillment to meet “anywhere-anytime” delivery schedules.

Big Data and Analytics

As more companies deploy IoT in their supply chains, it will accelerate their adoption of big data analysis. In fact, future supply chain operations will require and depend on the omnipresence of big data analysis.

The growing field of data science is critical to big data analysis. Data science takes advantage of advances in computing power and applies techniques from operations research, mathematics, statistics and computer science to glean insights from massive quantities of data in both structured and unstructured formats. Data mining is a commonly used tool that involves sifting through large, disparate piles of data to discover patterns and correlations. The discovery of patterns in data that had previously been overlooked can lead to smarter decisions in intralogistics. For example, British grocer Tesco correlated weather patterns with sales data to determine that it sells 50 percent more coleslaw, 250 percent more barbecue meat, and 25 percent fewer Brussel sprouts when the temperature in the summer rises 10 degrees. That analysis allowed Tesco to improve its on-stock availability of produce and meats in its stores. New techniques in data visualization further support decision making as they present the findings of an analysis in the form of charts and graphs that the human mind can grasp quickly.

Examining data for business insights is not new in that for years companies have undertaken descriptive analysis to evaluate and compare past performance of warehouse and supply chain operations. Today, however, the field of data analysis has expanded to

not only include the use of diagnostic analytics to troubleshoot root causes of problems, but also to include the use of prescriptive analytics to propose remedies and predictive analytics to envision the future, especially for product demand in the area of the supply chain. As supply chains become more demand driven, predictive analytics will likely take on a larger role than traditional forecasting, which uses the data of past events to predict future trends while factoring in additional information. In looking for patterns from seemingly non-related data and events, predictive analytics will enable companies to adjust production and inventory to ensure they have adequate supply for shifts in customer demand. For example, the analysis of chatter on social media might portend a shift in demand for fashion items. Finally, there's the emerging field of cognitive analytics, which uses machine intelligence and self-learning systems. The cognitive approach promises to find new ways of understanding data for diagnostic, predictive, and prescriptive analysis purposes.

Leveraging Big Data for operational insights presupposes that the underlying data elements are available and easily accessible. The implementation of IoT in the supply chain should increase the amount of data available for monitoring and analysis. In the years to come, the process, techniques, and need for deriving meaning from all of this data will only become more sophisticated as this field of technology matures. Because some supply chain partners will be reluctant to share information, companies can be expected to first employ Big Data analysis to improve performance into their own supply chain and DC operations.

3D printing

3D printers might seem like a novelty or high-end toy right now, but additive manufacturing, as it's also known as, will disrupt industrial and consumer supply chains of the future. Not surprisingly, many leading edge supply chain companies are investing big money in the future of this technology. There is now a 3D printing factory located within the UPS Worldwide Hub in Louisville, KY making it possible to print virtually any product and deliver it anywhere in the world

overnight. Amazon has also filed a patent request for trucks with 3D printers on board.

Customer expectations around personalized products and the need for mass customization could result in retailers manufacturing individualized products to customer specifications in the store itself. In the future, customers will enter the shoe store, have their feet scanned, and shoes will be printed to fit the exact contours of their feet in the style and color of their choice.

Additive manufacturing will also disrupt current practices in procurement and supply management. Manufacturers will cull their supplier base as they adopt 3-D printing for customer orders requesting product personalization. This manufacturing postponement will lead to fewer suppliers, except for specialized components, and less on hand inventory in the DC.

Spurred on by the demands of e-commerce, manufacturing postponement will shift from the factory to DC in many cases. The placement of an online order will trigger the DC to use 3-D printing to make the requested item or, more likely, customize the desired product to individual specifications. With online shoppers expecting prompt delivery, production time will have to be factored into the fulfillment process as DCs will shift from pick, pack, and ship centers to “make, pick, pack, and ship” centers.

The Intralogistics 4.0 Practitioner

The confluence of macroeconomic changes combined with advances in technology provide the tipping point for Intralogistics 4.0. Labor scarcity and rising costs are intersecting with the availability of new technology that brings decreasing costs. Consumer expectations for speed of delivery and lowest landed costs are on the rise with no sign of letting up. Companies are responding by pushing the service envelope for every bit of competitive advantage they can get. That means order fulfillment in the DC must be faster, better, and less expensive than ever before.

Ultimately, supply chains will set up self-managing intralogistics nodes where DCs leverage automation and robotics, as well as technically trained workers. The latter will be equipped with wearables and trained on how to maintain and manage the technology rather than how to execute the tasks.

The staples that will define the Intralogistics 4.0 practitioner will be:

- Data science
- Modeling and simulation
- Software to enable emerging technologies in a supportable fashion
- Software that can handle the highest transaction rates without performance issues
- Staff to support 24/7/365 operations

Although businesses may never get to a “zero-person DC,” the supply chain evolution has seen the steady replacement of human labor with machines and computers. Intralogistics 4.0 propels the warehouse to deploy automation and culminates in a paradigm shift in intralogistics design.

Unlike the DC operation of today, which is designed around human limitations, both from the standpoint of the worker and management, the 4.0 intralogistics center is run by robots and automation. The management of that center is left in the hands of high powered machines that possess knowledge of all resource capabilities within the center and past performance of the center under different circumstances to provide guidance with an intelligence that goes beyond human capacity.

To learn more about how Invata Intralogistics can help you in preparing for the advent of Intralogistics 4.0, drop us an email or call us at 860-819-3200.