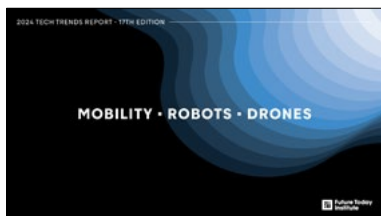


SUPPLY CHAIN - LOGISTICS

FUTURE TODAY INSTITUTE'S 2024 TECH TREND REPORT

Our 2024 edition includes nearly 700 trends, which are published individually in 16 volumes and as one comprehensive report with all trends included.

Download all sections of Future Today Institute's 2024 Tech Trends report at <http://www.futuretodayinstitute.com/trends>.





THE YEAR AHEAD: TECH SUPERCYCLE

The theme for our 2024 report is Supercycle. In economics, a “supercycle” refers to an extended period of booming demand, elevating the prices of commodities

and assets to unprecedented heights. It stretches across years, even decades, and is driven by substantial and sustained structural changes in the economy.

We believe we have entered a technology supercycle. This wave of innovation is so potent and pervasive that it promises to reshape the very fabric of our existence, from the intricacies of global supply chains to the minutiae of daily habits, from the corridors of power in global politics to the unspoken norms that govern our social interactions.

Driving this seismic shift are the titans of technology and three of their inventions: artificial intelligence, biotechnology, and a burgeoning ecosystem of interconnected wearable devices for people, pets, and objects. As they converge, these three macro tech segments will redefine our relationship with everything, from our pharmacists to our animals, from banks to our own bodies. Future Today

Institute’s analysis shows that every technology—AR/ VR/ XR, autonomous vehicles, low Earth orbit satellites, to name a few—connects to the supercycle in some way.

The ramifications are stark and undeniable. As this tech supercycle unfurls, there will be victors and vanquished, those who seize the reins of this epochal change, and those who are swallowed whole. For business leaders, investors, and policymakers, understanding this tech supercycle is paramount.

In this 17th edition of FTI’s annual Tech Trends report, we’ve connected the supercycle to the nearly 700 trends we’ve developed. Our research is presented across 16 technology and industry-specific reports that reveal the current state of play and lists of influencers to watch, along with detailed examples and recommendations designed to help executives and their teams develop their strategic positioning. The trends span evolutionary advancements in well-established technologies to groundbreaking developments at the forefront of technological and scientific exploration. You’ll see emerging epicenters of innovation and risk, along with a preview into their transformative effects across various industries.

We’ve visually represented the tech supercycle on the report’s cover, which is an undulating image reminiscent of a storm radar. Vertical and horizontal lines mark the edges of each section’s cover. When all 16 section covers converge, the trends reveal a compounding effect as reverberating aftershocks influence every other area of technology and science, as well as all industries.

It’s the convergence that matters. In isolation, trends offer limited foresight into the future. Instead, the interplay of these trends is what reveals long-term change. For that reason, organizations must not only remain vigilant in monitoring these evolving trends but also in cultivating strategic foresight—the ability to anticipate future changes and plan for various scenarios.

Our world is changing at an unprecedented rate, and this supercycle has only just begun.

A handwritten signature in black ink that reads "Amy Webb".

Amy Webb

Chief Executive Officer
Future Today Institute

TABLE OF CONTENTS

05	Top Headlines	20	ESG Tracking and Declarations	34	Authors
06	State of Play	21	Omnichannel Management Platforms	36	Selected Sources
07	Key Events	22	Diversifying the Procurement Process	39	About Future Today Institute
08	Likely Near Term Developments	23	Last-Mile Solutions	41	Methodology
09	Why Supply Chain & Logistics Trends Matter to Your Organization	24	Smart Ports	42	Disclaimer
10	Opportunities and Threats	25	Scenario: The OmniVision Chain	43	Using and Sharing the Report
11	Investments and Actions To Consider	26	Manufacturing & Distribution Enhancements		
12	Central Themes	27	Continuous Additive Manufacturing		
14	Ones To Watch	28	Smart Warehouses		
15	Important Terms	29	Nano-Fulfillment Centers		
16	Supply Chain & Logistics Management	30	Intelligent Packaging		
17	Augmented & Automated Processes	31	Autonomous Cobots for Warehousing and Delivery		
18	Real-Time Optimization	32	Scenario: The Chroma Information System		
19	Visibility Track and Trace	33	Scenario: Perpetual Motion Manufacturing		

TOP HEADLINES

Warehouses hire robot workers as nearshoring drives growth and manufacturing moves off-land. Driverless deliveries and innovative eco-friendly packaging are also emerging.

01 **Fulfillment Companies Hire Robots**

Human workers in warehouses are increasingly finding themselves working alongside robotic workers.

02 **Mexico Becomes a Nearshoring Target**

Exports from countries experiencing nearshoring to their regions, like Mexico, continue to grow.

03 **Driverless Deliveries Are a Reality**

Automated delivery is now an expectation with companies like EASE Logistics piloting platooning in trucking transportation.

04 **Packaging Is Not Just for Wrapping**

Packaging patents are trying to make disposal a more eco-friendly process—and even edible.

05 **Manufacturing Moves Off-Land**

Through ongoing research in additive manufacturing, researchers have found ways to manufacture more effectively in space and under water.

STATE OF PLAY

Spearheading a New Era of Advanced Automation and Crystal-Clear Visibility

After the pressure and volatility of 2023, the supply chain, logistics, and manufacturing industries are experiencing relative stabilization while dealing with ever-changing consumer demands, climate change disruptions, and labor shortages.

Illness and reduced staff are major reasons for delays and bottlenecks in supply chains. A concerted effort to attract new talent include creating better working conditions, training opportunities, and innovative recruitment strategies—some studies estimate that 87% of companies are trying such tactics to attract new workers. Consumers returning to in-store shopping have increased expectations for seamless and rapid fulfillment services like next-day delivery based on their online shopping experiences, and companies are looking to enhance their last-mile delivery platforms.

Investors and consumers keep pushing for supply chains to become greener, with a significant percentage of companies feeling the pressure to reduce their carbon footprint. As more companies—over 40%—make investments in electrification, resource management, and more sustainable practices, this will continue to grow. With 2023 being the hottest year on record, many of these industries are also experiencing disruption due to extreme weather and looking to diversify sourcing and procurement, along with reshoring, to address the issue. However, delays at ports and limited supplies of raw materials have combined into a worrisome challenge for manufacturing. Demand for logistics and manufacturing space continues to increase yet soaring construction costs are a barrier.

Many of these challenges are putting the focus on automation and the use of technology for greater efficiency and visibility. The integration of the data needed to make automated decisions still proves challenging, and much of the data remains siloed. The largest push across supply chains and logistics for artificial intelligence and machine learning has been in inventory and network optimization, as well as warehouse resource management.

KEY EVENTS

APRIL 25, 2023

Colors determines quality

Researchers at the University of Genoa are working on packaging that changes color depending on the quality of the product inside.

JUNE 15, 2023

Delivery robots require no humans

Cartken's delivery robots can now use AI for full Level 4 autonomy on sidewalks.

AUGUST 9, 2023

Revolutionizing automated routes

The EPG-Greenplan partnership reaches a milestone when logistics provider DANX starts implementing Greenplan's innovative "overlapping" algorithm in Denmark.

MAY 17, 2023

Driverless deliveries take off

Ohio-based EASE Logistics announces its launch of the first autonomous trucking haul in the US.

JUNE 28, 2023

Parabola lands funding

Parabola makes automating manual processes easy to manage, regardless of a team's technology proficiency.

LIKELY NEAR TERM DEVELOPMENTS

ON-DEMAND DRIVES INSTANTANEOUS PROCESSES

Change—whether from consumer demands, new technologies, or global shifts—is the one constant in the supply chain and logistics industries. It’s what leads to new offerings and services, such as the industries’ need to respond to the increasing expectations for on-demand and instantaneous deliveries, communication, production, and reports. Innovations in tracking and tracing goods, automation, and expedited and near-shored manufacturing are happening, but attention is still needed to address the shortages in capital and talent. Proper investment to meet the gaps through technology will be expensive, and could create a burden many smaller companies cannot bear unless they create a clear strategic roadmap. With talent droughts occurring in all three they will have to keep competing for talent and seek out workers willing to be upskilled.



Personalized Delivery Gets Automated

As delivery routes and last-mile deliveries continue to increase in speed and complexity, automation will let logistics companies create an intricate web of delivery offerings that can be unique to each customer.



Climate Insurance for Protection

As climate change continues to be a disruption, logistics providers will explore how they can insure against extreme weather events. These costs could be passed along to consumers who choose goods from more volatile regions.



Combating a Skills Drought

Increased automation and use of virtual agents raise the need for workers to know how to manage new tech-enabled work and tasks. This upskilling could be done through remote learning and working opportunities.



Virtual Agents Take Over

With workers continuing to grow in scarcity, virtual agents will take over back-of-house work in the warehouse. These virtual agents will soon be able to oversee themselves and their cobot workers, reducing the need for human intervention.



Instant Manufacturing Meets Demands

With manufacturing locations moving closer to the consumer and e-commerce increasing, manufacturers need to consider how to create products in the exact spot as their consumers.



Verification Based on Values

Global conflicts, combined with consumers and businesses wary of supporting governments with values antithetical to their own will increase demand for verification of supply chains. Granular data collection and transmission will enable this shift in transparency.

11 MACRO SOURCES OF DISRUPTION



Technology



Media & Telecom



Demographics



Environment



Government



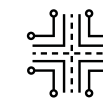
Public Health



Education



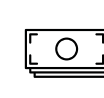
Geopolitics



Infrastructure



Economy



Wealth Distribution



WHY SUPPLY CHAIN, LOGISTICS & MANUFACTURING TRENDS MATTER TO YOUR ORGANIZATION

Track and Trace for Climate Accountability

As companies collect more data around their manufacturing processes, procurement procedures, and logistics for transporting goods, they will be able to create more in-depth reports to provide the level of transparency many governments and consumers require. This task can eventually be automated.

Streamlining Management Platforms

It can be hard to ensure multiple management platforms are interoperable, and that their data can be utilized across the system. An omnichannel platform synthesizes and streamlines processes and information into one concentrated tool, to establish consistent workflows.

Being Resource Resilient

While procurement gets disrupted by climate change and geopolitical conflicts, diversifying the procurement process and nearshoring can help mitigate future incidents. This will ultimately benefit the bottom line through customer satisfaction; however the upfront investment costs need to be charted quickly.

Communicating in Real Time

As consumers and businesses continue to monitor their goods and orders as they move through the supply chain and then through logistics channels, the ability to communicate changes in real time will offer a sense of stability and transparency. Ultimately, companies need to decide on the method for such communication so the information is clear and not burdensome.

Continuous Production

While e-commerce continues to increase, companies need to ensure the production of goods isn't interrupted or stopped. Continuous production through additive manufacturing can offer help in this area, and also sometimes reduce the raw materials needed to produce the goods.

New Management Needed

As cobots more closely resemble the typical worker, human managers might need new skills to manage them. Autonomous cobots can already travel without colliding into racks and other workers, but this technology will need to be monitored and probably further updated as warehouses undergo further developments.

OPPORTUNITIES & THREATS

Threats

Data silos will hinder the flow of information, and ultimately slow the automation process. Companies that have already managed to bring all of their data streams to one platform will have a leg up, and their data integration will support better decision-making.

Lack of raw materials will become a pressing issue for manufacturers that are not diversifying their procurement channels and taking climate change issues into account. Related delays will ultimately force customers to reconsider who they will purchase from.

As delivery routes get more complicated, they could be both too difficult for human delivery workers and too costly for autonomous delivery. If companies don't find the right balance, competitors will win out on savings realized from overlapping last-mile delivery routes.

Until it's fully automated, data collection could lead to bottlenecks and time-consuming processes. However, the granular level of data that needs to be collected cannot be hurried, especially as new EU regulations require presentation of the data before allowing the goods to pass through its ports or be sold to consumers.

Tech adoption costs will continue to deter modernization and weaken competitiveness. For companies that are market constrained and too focused on the bottom line, they may not see the long-term return on investment and miss out on investment opportunities.

Opportunities

Automation could augment production to help create goods more efficiently and deliver them faster. This can also offset talent shortages and help reduce costly errors that lead to recalls. It also helps with future preparedness.

Greater visibility means more efficient management of goods. Consequently, companies can optimize their inventory and thereby reduce the need for storage space. It also offers new ways to connect with customers and potential ways to upsell services.

Greater customer personalization can lead to renewed interest in lagging products. It also offers higher profit margins for goods that can be efficiently delivered. With more engagement and satisfaction, personalization data can also be leveraged to develop better products.

Amid talent shortages, staff augmentation and upskilling will create greater loyalty and better performance from employees, which ultimately impacts profitability and productivity. Augmentation will also improve future flexibility and workforce readiness as new technologies develop.

New forms of verification offer enhanced security and reinforces visibility and integrity with clients. As competitors work to mimic products and services, this level of verification can help reduce fraud and increase awareness of a company's specific practices.

INVESTMENTS AND ACTIONS TO CONSIDER

1

Consider investing in the automation of data collection and analysis. Prioritize the investment based on what tasks are being done in-house on the preferred platform, to avoid creating two sources of data that cannot be integrated. Such automation opens up more reporting and analysis of current processes for a strong understanding of what technology implementation should be next.

2

Upskill talent now so that they're ready to meet new technology needs—which could include how to manage or repair new equipment or cobots. This could become a new pathway to long-term careers and opportunities in your company.

3

Begin to investigate which cobot works best for you. Based on your company's size and scope of packaging and picking, this technology could serve different needs. Include strategic plans for future growth in this decision, or where staffing shortages are affecting your supply chains or manufacturers the most.

4

Optimize visibility that works for the customer. Cumbersome platforms with confusing reports only add to the overload of data most customers have to slog through. Use data to prioritize the channels your customers want and help them understand how to gain insights from the new visibility.

5

Invest in planning for new technologies that allow for better route optimization and last-mile delivery deployment. Watch regulations on drones and other forms of autonomous delivery, to help decide which areas to invest in first. Exploring both options now can prepare you to act when those regulations come to fruition.

6

Use your new data streams to offer insights that can improve your sustainability and responsibility messaging to your customers. However, this needs to be done in a way that is personalized to their needs, which means more micro-level and targeted communications.

CENTRAL THEMES

Automating Decisions and Processes

For companies working toward automation of decision-making and processes some are taking steps to bring their data into one knowledge bank. With variables like traffic jams, extreme weather, and fuel costs always at play, the logistics sector is most concerned with creating more efficient pathways for transporting goods. Progress in route optimization, coupled with autonomous vehicles, includes greater automated decisions on the flow of goods with minimal human intervention, and will ultimately lead to cost reductions due to fuel efficiency and less human error. For supply chains, automation of the routing and sourcing of raw materials, demand forecasting, tracking of inventory levels, and accelerating response times continue to be top ways to drive down costs and meet customer expectations. In manufacturing, companies are focusing their automation efforts on being able to make real-time process adjustments.

Closing the Last-Mile Gap

Companies in Europe, parts of Africa such as Keyna, and India are creating alternatives for more efficient last-mile solutions. Bangalore has seen the largest growth. With consumers demanding delivery within minutes to very granular locations, it's become a competitive imperative to innovate this expensive portion of logistics, with the ultimate goal of delivering value and speed to end consumers. Advances in AI for route planning and altering routes in real time are providing greater service and transparency for customers. Along with electrified transportation, micro-fulfillment centers are making progress on new last-mile methods. As companies experiment with using larger fleets of drones that can handle increasingly heavy items, this technology is combining with platooning efforts that could create swarm delivery for the last mile.

Authenticating Provenance of Goods

Customers and businesses can watch their goods throughout the entire process—from the time raw materials are picked up until they reach their final destination. Through new interconnected systems that provide real-time data, every step can be verified and recorded. Businesses and customers can possibly intervene if one step doesn't align with their needs, values, or expectations. Ensuring authenticity and compliance through this visibility is crucial and is happening through the use of new labels, product passports, and sensors. Also crucial is how the collected data gets managed and used. It can help prevent future bottlenecks if it can be integrated into platforms that offer the required visibility.

CENTRAL THEMES

Improving Warehouse Efficiency

In warehouses, delays can come from many sources such as injury or unexpected surges in demand. Responding to this risk, warehouses continue to become automated, dark, more connected and, in some cases, smaller. Whether they're using drones to scan packages and track inventory, automated picking, cobots that package the pallets, or augmented wearables for worker safety, warehouses are becoming more efficient. This efficiency is augmented by sensors that can tell if goods have spoiled or there is damage within the container. With such tools, tracking inventory and managing inventory levels is becoming increasingly efficient and more manageable, and a synergistic ecosystem is developing, where each technology reinforces the other. Additive manufacturing also helps create more efficiency by freeing up more space for storage of parts only when those parts are needed.

Hiring Robotic Staff

Each year, cobots become smarter, more autonomous, and more prolific, and this year is no exception. In fact, the first humanoid robot factory is set to open and produce 10,000 robots a year. These robots that work alongside human workers are being trained on more data that allows them to adapt and work around their human counterparts. Developers have focused on improving cobot safety measures, so a cobot knows what to do if it bumps into an unexpected obstacle or person. These cobots mitigate potentially harmful work for humans by either augmenting the human body or replicating repetitive tasks that could cause future injuries. Some of the augmented wearables can also offer predictive pathways through the warehouse to ensure worker safety. As autonomy continues to grow in robots and transportation, this trend will create new-found efficiencies and productivity, particularly during peak demand seasons.

The Intelligent Manufacturing Evolution

Manufacturing continues to transform from a traditional labor-intensive practice to a more sophisticated and interconnected system. Recent advances intend to create higher levels of productivity and efficiency, but they're also addressing sustainability requirements and enabling product personalization. The new tools and technology can spot flaws in products before they leave the floor, greatly increasing consistency for goods. Along with quality control, sensors and digital twins are getting companies to focus on predictive maintenance by reducing downtime during large runs or times of high demand. Additive manufacturing also allows for the integration of new materials that are themselves smarter and more connected. And it helps reduce the number of parts needed for production of a good, which can streamline production and reduce waste as only the parts needed are produced.

ONES TO WATCH

Dr. Alexandra Brintrup, professor at the University of Cambridge, for her work in data revolution within supply chain networks.

S. Vijay, assistant professor at Arasu Engineering College, for his work on autonomous drones.

Mārius Montmany and **Oriol Hernandez**, co-founders of Rever, for their work on instant refunds and label generation.

Arti Kütt, CEO of Cleveron, for his work on parcel robots and lockers.

Paola Lova, assistant professor at the University of Genoa, for her work on intelligent packaging.

Ioannis Kaloskampis, **David Bradnum**, **Charles McGowan**, **Paige Hunter**, and **Melissa Bui**, all of the UK's Data Science Campus, for their work using natural language processing and transformer-based deep learning models to construct supply chain networks from unstructured text.

Ieva Meidute-Kavaliauskiene, head of the Business Technologies and Entrepreneurship Department at Vilnius Gediminas Technical University, for her work in using neural networks within the supply chain.

Sehinde Afolayan, founder of Haul247, for his work in creating an end-to-end logistics platform in Nigeria.

Jörg Lamprecht, executive chairman and founder of Dedrone, for his work on a global network of urban drone detection services.

Antonio Spears, co-CEO at City Global, for his work on augmented reality technology in product development.

Mor M. Peretz, Dr. Alon Cervera, and Dr. Eli Abramov, co-founders of CaPow, for their work in bringing perpetual power to autonomous robots.

Ali Ekti, researcher at Department of Energy's Oak Ridge National Laboratory, for his work in the development of low-powered sensors for pavement markers.

Sachin Sharma, doctoral student at Western Michigan University, for his contributions to the research on autonomous driving technologies.

Zachary Asher, assistant professor of mechanical and aerospace engineering at Western Michigan University, for his work on pavement markers supporting autonomous driving in tough conditions in remote areas.

Dr. Emma Yang, assistant professor at The University of Texas at Arlington, for her work on hybrid additive-subtractive manufacturing equipment.

Dr. Raymond Weitekamp, founder of Poly-Spectra, for his work on generating stronger 3D printed materials.

Pascal Bensoussan, chief product officer at Ivalua, for his work in AI-powered contract digitization and purchasing optimization.

IMPORTANT TERMS

Additive manufacturing

A manufacturing process of creating objects by adding material layer by layer. It is synonymous with 3D printing but includes using reactive materials for 4D printing.

Customer relationship management (CRM)

A tool that manages a company's interactions with current and potential customers.

Enterprise resource planning (ERP)

Integrates all facets of an operation, including development, manufacturing, sales, and marketing.

Environmental, social, and governance (ESG)

Refers to the three central factors in measuring the sustainability and societal impact of an investment in a company.

Fulfillment centers

Warehouse facilities used to store, package, and ship consumer goods.

Last-mile delivery

The final step of the delivery process where a product moves from a transportation hub to the final delivery destination, typically a personal residence.

Logistics

The detailed coordination and implementation of complex operations involving the movement of goods, services, or information from origin to destination.

Order management system (OMS)

A system that facilitates and manages the order fulfillment process.

Product lifecycle management (PLM)

A software solution that manages the entire life-cycle of a product, from inception, through engineering design and manufacturing, to service and disposal.

Procurement

The process of sourcing and acquiring the goods and services a company needs to fulfill its business model. It involves the negotiation of prices, terms, and contracts for purchasing.

Supply chain

The entire system of producing and delivering a product or service, from the very beginning stage of sourcing the raw materials, to the final delivery of the product or service, to end consumers.

Transportation management system (TMS)

A system that plans, executes, and optimizes the physical movement of goods, both incoming and outgoing.

Warehouse management system (WMS)

A system that supports and optimizes warehouse or distribution center management.

SUPPLY CHAIN & LOGISTICS MANAGEMENT

2ND YEAR ON THE LIST

AUGMENTED & AUTOMATED PROCESSES

WHAT IT IS

Supply chain and logistics providers are continuing to harness AI-enhanced automation and AI-augmented decision support solutions to stay ahead and capture value right from day one of implementation.

HOW IT WORKS

AI-driven supply chain management models can opt for either a data-consolidation approach, by harnessing extensive training data sources, or use multiple specialized models tailored to specific domains. Companies such as Mariner and Landing AI provide solutions for manufacturing—including defect detection—which work with limited and imperfect data sets. This approach differs from big data solutions from providers such as Kitov and Cognex, which work by ingesting huge quantities of data.

Parabola, a Series B startup, uses AI to automate complex manual processes through familiar spreadsheet functionality, and is usable by teams of all technical aptitudes. In the realm of cloud-based solutions, Adiona has created an Optimization Software-as-a-Service (OSaaS) that helps businesses improve their logistic processes while cutting costs.

Going even further, researchers at the University of Cambridge are developing a platform that can make decisions and autonomously act on behalf of stakeholders in supply chains. This system has virtual agents that bridge internet of things data and machine learning, possessing the ability to select suppliers, procure goods, and respond to unplanned events through pricing adjustments and automated rerouting. And Carrier Logistics Inc. has introduced AI-driven routing logic and planning optimization with a unique focus on terminal optimization for trucking fleets. The software features the ability to automatically plan shipments for every customer at every terminal, accounting for various factors like equipment, time windows, and traffic.

WHY IT MATTERS

Implementing augmented and automated processes significantly diminishes manual labor and human error, which translates into substantial cost reductions, greater efficiency, and an optimization of resources. It can also help make better, data-informed decisions. And by reducing errors and omissions, potential setbacks in the supply chain can be minimized. As access to automation grows, employees will gain the sense that they can more effectively contribute to growing the company and the bottom line. And automation can also prevent downtime-related losses by forecasting the least-disruptive times to conduct maintenance while extending the life of equipment through proper maintenance. Using automation to select suppliers could further increase efficiency but also lead to questions as to why those companies were selected in the first place. Defining the parameters for AI's selection criteria will be incredibly important. By optimizing routes and reducing unnecessary mileage, companies can reduce fuel consumption and lower carbon emissions, aligning with the growing importance of sustainability in the supply chain and logistics industries.

2ND YEAR ON THE LIST

REAL-TIME OPTIMIZATION

WHAT IT IS

Companies can increase the control of the flow of goods, maximize fuel efficiency, and increase sustainability when they are able to optimize routes in real time, while still delivering their goods on time.

HOW IT WORKS

Real-time supply chain optimization offers immediate insights, letting companies improve efficiency, reduce costs, optimize routes, and adapt to changing conditions. London-based Sensat creates digital twins for physical infrastructure; the digital replica updates in real time with automatic drone updates, camera feeds, and live data. Moving from visualization to real-time control, French company Zoio's ROBIN presents a real-time SaaS using IoT trackers to monitor product and equipment locations at every production stage.

Aera Technology has partnered with Colgate-Palmolive, aiming to provide a single source of truth for data across multiple sources, predict optimal product allocation, and prioritize fulfillment and safety stock demand.

Fleetroot's IoT platform offers real-time tracking, route optimization, and order management for fleets. In the realm of real-time fleet management, Nvidia's cuOpt, an accelerated optimization engine, can solve complex routing problems with subsecond solver response times for dynamic rerouting, job scheduling, and robotic simulations. It achieves world-record accuracy with a 2.98% error gap on the Gehring & Homberger benchmark.

Bettermile's cloud-based logistics platform distinguishes itself with features like real-time tracking, dynamic route optimization, and enhanced communication. Notably, it provides tailored solutions for specialized shipping industries, ensuring secure and punctual deliveries aligned with industry regulations. Lastly, on the note of eco-conscious routing, Greenplan stands out with its ability to optimize routes with a focus on diminishing carbon footprint while allowing spontaneous assignments in daily routes.

WHY IT MATTERS

Real-time solutions make it so companies can adapt to changing conditions, ensuring seamless operations and minimizing disruptions while containing costs. Businesses that embrace real-time optimization can consistently monitor and adjust operations, which will help them maintain high standards of performance and increase customer satisfaction. Innovations that solve routing problems or merge routes will achieve new efficiencies and previously unrealized areas of potential. This kind of dynamic routing could also offer the ability to create more dynamic pricing instead of fixed rates, depending on the level of efficiency that can be achieved. Because fuel is one of the biggest costs to these industries, this kind of optimization could result in almost immediate savings. But these real-time solutions can also dovetail to ensure transportation professionals do not exceed their allotted hours while providing greater insights on how they can maximize time on the road. Various conditions in the future such as sales, holidays, product runs, extreme weather, and traffic due to aging infrastructure could all be alleviated through the predictive planning these platforms offer.

2ND YEAR ON THE LIST

VISIBILITY TRACK AND TRACE

WHAT IT IS

Track and trace solutions let organizations and customers track movement at every stage of the supply chain, helping manage uncertainty and disruptions in real time.

HOW IT WORKS

Shipping track and trace is the backbone of modern logistics. In collaboration with British Telecom, Gorilla Technology Group has introduced a container identification and container damage detection solution; this innovation uses AI and machine learning to analyze video footage, identify containers, track movements, and detect damages.

DB Schenker has introduced ultra-thin tracking labels in partnership with Sensos. These disposable labels can be attached to containers, pallets, or cartons to enable real-time tracking of shipments across land, air, and ocean transport. They provide location and temperature data over the mobile network, ensuring security for valuable consignments.

DNA tags and traceability systems represent a novel frontier in supply chain security, offering atypical authenticity verification. Applied DNA Sciences employs synthetic DNA tags: Sprayed as a fine mist, they can be used for everything from tracking microcircuits for the Department of Defense to tracing cannabis supply chains, making it a potent tool against counterfeiting. Eurofins and Applied DNA Sciences have further partnered to pioneer a DNA-based traceability system in the leather supply chain. The unique molecular signatures of synthetic DNA tags make them impossible to copy, providing forensic evidence of product authenticity and safeguarding against counterfeit goods.

Continuing the exploration of supply chain security, Swiss startup ScanTrust combines secure QR codes and business intelligence software for supply chain data. Its QR codes facilitate anti-counterfeiting for consumers using just a smartphone and require no programming.

WHY IT MATTERS

Track and trace solutions are enhancing logistics efficiency and customer service. Synthetic DNA tags represent a significant advancement in supply chain security, by offering unparalleled authenticity verification and protection against counterfeiting, strengthening brand trust and traceability. Potential benefits include improved visibility into the supply chain for customers and better inventory management for companies. Companies can reduce excess inventory, lower storage costs, and optimize stocking levels based on real-time demand if they properly track their goods. But in the future, the technology could prove problematic as synthetic biology scales and DNA copyrights. The security for tracking will become even more important if supply chains continue to be disrupted, and companies will have to rely on their customers' faith in the business to maintain stability. Hacking of track and trace opens up new forms of digital piracy that should be a concern.

2ND YEAR ON THE LIST

ESG TRACKING AND DECLARATIONS

WHAT IT IS

With ESG tracking and declarations, companies can align their supply chains with their environmental, social, and governance goals, to foster transparency, responsibility, and sustainable practices.

HOW IT WORKS

As more companies make ESG tracking a priority, a flurry of VC funding has opened up for startups focused on ESG reporting and management. That includes Germany-based IntegrityNext, which helps companies audit their supply chains for ESG compliance, and France's SESAMm, which provides corporations with ESG insights into their supply chain. CarbonChain specializes in assisting industries with high emissions—such as agriculture, metal, mining, and oil and gas—to monitor their supply chain emissions. Companies upload their supply chain data on the platform and receive comprehensive emissions reports, complete with detailed breakdowns at the asset level and AI-generated sustainability insights.

Sheer Logistics introduced its own customized ESG dashboards that enable managed transportation clients to monitor real-time Scope 3 carbon dioxide emissions across all transportation modes in their supply chain. These dashboards aggregate transportation data, ensuring clients can accurately track, measure, and report emissions following a globally recognized standard developed by the Global Logistics Emissions Council.

In line with this trend, Apple released a new framework highlighting its progress on renewable energy adoption, efficiency improvement, and materials innovation. To do this, the company conducted in-depth analyses of the clean energy percentage used in manufacturing for each product and tracked the impact of expanded recycled materials usage on device climate footprints.

WHY IT MATTERS

ESG tracking and reporting ensure compliance with ESG standards, thus reducing the risk of regulatory issues, financial penalties, and reputational damage. ESG tracking is also a strategic asset in building a resilient, ethical, and competitive business. It can also help companies be better prepared for future risks to their resources in regions that are vulnerable to climate change. Making this kind of information publicly available enhances transparency and accountability, fostering trust among stakeholders, including consumers and investors. This is increasingly important as consumer awareness and concern about environmental and social issues grow; companies with transparent and responsible practices in their supply chains can significantly influence purchasing decisions. Furthermore, prioritizing ESG tracking gives companies a competitive advantage in the market. But it's not just about public perception: ESG tracking and declarations equip companies to better adapt to changing economic and environmental conditions, providing resilience against the challenges of sustainability.

2ND YEAR ON THE LIST

OMNICHANNEL MANAGEMENT PLATFORMS

WHAT IT IS

A comprehensive platform that includes everything from warehouse management systems, to enterprise resource planning, to transportation management systems eases the responsibilities behind sourcing, manufacturing, and delivering products to customers.

HOW IT WORKS

Omnichannel, a pivotal strategy in modern commerce, seamlessly integrates varied sales and distribution channels to provide consumers a unified expedited experience while minimizing inventory. Recently acquired by Ingka Investments, the investment arm of Ikea, Made4net specializes in a cloud-based warehouse management system and end-to-end supply chain execution software. Its omnichannel fulfillment solution will boost Ikea's operations, enhancing order fulfillment accuracy and supply chain visibility across 482 locations. Target has also highlighted the success of its omnichannel efforts: In a recent earnings report the retailer boasted a 4% growth in same-day services and a 7% increase in drive-up usage.

FlowSpace's software provides centralized visibility and reporting, offering modern omnichannel solutions to efficiently manage and optimize supply chain operations, whether a company uses its own facilities or FlowSpace's network. And Maersk has introduced an e-commerce fulfillment solution that streamlines warehousing, order processing, and last-mile deliveries, ensuring end-to-end visibility and reducing the need for multiple logistics partners.

Omnichannel fulfillment also boosts order volume and necessitates quicker deliveries for smaller orders. Blue Yonder's Warehouse Execution System optimizes warehouse operations by efficiently allocating tasks to the appropriate resources, resulting in increased capacity and operational excellence. And Belgium's Alpega provides a comprehensive logistics system for end-to-end transportation services by facilitating real-time communication between manufacturers and logistics providers while streamlining transportation requests into a single system.

WHY IT MATTERS

Omnichannel management platforms are essential in the supply chain, logistics, and manufacturing industries for creating a cohesive and efficient consumer experience across various sales and distribution channels. By centralizing operations, these platforms greatly enhance customer retention and satisfaction. They skillfully balance minimizing inventory levels with maintaining product availability, which reduces holding costs and boosts the overall efficiency of supply chain operations. Centralized reporting features simplify the management and optimization of supply chain activities. Additionally, the cost-efficiencies introduced by these platforms span multiple facets of supply chain operations, including warehousing, order processing, transportation, and administration. Importantly, these platforms are designed for scalability, enabling businesses to adjust to fluctuating order volumes and smoothly expand operations. This adaptability is crucial for growth and meeting market demands, making omnichannel management platforms a strategic tool for businesses aiming to streamline their operations and effectively scale.

2ND YEAR ON THE LIST

DIVERSIFYING THE PROCUREMENT PROCESS

WHAT IT IS

Companies are expanding their supplier base to make it more inclusive and in line with their corporate values—which can also benefit their bottom line. They're achieving this through new technologies offering transparency and onboarding efficiencies.

HOW IT WORKS

Broadening the procurement process is vital to bolster adaptability and mitigate risks like supply interruptions and price fluctuations. Linkana streamlines supplier onboarding and governance with automated compliance processes, reducing the hassle of vetting new suppliers. Its methodology identifies diverse and inclusive economy suppliers, automates risk analysis, and provides access to a vast B2B network.

Delving into cloud-based solutions, Ivalua offers an AI-enhanced source-to-contract process that simplifies supplier risk assessment, fraud reduction, and contract analytics. Omnia Partners' Opus supports procurement with a simplified platform providing access to hundreds of cooperative contracts. Users can requisition from multiple suppliers in a single transaction and access real-time product data, eliminating the need for multiple websites or third-party platforms.

In digital procurement intelligence, Smart Cube's Amplifi PRO, an on-demand procurement intelligence platform, introduces AI/machine learning functionality for enhanced search capabilities. Users can post sourcing questions and get summarized responses within seconds. On a similar note, Scoutbee's Intelligence Platform incorporates generative AI features to provide deep insights into supply bases. NASA has introduced its Acquisition Innovation Launchpad to accelerate innovation communication, diversify the industrial base, and modernize procurement. With this initiative, NASA's focus shifts to modular procurement approaches, emphasizing safe risk-taking and agility to adapt to a fast-paced technological environment.

WHY IT MATTERS

Diversifying the procurement process is crucial in these industries because it significantly mitigates the risks related to sole-sourcing. By sourcing from a variety of suppliers, businesses can reduce vulnerabilities such as supply interruptions, price volatility, and weakened negotiation positions, thereby fortifying the resilience of their supply chains. Streamlining the supplier onboarding process through automated compliance procedures simplifies and accelerates the vetting of new suppliers, conserving time and resources. This automation not only facilitates engagement with a broader range of suppliers but also minimizes risks linked to new, untested suppliers, contributing to a more dependable supply chain. Additionally, a diverse procurement strategy yields richer data and insights, improving the efficiency and effectiveness of decision-making processes in the supply chain. Overall, diversification in procurement is not just a risk management tactic but a strategic approach to building a robust, agile, and data-rich supply chain infrastructure.

2ND YEAR ON THE LIST

LAST-MILE SOLUTIONS

WHAT IT IS

Companies are seeking to shorten the last mile to increase their margins. Several new advances in technology are offering faster solutions and increased range of delivery.

HOW IT WORKS

Last-mile solutions are the linchpin of modern supply chains, ensuring timely deliveries, cost-efficiency, and a superior customer experience while addressing urbanization and sustainability challenges. Manna, an Irish company, is tackling the last mile in the sky: Its all-electric, zero-emission drones have an average delivery time of three minutes and offer sustainable shopping options while prioritizing customer privacy.

For ground-level solutions, Cartken's delivery robots have achieved Level 4 autonomy on sidewalks, significantly reducing reliance on human operators and enabling cost-effective autonomous last-mile deliveries. AxleHire enhances last-mile delivery accuracy with its technology, helping cross-border e-commerce companies achieve next-day shipping upon entry into the US. Similarly, DeliveryDefense from UPS Capital uses predictive analytics to assess delivery risk associated with addresses across the US. It empowers e-commerce retailers to make informed decisions before shipping, enhancing the likelihood of successful deliveries. And Curri, which focuses on on-demand, last-mile logistics for the construction industry, offers nationwide fleet services for various load types, providing real-time tracking, proof-of-delivery, and comprehensive visibility.

Shifting to environmental impact, Estonian tech company Cleveron has introduced a battery-powered outdoor parcel locker that significantly reduces CO2 emissions in the last-mile sector. Cycle, a B2B mobility solution for delivery services and couriers, enables sustainable last-mile delivery with e-bikes and has secured 10.3 million euros in Series A funding.

WHY IT MATTERS

Last-mile delivery solutions are crucial for ensuring timely and efficient deliveries—a key factor in meeting customer expectations and maintaining a competitive edge. They significantly reduce delivery costs by optimizing routes, decreasing dependence on human labor, and increasing overall delivery efficiency. Providing a superior customer experience, vital for fostering brand loyalty and encouraging repeat business, is another critical aspect of last-mile solutions. Technological advancements such as dynamic routing algorithms and predictive analytics play a significant role in enhancing the accuracy and efficiency of these deliveries, making them both successful and cost-effective. Moreover, the development of specialized last-mile services for specific industries, like on-demand logistics in construction, exemplifies the innovative potential of these solutions to meet unique industry needs. Last-mile solutions are not just a final step in the delivery process; they are strategic tools for improving customer satisfaction, reducing operational costs, and driving innovation tailored to industry-specific requirements.

2ND YEAR ON THE LIST

SMART PORTS

WHAT IT IS

The congestion at ports that arose during the pandemic has begun to ease, but concerns about the future have companies looking for new shipping routes, new devices for monitoring congestion, new smart technology implementation, and new ways to expedite loading and unloading.

HOW IT WORKS

Europe's two largest shipping gateways have begun a series of investments to manage increasing shipping activity. The Dutch port of Rotterdam, known as one of the best smart ports in the world, is expanding its fully automated capacity and hinterland connectivity, while the Antwerp-Bruges port has launched an extensive digital radar and camera network to manage its substantial shipping traffic.

Amid these investments, Awake.AI has introduced the Smart Port as a service platform, leveraging Intel technology, AI, and 5G to enhance operational efficiency in ports. The platform utilizes machine-learning models and sensors to provide real-time awareness of cargo flows, optimized port utilization rates, and reduced emissions.

The Port of Ponce in Puerto Rico is set to become a Smart Port Lab through a partnership with Scale AI. A \$2 million project will develop AI-enabled port infrastructure, including document processing, route optimization, and object recognition. This initiative aims to modernize shipping and transportation equipment, unify shipping and port data, and enhance operations for the port.

In Asia, Langkawi Port is also focusing on enhancing its smart port infrastructure. It has partnered with CelcomDigi to use AI-driven safety and security solutions to analyze vehicles, create smart digital boundary control, and conduct general surveillance to ensure efficient and secure port operations. And Tianjin Port Group and Huawei are deepening their cooperation to create a digital twin of the port leading to Beijing. This initiative involves constructing automated terminals, upgrading traditional terminals, and making the overall port more automated and intelligent.

WHY IT MATTERS

Smart ports are using cutting-edge technologies like AI, 5G, and digital radar networks to revolutionize operations in the supply chain, logistics, and manufacturing industries. By providing real-time insights into cargo movements, these ports optimize utilization rates and streamline processes, leading to cost reductions and enhanced supply chain efficiencies. This shift marks a significant stride in the maritime sector's digital transformation, by incorporating the use of digital twins—virtual replicas of physical ports—for smarter, more efficient operations. Additionally, features such as vehicle analytics, digital boundary control, and enhanced surveillance bolster overall safety and security, mitigating risks and ensuring uninterrupted port activities. Smart ports also play a pivotal role in the global trend toward connectivity and interconnectivity. They enhance hinterland links and unify shipping and port data, facilitating the management of extensive shipping traffic. In essence, smart ports are not just about technological upgrades; they represent a holistic approach to redefining maritime logistics, emphasizing efficiency, safety, and global connectivity.

SCENARIOS

SCENARIO YEAR 2031

The OmniVision Chain

An immersive omnichannel platform called OmniVision has transformed how supply chain management controllers operate. Gone are the days of monitoring operations from a physical warehouse; now, controllers navigate a virtual landscape that mirrors the real-time dynamics of the global supply chain. Within the OmniVision environment, management controllers—equipped with advanced VR gear—stand amid a digital twin of the supply chain world. They observe a holographic globe where supply routes, manufacturing hubs, and distribution centers pulse with life. Through intuitive gestures, they zoom into specific areas, inspecting operations with incredible detail. They can visualize everything from cargo ships navigating oceans to robotic arms assembling products in factories.

One of the platform's groundbreaking features is real-time ESG reporting. Controllers can instantly access a site's ESG metrics and observe live data streams of energy consumption, waste management, and labor practices. This transparency enables them to uphold ethical standards and swiftly make informed decisions. When a worker strike or a disruption occurs, the controllers, with a mere flick of their fingers, reroute production to an alternative site. This instant transition is possible thanks to OmniVision's predictive analytics and interconnected global network. Customers, on their end, have embraced MyVisionLink, a personalized version of OmniVision that syncs with their preferences and purchase history, allowing for a harmonious interaction between consumer demand and supply chain responsiveness. This synergy ensures that product availability and delivery expectations are perfectly aligned, creating a seamless and satisfying customer experience.

MANUFACTURING & DISTRIBUTION ENHANCEMENTS

2ND YEAR ON THE LIST

CONTINUOUS ADDITIVE MANUFACTURING

WHAT IT IS

The production process known as continuous additive manufacturing streamlines the creation of items by constantly printing parts, thereby reducing downtime and enabling the efficient production of complex, customized products.

HOW IT WORKS

Continuous additive manufacturing drives a decentralized just-in-time approach to production. To address speed bottlenecks, start-up Ambots harnesses autonomous swarm robots for its solution, breaking down digital designs into manageable tasks through proprietary chunk-based 3D printing. Ambots is now leading the software development for a \$3.5 million project that will 3D print horizontal mission structures for the US military.

For metal additive manufacturing, a collaborative research effort in South Korea has introduced a novel technology, enabling continuous additive manufacturing in various orientations. In another approach to 3D metal printing, Fabric8Labs, a San Diego startup, is developing electrochemical additive manufacturing. The room-temperature technique builds rapidly at the atomic level from a water-based feedstock containing dissolved metal ions. This approach allows for micron-scale feature resolution and complex internal features, and can print onto temperature sensitive substrates such as PCBs, silicon, or existing metal components.

For hybrid additive-subtractive manufacturing, a researcher at the University of Texas at Arlington is exploring equipment that could efficiently repair and remanufacture parts, even in resource-constrained environments like space. VulcanForms integrates additive and subtractive manufacturing, as well as in-process sensing and machine learning to enable an industrial scale laser metal additive manufacturing solution. It produces parts for companies in the medical, defense, semiconductor, and aerospace industries, turning designs into finished parts in a matter of days. Researchers at EPFL's Laboratory of Thermomechanical Metallurgy have validated the effectiveness of acoustic monitoring in laser-based additive manufacturing, enhancing product quality in industrial sectors using laser powder bed fusion.

WHY IT MATTERS

Continuous additive manufacturing is pivotal in cutting down on time and costs in the supply chain and manufacturing sectors. It also fosters a decentralized production model, enabling manufacturing at or near the demand point, minimizing transportation needs and costs. This method supports the production of customized products on demand, which is particularly advantageous for industries needing unique parts, such as health care and aerospace. Moreover, the hybrid of additive and subtractive manufacturing in one continuous system catalyzes innovation in fields like aerospace and defense, allowing for on-site component repairs and diminishing the reliance on complex supply chains for part replacement. It also expedites the R&D cycle, crucial for sectors that depend on swift technological advancements and adaptability. As this process continues to scale, it will create new forms of business services, and become increasingly important to the retail world. The selling of materials for these services also offers a potential new business venture, which would require large socialization efforts for consumer adoption.

2ND YEAR ON THE LIST

SMART WAREHOUSES

WHAT IT IS

Smart warehouses are technologically advanced facilities that leverage automation, AI, and real-time data analytics to optimize inventory management and streamline the entire supply chain process.

HOW IT WORKS

While IoT adds complexity to smart warehouses by generating vast amounts of data from various devices, edge computing supports a solution by processing all the data locally. Belgian startup Edgise is specializing in developing hardware for edge computing applications, enhancing AI processing speed in industrial systems, and optimizing processes by bringing AI closer to the data source. Another instance is Seattle-based Loopr, which offers AI-powered edge applications for defect scanning, maintenance prediction, and inventory management.

Digital twin solutions can also help, enabling real-time monitoring, analysis, optimization, and predictive maintenance. San Francisco startup Datumix offers a virtual 3D simulation and AI-driven digital twin for equipment condition monitoring, improving loading and unloading efficiency by up to 30%, and reducing labor costs by 15%. German company Cognition Factory also offers an AI-based digital twin solution for warehouse simulation.

Amazon is deploying AI-powered damage detection to its warehouses to speed up fulfillment: The company's computer-directed facility in San Antonio employs robots for inventory management, storing 18 million items at any given time and shipping 2 million items on a weekly basis. And in the spectrum of measurement innovations, MoistTech's implementation of near-infrared technology is a notable breakthrough. Through nondestructive, contactless analysis, it achieves an accuracy level of 0.1%, underpinning precise quality control and moisture management for optimized energy usage.

WHY IT MATTERS

Smart warehouses represent a significant leap forward for the supply chain, logistics, and manufacturing industries. Utilizing edge computing, AI, and digital twin technologies, they process vast amounts of data to optimize operations, demonstrating the critical role of advanced technology in logistics. Edge computing will become a necessity as it empowers smart warehouses by reducing latency, enabling real-time decision-making, and enhancing overall operational efficiency—ensuring timely and precise responses to dynamic warehouse challenges. Digital twins can optimize material handling systems, enabling easy planning, deployment, and continuous improvement of mobile robots. Predictive maintenance of equipment minimizes downtime, ensuring an unbroken delivery chain, while AI in quality control guarantees product standards, boosting customer trust and mitigating risks. The rich data gleaned from smart warehouses offer insights for streamlining operations, providing a competitive edge and enabling quick adaptation to market shifts. This transformation is not just about efficiency; it's about redefining the supply chain ecosystem to be more responsive, resilient, and customer-centric.

2ND YEAR ON THE LIST

NANO-FULFILLMENT CENTERS

WHAT IT IS

Nano-fulfillment centers enhance supply chains and logistics by enabling hyperlocal, efficient, and swift last-mile deliveries. These can be small infill sites in the urban center of cities that bring manufacturing and delivery closer to the consumer.

HOW IT WORKS

Automated, localized warehousing facilitates same-day and even quicker delivery to meet the growing demand for speedy e-commerce services. Retail giants like Walmart are already experimenting with this: The company is creating next-generation fulfillment centers that blend robotics, AI, and human expertise to set new standards for delivery speed. These centers aim to reach 95% of the US population with next-day or two-day shipping.

Other startups are focusing on creating technology that can be widely deployed. Nimble specializes in intelligent robotic fulfillment systems designed to efficiently pick, pack, and ship e-commerce orders, focusing on picking as the hardest part of the puzzle. Its technology reduces warehouse space requirements and offers rapid delivery, letting companies outsource their warehousing needs. In a similar vein, KwikShelf empowers Nigerian merchants with efficient inventory storage and order fulfillment. It plans to establish multiple e-commerce fulfillment centers across large Nigerian cities.

However, finding the right place to set up nano-fulfillment centers can be challenging and costly. Mowito operates automated nano-fulfillment centers across Bengaluru, India, where the only human staffers are the delivery personnel who pick up orders. Its AI-driven robotic systems improve order accuracy, reduce operational costs, and enable 24/7 retail store operations.

On a regulatory note, Paris recently implemented a ban on dark stores, which are distribution centers for rapid grocery and household item deliveries. Paris authorities argued that these dark stores violated urban planning laws, categorizing them as warehouses, which are prohibited in residential zones.

WHY IT MATTERS

Nano-fulfillment centers are crucial for e-commerce success as they cater to the modern consumer's demand for rapid delivery. By localizing and automating warehouses with advanced robotics and AI, these centers streamline order processing, reduce errors, and enhance efficiency. They utilize predictive analytics to forecast consumer behavior, strategically stocking items to expedite last-mile delivery. But as regulations evolve, such as the dark store ban in Paris, the industry must navigate new compliance landscapes. One option is to work with local governments overseeing urban centers looking for ways to utilize vacant spaces—dark stores can in fact prevent urban decay. Outsourcing to nano-fulfillment providers offers companies cost-effective warehousing solutions, eliminating the need for large, traditional storage spaces. Upskilling workers to work in these facilities will help companies that face backlash for reducing their dependency on human workers. These centers also represent a strategic evolution in logistics, by prioritizing speed, efficiency, and adaptability to changing market demands.

2ND YEAR ON THE LIST

INTELLIGENT PACKAGING

WHAT IT IS

Intelligent packaging, equipped with real-time monitoring and quality assessment capabilities, is necessary for reducing food waste, maintaining product freshness, and optimizing environmental benefits.

HOW IT WORKS

Clarkson University's biosensors lab has devised a food degradation sensor that enhances intelligent packaging. Discreetly placed within the packaging, the sensor changes color when food begins to spoil, minimizing the risk of throwing away food prematurely. The University of Genoa's Department of Chemistry has similarly pioneered a smart packaging technology capable of detecting amines, compounds that signify protein degradation in meat, fish, and dairy. As amines accumulate during degradation, the packaging undergoes a noticeable color change, serving as an intuitive indicator of product quality. And the UK-based company "It's Fresh!" focuses on extending the shelf life of fresh fruits and vegetables by controlling ethylene levels in the local environment, which is a key factor influencing ripening and spoilage. Recently, Nestle announced its research in using haptic feedback in packaging to provide information about its products.

French company Lactips pioneered the development of edible packaging using casein protein derived from milk. While mimicking plastic's flexibility, Lactips' patented film biodegrades within 18 days, demonstrating eco-friendliness and good performance in keeping perishables fresh. Israeli designer Naama Nicotra's NakedPak transforms edible packaging into a culinary art form: Her innovative edible wrappers include spices and dissolve into delectable sauces when heated. Polynatural, based in Chile, addresses carbon emissions with "Shel-Life," a 100% plant-based emulsion coating that preserves fruits and vegetables during transportation. And Austrian startup Speech Code has a novel sound-based packaging solution for the visually impaired. Its users can scan a unique code image to translate it into text or audio format without requiring internet access.

WHY IT MATTERS

Intelligent packaging should be a critical focus for the supply chain, logistics, and manufacturing industries, as it provides real-time data on product conditions, enhancing food safety and minimizing waste. Sensors will continue to advance, offering new warning systems these industries can capitalize on. Companies should start exploring embedded packaging sensors that detect food degradation, ensuring only fresh, high-quality products reach consumers, which will help maintain brand integrity. Edible packaging presents an eco-friendly alternative, by cutting down on waste and environmental impact. While this novel innovation sounds promising, its success depends on consumer socialization. Reusable packaging further supports a circular economy by encouraging repeated use and reducing waste generation. These smart solutions are not just environmentally beneficial; they also bolster consumer trust and engagement through their active participation in sustainability, offering strategic value to businesses looking to innovate and maintain a competitive edge.

2ND YEAR ON THE LIST

AUTONOMOUS COBOTS FOR WAREHOUSING AND DELIVERY

WHAT IT IS

Autonomous cobots—robots that work next to human workers—and other equipment are augmenting the warehouse and delivery spheres with safety and efficiency.

HOW IT WORKS

Autonomous cobot-powered innovations are transforming logistics for efficiency, safety, and sustainability. BionicHIVE brings futuristic efficiency to existing warehouses with its AI-powered robots that can easily traverse shelves. Exotec's Skypod system functions as an automated fleet of robots, workstations, and conveyors: The solution contains 3D movements without the need of complicated infrastructure, operates in varied temperature conditions, and can access any item within two minutes, enabling a human-free environment.

Clevon, in partnership with Lithuanian grocery chain IKI, is pioneering Europe's first fleet of autonomous robot carriers for daily delivery services. In the US, EASE is partnering with the Ohio Department of Transportation and DriveOhio to deploy connected and automated trucks on revenue-generating routes. Kratos is also extending its platooning technology for self-driving trucks to the Ohio-Indiana region. This technology enables human-operated lead vehicles to be followed and mimicked by unoccupied follower vehicles.

Drones can provide rapid, precise, and efficient transportation while reducing environmental impact. Walmart is expanding its drone delivery in Dallas-Fort Worth through its partnership with Wing. Going beyond drones, MightyFly manufactures and operates long-range autonomous cargo aircraft that enable same-day deliveries with a payload capacity of 500 pounds, a 600-mile range, and speeds of 150 mph.

In enhanced robots, CaPow is providing autonomous and mobile, perpetual cobots, ensuring 100% fleet utilization by eliminating charging downtime. Aptronik unveiled Apollo, a humanoid robot, which features advanced force control architecture for safe interaction with humans. And Agility Robotics announced that its RoboFab facility will pioneer mass-producing humanoid robots, offering greater flexibility and versatility compared to current industrial robots.

WHY IT MATTERS

Autonomous cobots are revolutionizing supply chains by enhancing warehouse operations with their adaptability, safety, and efficiency. They're capable of working alongside humans and seamlessly integrate into current layouts. Advanced technologies are evolving warehouses into human-free zones, increasing efficiency and operational speed. Drones complement these efforts with their swift, precise, and sustainable delivery methods. Humanoid robots with sophisticated force control are stepping in, safely collaborating with human workers for tasks like unloading and picking, bolstering various industries. With their ability to handle repetitive duties, cobots free up human staff for complex tasks, while their embedded sensors offer vital real-time data, making them key to strategic decision-making. Their advanced safety features prevent accidents, ensuring a harmonious human-robot coexistence. Multifunctional, they manage inventory, quality control, and maintenance, proving indispensable to modern logistics. Despite the initial investment, the long-term savings on labor and increased efficiency solidify cobots as a strategic asset for the industry's future.

SCENARIOS

SCENARIO YEAR 2030

The Chroma Information System

By 2030, the world has embraced the Chroma Information System, a groundbreaking innovation in smart packaging that ended the era of uncertainty in food and medicine quality, giving rise to an unprecedented level of consumer safety and confidence. Every consumable product—from the freshest loaves of bread to the most critical heart medication—is encased in this intelligent packaging, which is equipped with micro-sensors powerful enough to detect the slightest change in the product's integrity. These sensors actively monitor the molecular composition to ensure that the contents remain within the optimal range for human consumption. Each package syncs to the purchaser's wearable device, which holds their personal health and safety data. This harmonious interaction between packaging and personal tech is the cornerstone of consumer safety. The labels now act as an information display. With a simple tap, customers can see how much longer they have to eat the food or if they should get a refill on their prescription. The labels also change colors when the sensors detect a deviation—be it spoilage or a mismatch with the buyer's health profile. When the packaging's exterior, normally vibrant and inviting, morphs into a universal shade of brown—a color specifically engineered to be perceived across the spectrum of color vision—it indicates that it is time to either recycle or compost the goods.

This color change is not just a warning; it initiates an automatic return process. As soon as the product is set down, smart surfaces in homes and stores process the Chroma data and activate a return mechanism. Drones or automated systems retrieve the item, ensuring that it never reaches the consumer's cart or cupboard. The Chroma Information System has rewritten the narrative of consumer safety, where transparency is not just about what lies within but also about taking immediate action when standards are not met.

SCENARIOS

SCENARIO YEAR 2029

Perpetual Motion Manufacturing

As dawn breaks over the horizon in 2029, a fleet of autonomous trucks are seen roving the highways. These are no ordinary vehicles; they are the pulsing arteries of the world's supply chain, the pioneers of a logistic revolution—they are Platooning Pioneers. Each truck is an autonomous powerhouse, fitted with state-of-the-art additive manufacturing plants, their cargo bays printing orders for toothbrushes, cutlery, glasses, bowls, and wearable cases in real time. The smart highway allows the platoon to be monitored by an intricate network of sensors, relaying information back to the AI command center that calculates every move with precision. There is no need for stops; the platoon is a rolling fortress of productivity, a never-ending loop of delivery and manufacturing. Above, a swarm of drones buzzes like worker bees, each one departing from its respective truck with a package. They scatter across the landscape, their flight paths choreographed by algorithms, ensuring that every product reaches its destination on time. The Platooning Pioneers company offers services that slash delivery times, reduce inventory costs, and minimize waste. This is the epitome of just-in-time manufacturing, a system where the supply chain is not just a route but a mobile assembly line. The Platooning Pioneers have set the stage for an era where roads are no longer mere paths but dynamic streams of creation and distribution.

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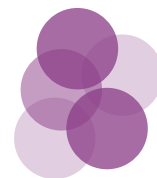
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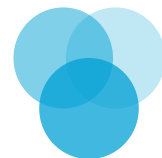
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