White paper

Enabling the digital factory 4.0

Connected solutions for a more efficient and sustainable future

Contents

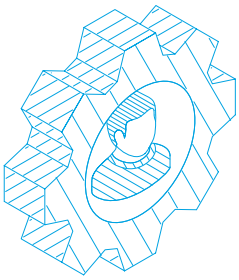
Introduction

The digital revolution is already here – and it waits for no one

The digital revolution used to be the future. Now it's here. Many business sectors, such as finance, media and retail, have already experienced the full force of the changes. But large parts of the packaging industry still need to adapt. By late 2019, 50% of food and beverage operations were still in the planning stages for digital transformation, lagging 11% behind other industries.[1]

Looking at this differently, it means that 50% of the packaging industry had already left the planning stages and moved on to preparation and implementation. If your company has yet to do so, this document is for you.

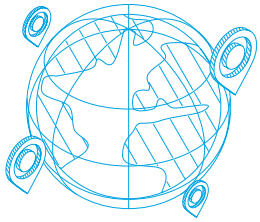
Traditional companies all around the world will soon be in the midst of a digital revolution, if not there already. It is a revolution that has the potential to upend existing business models. The pace is fast and major changes are inevitable. This presents both opportunities and challenges for companies of all sizes, across all industries.



FUTURE:
Human-robot co-working Bio-economy
- Robotics and AI
- Sustainability
- Renewable resources
- Bionics

INDUSTRY **5.0**

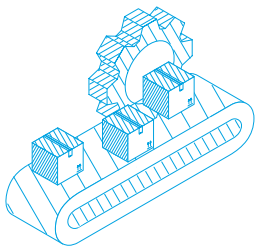
Digitalization



2001:
China joins World Trade Organization
Based on offshoring production to low-cost economies

INDUSTRY **3.5**

Automation



1870:
First Conveyor belt
Based on mass-production achieved by division of labor and the use of electrical energy and assembly lines

INDUSTRY **2.0**

Mechanization

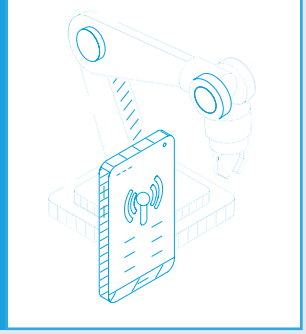
THE EVOLUTION OF INDUSTRY 4.0

Personalization

INDUSTRY **4.0**

2011:
First Cyber-physical sytems

The introduction of connected devices – IoT, data analytics, cloud computing, and artificial intelligence technologies to automate processes further

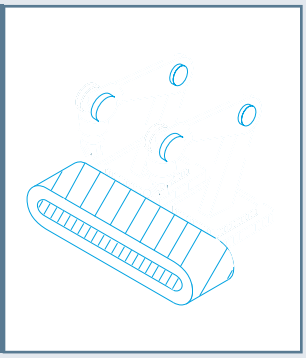


Globalization

INDUSTRY **3.0**

1969:
First programmable logic controller

Based on the use of electronics and IT to further automate production

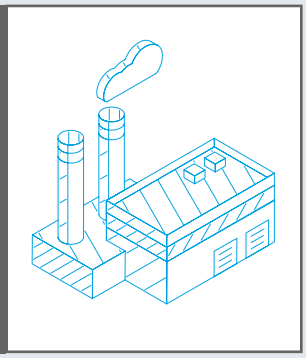


Electrification

INDUSTRY **1.0**

1784:
First mechanical loom

Based on the introduction of mechanical production equipment driven by water and steam power



Source: Own illustration

The fourth wave

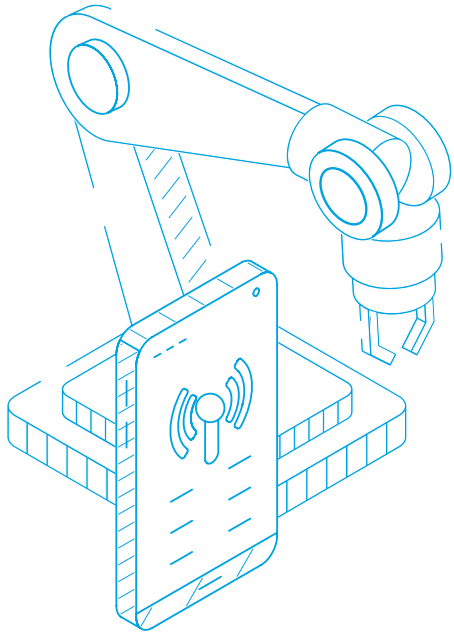
Sometimes referred to as Industry 4.0, the digital revolution is the fourth wave of industrial development. The first wave brought mechanical power into manufacturing and processing. The second wave saw the entry of electrification and assembly lines. The third wave brought automation and Programmable Logic Controllers (PLCs). Now, with wave number four, information technology (IT) is impacting processes in a fundamental way as the lines between IT and operational technology (OT) become blurred.

OT is represented by the hardware on the factory floor – the devices doing the actual work. In many cases, these pieces of equipment are already automated, but frequently in a piecemeal and insular fashion, just integrating a few machines that affect a certain part of the process.

With Industry 4.0, all machinery, control systems, and IT systems will be connected horizontally and vertically throughout the organization, cooperating to achieve the most optimal outcome.

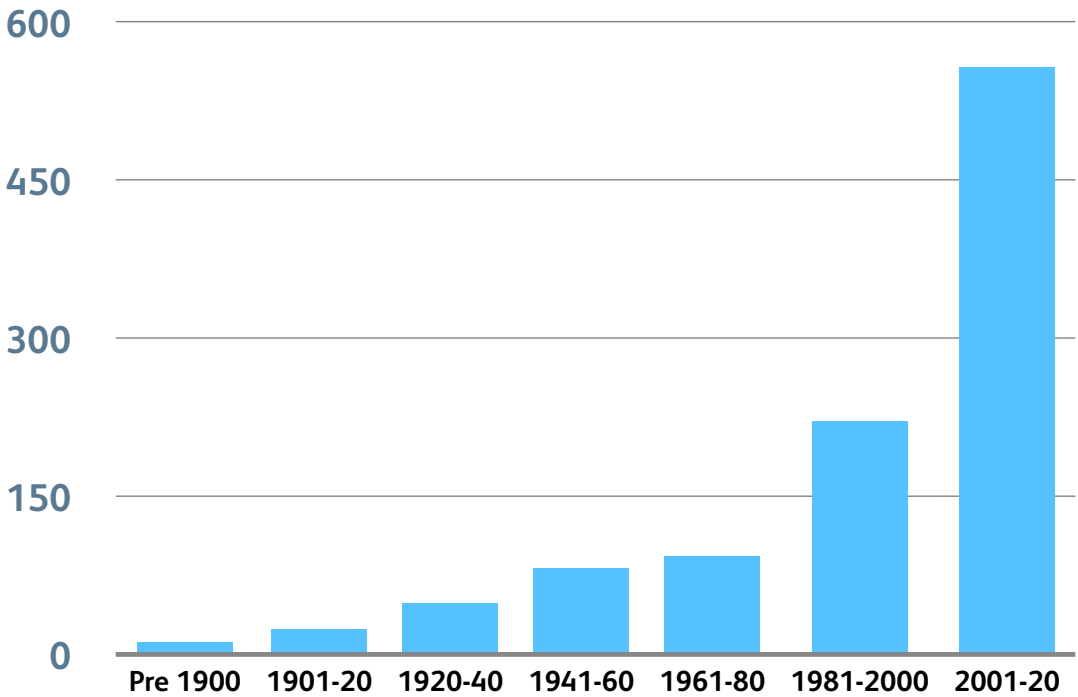
Any devices, including everything from smartphones and wearables to sensors on production lines, can be connected to each other and to automated systems. This development, which brings together IT and OT, is frequently described as the Internet of Things (IoT). The branch of IoT that refers to industrial applications is sometimes referred to as the IIoT (Industrial Internet of Things).

Packaging lines, with equipment from multiple vendors, will be connected seamlessly to supervisory systems and controlled from devices of the operator's choosing. Companies need to operate a complex, multilayered IT environment based on open protocols and high security. The digital revolution reshapes how business is conducted and how industrial processes operate. We are only at the beginning of this revolution. But make no mistake, it is a revolution, it is coming our way, and it will change the way we work.



INDUSTRY **4.0**

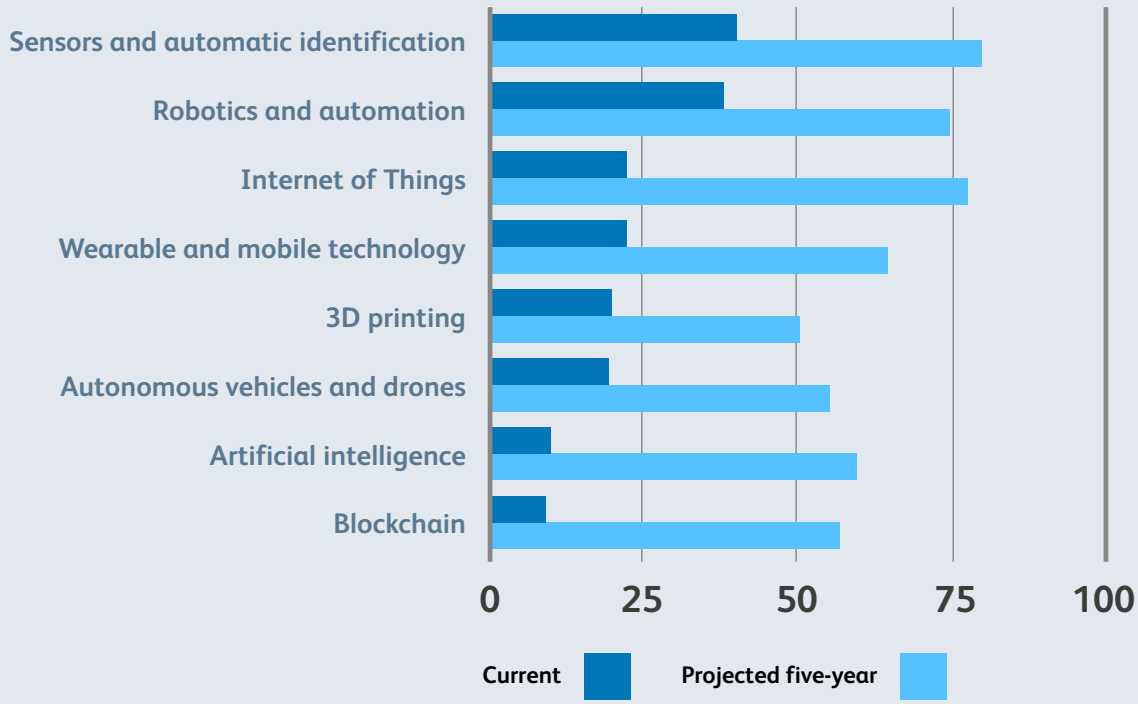
The pace of technology change accelerates



The pace of technology change accelerates – the number of US patents on industrial manufacturing processes registered was 153% higher in 2001-20 compared to the previous 20-year period.

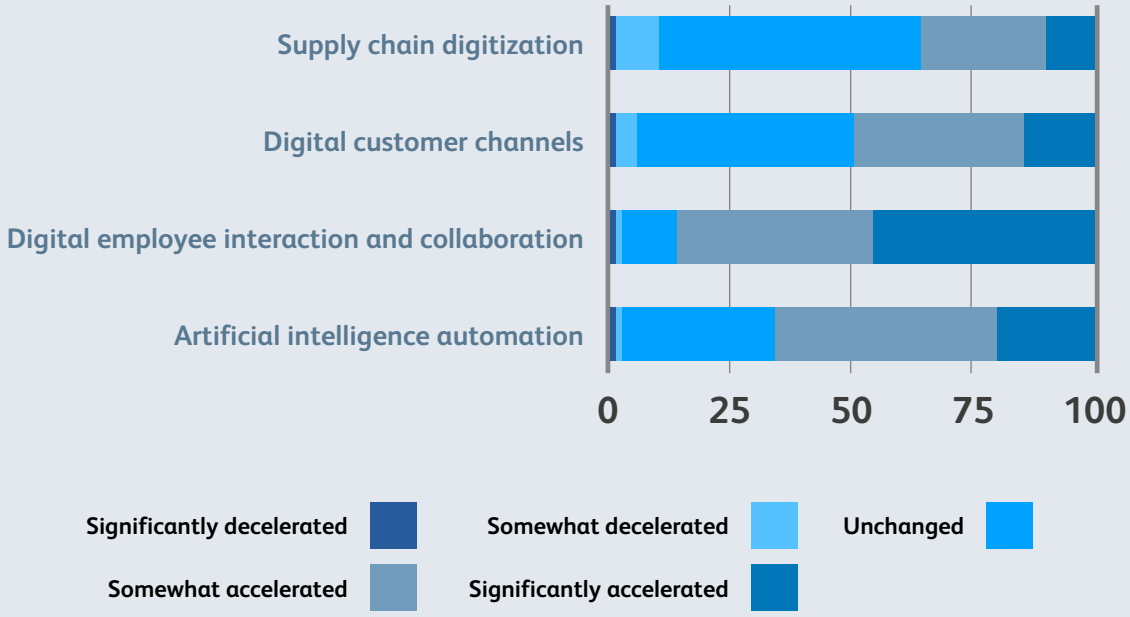
Source: Manufacturing process innovation for industrials, McKinsey & Company, September 2021

Manufacturing companies adoption rate of technology



Source: After years of dithering, companies are embracing automation, The Economist, January 2021

How the companies adoption rate has changed for the following trends since the COVID-19 outbreak



Source: After years of dithering, companies are embracing automation, The Economist, January 2021

Chapter 1

How the market is changing

Digital technologies help make the supply chain more efficient

The digital revolution is already well underway in many business sectors, but packaging is not one of the pioneering industries. In our industry, companies still tend to rely on the automation of single pieces of machinery and the skill of key individuals.

But, in the not-too-distant future, devices will communicate directly with each other and adapt the process to changing requirements. For instance, if a laser coder is better suited to a particular application than an inkjet printer, new modules will be able to enter the production line at any time. Time, investment, and a significant amount of work will be required to make this a reality, but it will happen more quickly than the 30 years it took for the Internet to become firmly established in the industrial environment – we may be as little as 10 years away.

The packaging sector may not have been in the first wave of industries to adopt the IoT, but change will come to our industry, too.

Maintenance costs of factory equipment are estimated to be reduced by 10-40% with predictive maintenance

New technology delivers simpler operations

Industry 4.0 brings with it manufacturing technologies that are more complex but ultimately simpler to operate.

Central to this approach is the concept of edge computing. Just a few years ago, components were not sufficiently smart to talk to each other over the network without the assistance of a central server. Edge computing now allows processes to occur locally rather than in the cloud. With recent advances in computer technology, processing of data takes place in the actual device, without having to send all the data up to the cloud first. This reduces latency, provides more robustness to connectivity issues, and reduces congestion on the network.

Another crucial technology is digital twins. These are digital copies of physical devices. The digital twin contains all the component's data and can simulate all its actions. If an abnormal parameter threatens to disrupt the operation of the device, the digital twin finds out first and can sound the alarm, or take remedial action. Large collections of digital twins can be brought together to simulate an environment, for instance a plant. Such simulations of the real world, which may combine elements of virtual reality with other layers of information, such as augmented reality, are also known as the industrial metaverse. This has been mooted as the fifth wave of industrial development, Industry 5.0[2].

Analytics could cut downtime by half

These types of systems generate enormous amounts of data. Who will have the time to look at it all? Enter the concept of big data. Of all the information currently being collected with IoT devices, less than 1% is used.[3]

But this is about to change. Analytic tools are now becoming available to help make this information useful. For instance, it can be used for automated machine monitoring and diagnostics.

The potential gains are significant. In a study by the McKinsey Global Institute, maintenance costs of factory equipment are estimated to be reduced by 10-40% with predictive maintenance. Downtime may be 50% less than today. Better maintenance means machinery works better and lasts longer. The improvements in maintenance could cut capital equipment investment in machinery by 3-5%.[4] Assessment of future market conditions, accurate targeting of customers and supply chain optimization can all be more easily achieved by using analytics.

Other technologies will also be needed to complete the factory of the future. Robotics, once the preserve of big companies with big budgets, are becoming increasingly available, as well as more sophisticated, and will help companies of all sizes with picking and sorting. Augmented reality applications will allow supervisors to provide virtual hands-on assistance to staff at remote locations.

With the IoT, manufacturers can gain a comprehensive view of what is going on at virtually every point of production. This visibility can allow adjustments to be made in real-time, helping to maintain an uninterrupted flow of finished goods, as well as help avoid defects.

Companies will have better opportunities than ever before to optimize the efficiency of equipment and staff. Real time data can provide immediate as well as historical insight to production performance throughout numerous facilities.

This visibility helps enable manufacturers to track and optimize their production and processes, improving productivity and profitability. With remote access, equipment can be evaluated and adjusted from locations other than the production floor.

Applying IoT in processes may be easier than generally thought. With 40 years of automation behind us, many machines are already equipped with sensors and actuators, or can be retrofitted. The required modifications normally include a reliable communication network, data security, and storage. Machines can then be easily connected to local mesh networks using Wi-Fi or Bluetooth, without the cost of laying cable.

IoT devices give manufacturers a comprehensive view of what is going on at virtually every point of production

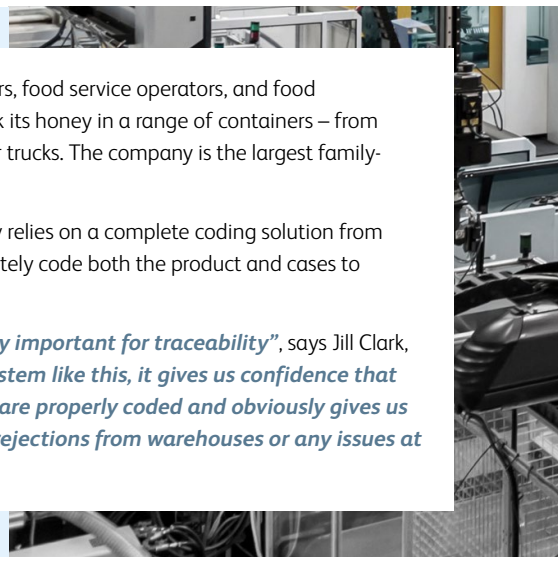
CASE STUDY

Sweet success of accurate coding

Dealing with the demands of consumers, retailers, food service operators, and food manufacturers, Dutch Gold Honey needs to pack its honey in a range of containers – from eight-ounce plastic, squeezable bottles to tanker trucks. The company is the largest family-owned honey company in the United States.

To keep up with this demand, Dutch Gold Honey relies on a complete coding solution from Videojet Technologies Inc. to quickly and accurately code both the product and cases to successfully meet customer requirements.

"Having products coded properly is incredibly important for traceability", says Jill Clark, Director of Sales and Marketing. ***"By using a system like this, it gives us confidence that the products we put out to the marketplace are properly coded and obviously gives us peace of mind that we are not going to see rejections from warehouses or any issues at the store levels."***



The growing need for productivity, security, and traceability

In addition, several market drivers are pushing the packaging industry in the direction of more automation.

Tracking and traceability of goods along the supply chain is extremely important across a range of industries. There is also a growing need for smarter technologies to help achieve greater productivity, security, and traceability. The need for traceability was highlighted by the recent COVID-19 pandemic, as it caused a sudden spike in consumer interest for supply chain transparency. Today, a gap remains in end-to-end traceability. Farm-to-fork is one area, even if there is progress, but also traceability at the point-of-sale as recommended by the Retail Grocery GS-1 Standard initiative. In the future, we can expect consumers to critically scrutinize the brands they purchase. Digital traceability solutions can play a central role to help reassure consumers that food is safe to eat, is sourced responsibly, and has the nutritional content they require.

This can also help combat product tampering and counterfeiting.

The rise of counterfeiting demands more sophisticated coding

The pandemic also highlighted the need for manufacturers to be flexible in the face of challenges such as fluctuating demand and supply chain volatility. Print management needs to be equally agile, enabling manufacturers to make formula adjustments due to shortages or disruption. Production runs are also generally becoming shorter. In addition, there may be a requirement to print items such as a promotional QR code on part of the batch.

This means demand for high-quality, durable codes is increasing. Codes are also becoming more complex.

This will also help combat counterfeiting, which has increased by more than 10,000% over the last 20 years. Today, between 5 and 7% of all goods traded worldwide are counterfeits.[5]

The pharmaceutical industry is perhaps the place where the threat is most acutely felt. Here, the risk of counterfeiting needs to be minimized to help ensure the safety of products and the trust of consumers.

Reliable track and trace solutions are available to enable monitoring of an entire supply chain, from the manufacturer's packaging line to the point of sale.

Counterfeiting has increased by more than 10,000% over the last 20 years

Track and trace helps secure supply chains

Tracking and traceability can also help keep track of products for manufacturers that produce for several customers on the same packaging line.

Online retail is another sector that can benefit from supply chain transparency, as 80% of their consumer complaints concern late deliveries.

Following the significant disruption during the COVID-19 pandemic, companies are faced with the task of building more resilient supply chains for the future. Using buffers, strategic inventories, and alternative suppliers and dynamically switching the flow, businesses can reduce the risk of complete network shutdown.

Using predictive strategies, companies can calibrate their response to external events by deploying cross-departmental teams, simulations, early warning systems, and strategic planing to help ensure the supply chain remains functional under a wide range of scenarios.

Chapter 2

Impact of the new market conditions

Changing with the times: how external forces are impacting the coding and marking industry

By placing a code on the product before it leaves the factory, the manufacturer can meet the regulatory requirements in an effective way. But today, many manufacturers also want to be able to follow the product into the marketplace. Modern coding technology helps them meet this requirement.

Adaptive coding technology also helps manufacturers respond to fluctuations in demand, which may cause product lines to change frequently. Operations need to support a growing number of stock keeping units (SKUs) and labeling requirements. By late 2019, 67% of companies in the food and beverage industry were planning an increased SKU count for the following year.[6]

In addition, consumers have a growing interest in the nutritional content of the food, its origins, and the way it has been produced. This includes aspects such as animal welfare, labour origin, country of origin, environmental footprint, and other aspects.

Coding technology helps manufacturers meet this demand for information. Retailers want to respond to these requirements from consumers and are looking to the packaging industry to deliver the solutions. If handled successfully, this interest can be converted into customer loyalty.

In addition, if serialization is added to the code, the manufacturer can form a direct relationship with the end user, independent from the retailer. This involves tracing each product via a unique serial number from manufacture right to the end user.

The code follows the product through the distribution chain, to physical retail shops as well as online stores. Having this opportunity to build customer loyalty can be very valuable for the manufacturer.

One example here is a manufacturer of formula milk that introduced serialization of products sold in China, as this is a legal requirement in this particular market. This turned out to be such a successful tool for engaging with customers that it was also introduced elsewhere, in markets such as Germany, the Netherlands, and France.

Serialization can also help reduce warranty cost by helping to ensure that only approved consumables are used during the warranty period. For instance, a leading car maker is cooperating with a manufacturer of lubricants to make sure the correct oil is used in all applications during servicing.

End-to-end product traceability efforts are gaining momentum as a strategic opportunity for companies to create more sustainable and connected ecosystems

Traceability regulations

Farm-to-fork traceability covers everything that EU citizens eat and drink, and has existed in the EU since the adoption of the General Food Law of 2002.

Food players must be able to prove at any time the origin, destination, and composition of products to national or EU authorities, all along the supply chain. The EU Green Deal targets a more sustainable food environment by 2030, with greener raw materials production, fewer additives, fewer pesticides, more transparent product labels, and eco-friendly packaging. The recent Sustainable Product Regulation proposal, adopted in 2022, goes one step further into product traceability and transparency to consumers, with the implementation of Digital Product Passports and Phase 2 of the European Blockchains platform (EBSI).

EU FOOD TRACEABILITY

EU General Food Law makes traceability compulsory for all food and feed businesses, requiring that all food and feed operators implement special traceability systems to be able to identify where their products have come from and where they are going and to provide this information to the competent authorities rapidly.

EU General Food Law (GFL) Implementation guideline including Article 18 of the Regulation applies to food business operators at all stages of the food/feed chain, from primary production (food producing animals, harvests), food/feed processing to distribution and supply, including brokers, regardless of whether they take physical possession of the food/feed in question.

European Parliament Decision No 768/2008/EC on a common framework for the marketing of products and circulation makes traceability compulsory for all food and feed businesses, requiring that all food and feed operators implement special traceability systems to be able to identify where their products have come from and where they are going and to provide this information to the competent authorities rapidly.

EU Regulation No 931/2011 on the provisions to implement the traceability requirements to food business operators in respect of **food of animal origin.**

EU Regulation No 1169/2011 on the provisions of food information to consumers to have the **mandatory list of information on the packaging.**

2002 2004 2006 2008 2010 20

US FOOD TRACEABILITY

Public Health Security and Bioterrorism Preparedness and Response Act directs the Food and Drug Administration (FDA) to take steps to protect the public from a threatened or actual terrorist attack on the U.S food supply and other food-related emergencies. Food traceability becomes mandatory.

The **FDA Food Safety Modernization Act (FSMA)** of January 4, 2011, amends section 415 of the Federal Food, Drug, and Cosmetic Act to **require that facilities engaged in manufacturing, processing, packing, or holding food for consumption** in the United States submit additional registration information to FDA, including an assurance that FDA will be permitted to inspect the facility.

Specifically, if FDA determines that food manufactured, processed, packed, received, or held by a registered food facility has a reasonable probability of causing serious adverse health consequences or death to humans or animals, FDA may by order suspend the registration of a facility that created, caused, or was otherwise responsible for such reasonable probability; or knew of, or had reason to know of, such reasonable probability; and packed, received, or held such food.

FDA publishes the **Smarter Food Safety Blueprint**, a new approach to food safety, leveraging technology and other tools to create a safer and more digital, traceable food system. It is centered around four core elements

- Tech-enabled traceability, including blockchain
- Smarter tools and approaches for prevention and outbreak response
- New business models and retail modernization Food safety culture

Echoing the EU Green Deal for Food, the FDA set the direction for traceability with its Smart Food Safety Blueprint.

However, the US is at the beginning of its end-to-end traceability journey, and its traceability framework is less directive than EU measures. Instead, the FDA makes recommendations and encourages operators to collaborate, for example through GS1 standards.

Source: Own figure based on US Food and Drug Administration, European Union, European Commission and European Parliament

EU Green Deal 2030 to reduce the environmental and climate footprint of the EU food system and strengthen its resilience, ensure food security in the face of climate change and biodiversity loss and lead a global transition towards competitive sustainability from farm to fork, tapping into new opportunities.

European Commission launched phase two of the **European Blockchain Services Infrastructure, EBSI,** which intends to use distributed ledger technology to meet the EU's climate targets.

EU Sustainable Product Regulation proposal adopted on 30 March 2022, under the framework of the EU Green Deal, setting the objective of becoming the first climate-neutral region by 2050 and launching the Digital Product Passport.

New Regulation on the transparency and sustainability of the EU risk assessment in the food chain aiming at increasing the transparency of the EU risk assessment, on strengthening the reliability, objectivity, and independence of the studies used by the European Food Safety Authority (EFSA), and revisiting the EFSA governance.

EU Food Labeling Revision of rules on information provided to consumers to help consumers make healthier and more sustainable food choices and tackle food waste.

EU Regulation No 208/2013 on the traceability of batches of sprouts and seeds intended for the production of sprouts.

EU roadmap on the transparency and sustainability of the EU risk assessment in the food chain remaining challenges).

Rapid Alert System for Food and Feed Annual Report publication showing origin of alerts, notifications per product type, reasons for alerts, etc.

General Food Law Fitness Check procedure to assess the law performance (improvements and remaining challenges).

Farm-to-fork Agri food chain procedure to assess the law performance (improvements and remaining challenges).

General Food Law Fitness Check refit of 2014.

The new Transparency Regulation showing published in 2019, entered into force 20 days after publication and became applicable on 27 March 2021.

2014 2016 2018 2020 2022

EU FOOD TRACEABILITY

FDA publishes **"Requirements for Additional Traceability Records for Certain Foods"** on its Food Traceability List. Referred to as the "Food Traceability Proposed Rule," it's part of the FDA's New era of smarter food safety and aims to standardize the data elements and information required to rapidly and accurately identify foods that may be causing illness. It defines additional recordkeeping requirements for businesses that manufacture, process, packs, or hold foods on the FDA's Food Traceability List, which must establish and maintain records containing **Key Data Elements** (KDEs) associated with specific **Critical Tracking Events** (CTEs).

FDA recommends industrials to collaborate through the **Foodservice GS1 US Standards Initiative** to help address challenges where GS1 Standards can have a positive impact: driving efficiency across the supply chain, providing complete and accurate product data, meeting traceability demands, improving data quality.

FDA recommends industrials collaborate through the **GS1 US Retail Grocery Initiative** to help address challenges where GS1 Standards can have a positive impact: enhancing data quality, enabling end-to-end supply chain visibility, improving operational efficiencies.

FDA makes clarifying **modifications to the Food Traceability List and publishes a detailed FAQ** that answers the questions that emerged following the announcement of the Proposed Rule.

FDA publishes the **Smarter Food Safety Blueprint**, a new approach to food safety, leveraging technology and other tools to create a safer and more digital, traceable food system. It is centered around four core elements

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Final **Food Traceability Rule** under the consent decree, FDA must submit a final rule to the Office of the Federal Register by November 7, 2022, including the proposed requirements on:

• **Critical Tracking Events** Growing, receiving, transforming, creating, and shipping are Critical Tracking Events (CTEs) for which records would be required.

• **Key Data Elements** Required records would need to contain specific Key Data Elements (KDEs). The KDEs would depend on the CTE being performed.

The KDEs required would vary depending on the CTE that is being performed. The records required at each CTE would need to contain and link the traceability lot code of the food to the relevant KDEs.

US FOOD TRACEABILITY

Meeting more stringent government regulations

On top of all this, the government regulations concerning packaging and coding, that need to be followed, are becoming more stringent.

Requirements to trace foods from farm to fork are on the increase. France and the UK have laws holding companies responsible for human rights abuses in their supply chain. Environmental abuse in the supply chain is unlawful in France and Germany. In the US, the Food and Drug Administration (FDA) is proposing regulations that would require participants in the food value chain to maintain electronic records for food recall investigation.

In addition, as part of making Europe climate neutral by 2050, the set of policy initiatives known as the EU Green Deal also includes farm-to-fork regulation.

Reducing human error in the recall process

Product recall is another area where coding plays an increasingly important role. Hundreds of products are recalled each year to prevent hazards such as poisoning, choking, burns, or fires. In such instances, products need to be traced accurately through the supply chain.

As a result of an E-coli outbreak in 2018, Walmart had to destroy millions of heads of lettuce, just to be on the safe side.[7] Such draconian measures cause huge financial losses. If the route through the supply chain can be accurately mapped, a more targeted approach can be adopted. Using blockchains, codes can be kept secure throughout the supply chain.

A higher degree of automation reduces the scope for human error as the coding process becomes more complex. Eliminating data entry by manual operators helps ensure that the right product ends up in the right package with the right label.

Adding a new dimension to code information

The simplest form of bar code is the 1D bar code; vertical liness of black and white space containing information readable by machines.

In recent years, 2D bar codes have risen in prominence. These do not use bars as such; using rectangles, dots, hexagons, and other patterns, they are also known as matrix codes or QR codes. The advantage of this type of code is that it can hold much more information.

In addition there are 3D codes that are engraved or embossed into metal, where the height of the symbol forms part of the code. These are used in certain parts of the manufacturing sector. The purpose here is not to hold more information, but to provide an alternative in challenging environments where white space is difficult to maintain.

In particular, the use of 2D codes has increased significantly in recent years and the average code length is expected to increase from 30 to 60 characters in the near future.

The recently introduced standard for bar codes, GS1 EPCIS, makes it easier for trading partners to share information about the physical movement of goods across supply chains., track and trace products, manage inventory, and provide accurate information on supply chain custody.

CASE STUDY

Dual-QR code helps ensure consumer confidence

Danone is using Laetus serialization technology to print a dual-QR code on infant formula boxes. The serial code is generated from Danone ERP system and transferred to Laetus software to form a dual-QR code. The Laetus hardware is able to print and verify the inner QR code and the outer QR code that are a unique combination of serial codes to the package at the item level.

Through the outer QR codes, consumers get access to rich information by scanning the code with their mobile devices. The inner-QR codes are located under the cover of the boxes. When the inner QR code is scanned, it triggers a one-time, initial message, verifying the product is authentic. Any subsequent scan of the inner QR code will trigger an alert that the product has already been opened.

When a consumer scans the inner-QR code, the serial number is transferred to Danone's ERP system. If the code exists in the database and hasn't been scanned before, the box is a genuine product.

Blockchains help ensure secure traceability

The information referenced in the code is usually stored in a traditional database. But if a blockchain is used instead, a range of benefits can be achieved.

The objectives of supply chain management are to optimize the product flow, the information flow, and the financial flow. Blockchain technology can help improve the latter two flows, helping to share information in real time between business partners.[8]

Rather than keeping all the records in a central database, blockchain technology enables the use of a distributed ledger. This is a shared and synchronized record that is geographically spread between its users. The blockchain is a growing list of records, or blocks, that are securely linked together. Each block contains information about the previous block, forming a chain.

The distributed ledger has two central features that distinguishes it from a traditional database. Firstly, it uses a consensus mechanism, shared between its users, to validate the information.

Secondly, any changes to the database are immutable. This means that no existing information can be deleted – information can only be added. This creates a secure data trail that helps with the security and traceability of products.

The database contains the history of all exchanges between the users in the supply chain, such as growers, processors, and packaging companies, since the creation of the product. It can store information about the product and how it was produced. This way, it provides consumers with transparency, enabling them to trace the origins of products that they may want to find out more about for nutritional, medical, environmental, ethical, or other reasons, helping to build trust between a manufacturer and end users.

One example is the Aura Blockchain Consortium that was set up in 2021, by LVMH, Prada Group, Richemont's Cartier brand and OTB Group, to provide an authentication platform for the luxury goods sector.

Blockchains help cut costs

While the use of blockchains increase the cost of IT, it also has the potential to improve productivity and reduce costs in many areas.

According to a report by Cisco and Boston Consulting Group,[23] the financial gains can be in the region of 0.4% to 0.8% of revenues.

This includes savings in areas such as reduced inventory holding, lower costs for trade finance, and less opportunity for theft and fraud.

Whether this will offset the higher costs for IT will be a matter for the market to establish. Initially it will probably be used mostly for high ticket items, but costs will likely be reduced over time.

It was recently joined by Hennessy Cognac. The blockchain enables the drinks manufacturer to help ensure full traceability of its products, from the origin of materials all the way to the consumer. The worldwide trade in counterfeit goods is vast. Some estimates value the total annual trade in fake goods at about $4.5 trillion, with luxury items accounting for about 60% of that. While it is difficult for brands to stop counterfeiters from copying their goods, they can make the genuine articles easy to identify using blockchain technology.[9]

Blockchain technology also facilitates transactions between business partners in the chain. Using a distributed ledger, secured by blockchain technology, helps ensure that the information is shared in real time and is traceable as well as transparent.

Using blockchain it can, for instance, be possible to trace not just a simple product, such as a package of strawberries, from farm to fork. Even complex products, such as a chocolate bar with all its ingredients – the cocoa beans, raisins, nuts, etc. – can all be traced and verified through the blockchain. The complexities of providing this level of transparency will be shared between all stakeholders in the value chain, who are all responsible for their own data. The manufacturer, as the owner of the complete product, decides how much of the information should be available to access through the code.

Blockchain technology is frequently confused with cryptocurrencies, such as Bitcoin. However, blockchain is just one of the technologies used to make up a cryptocurrency. Financial transactions can be part of the blockchain, but do not necessarily have to be. Even though blockchain technology has been pioneered in financial applications, it can be used to keep secure, tamper-proof records for any type of industry. Use cases have been identified across a wide range of industries. Food origin, quality tracking, micro grid, safety, and energy trading are some of the industries benefiting from blockchain technology.[10]

A blockchain does not necessarily have to use every feature that the technology offers. Blockchain technology has a reputation for using IT resources intensively, rendering the technology complex and costly. But for more limited applications, organizations often use private blockchains. In such cases, the consensus mechanism is decided between its members. This can make the technology more manageable, as it uses a limited feature set.[11]

The cost benefits in the wider supply chain means that the use of blockchains is expected to grow substantially over the coming years.

The financial benefits could be somewhere between 0.4 to 0.8% of revenues, according to a report by Cisco and Boston Consulting Group.[12]

Benefits include reduced inventory holding costs, as companies gain visibility of the supply chain and can reduce the stock they hold as buffer. According to World Economic Forum, distributed-ledger technologies could solve so many problems in this area that $1 trillion of new trade could take place globally.[13]

CASE STUDY

Tracking the daily catch from the depths to the dish

In the south Atlantic, Austral Fisheries is tagging every captured Patagonian toothfish it catches. The tagging information and the geolocation of the ship are used to verify that the fish was caught in a location where fishing is sustainable. When the ship returns to shore, a QR code is affixed, enabling consumers to follow the fish all the way from the depths to the dish.

Blockchain with IoT can deliver substantial financial impact

Lever	Incremental benefit of blockchain in an IoT enabled supply chain	Incremental benefit, by driver (%)	Range (%)	Economic impact	Driver's share of revenues (%)	Optimization possible (%)
Real-time traceability	Reduce the need for buffer stock through real-time visibility of products and shipments Use real-time data to enable rerouting of urgent shipments to faster routes	0.22	0.17 to 0.26	Inventory holding cost ↓	Inventory carrying costs 2.0 to 2.5	Optimization with real-time tracing on blockchain: -10
Elimination of LC fees	Minimize or eliminate fees by automating the LC creation, approval, and execution process using smart contracts	0.42	0.28 to 0.56	LC fees ↓	LC transaction fees -0.56	Portion that can be eliminated: 50 to 100
Faster dispute resolution	Ensure speedy insurance claim filing using IoT sensors to detect and time stamp events and smart contract rules and triggers that act as the adjudication protocol	0.02	0.01 to 0.02	Blocked working capital ↓	Average of goods damaged per shipment -2.3	Reduction in dispute resolution time: -75
Reduced dependency on brokers	Minimize or eliminate fees by automating the LC creation, approval, and execution process using smart contracts	0.03	0.00 to 0.06	Brokers' fees ↓	Customs brokerage per shipment 0,01 to 0.13	Reduction through blockchain use: 50
Minimal pilferage and fraud	Detect pilferage events by using IoT sensors and expedite dispute resolution by leveraging timestamped data that has not been tampered with	0.11	0.07 to 0.15	Pilferage and fraud ↓	Probability of theft per shipment 0.14 to 0.19	Savings with blockchain: 50 to 80
Efficient container utiization	Autonomously fill and charge for unutilized container capacity using IoT sensors to track usage patterns and blockchain to record container space purchases	0.02	-0.02	Container costs ↓	Container cost per shipment -0.2	Optimization through container sharing: -10
		0.82	**0.6 to 1.0**			

Note: LC = Letter of credit. The analysis assumes 40 to 60 working capital days.
Source: Pairing Blockchain with IoT to Cut Supply Chain Costs, BCG and Cisco, December 2018

Digital transformation drives customer insight

Customers also increasingly expect to be able to approach a company and its products through whichever channel they choose. Companies need to focus on providing a seamless customer experience across all channels when they lose the ability to have different product offerings in different channels. The digital transformation is driving this development, as all information about the brand is available at all times.

But the good news, from a brand owner's point of view, is that the sales and marketing systems can provide a wealth of data and insights. AI, machine learning, and predictive analytics are becoming increasingly embedded in the marketing practice, with technologies such as AI data miners, chatbots, and virtual assistants. The code helps trace the product through the channels and provides the link from the physical product to the IT systems.

Promotional coding provides a direct link to consumers

In an effort to reinforce brand loyalty, manufacturers frequently use promotional coding to launch targeted campaigns using variable codes on their products with web linked content. Consumers can spend twice as much on products that they are loyal to, compared to those where there is no emotional attachment.

Valuable marketing data can be linked to specific purchases as digital solutions replace pre-printed promotional pieces.

Promotional coding solutions allow manufacturers to directly connect with consumers with the application of intelligent variable codes on their products. The assigned code uses embedded product identifiers, SKU or channel information to provide a unique digital proof of purchase. Many printers can also accept externally generated codes in various methods and supply production-specific reporting data if needed. Manufacturers have the opportunity to become ever more targeted with their marketing activities using the fingerprint on each product to connect with the end user.[14]

By linking valuable demographic data to specific purchases, you can push your target marketing efforts to a whole new level.

This is only the beginning of this development. Artificial intelligence and machine learning will be a massive game changer when making more sense of the massive amounts of data collected through loyalty programs. More than just referencing past purchases, they will cater to consumers' personal tastes and preferences when building a connection with the brand.

Gamification – the method of triggering similar responses as those experienced when playing games – will increasingly be used to engage consumers and strengthen loyalty.

Non-fungible tokens (NFTs) may come to play a significant role here. These are digital assets that work like cryptocurrencies and can be traded within a loyalty scheme. Paid loyalty will also grow in significance, as demonstrated by the success of Amazon Prime.

Brand values, such as commitment to sustainability, will be increasingly important for customers when choosing which brands to be loyal to.

Modernized IT security is more important than ever

Another significant challenge is IT security. Any technology introduced needs to be up to date, or it risks being compromised.

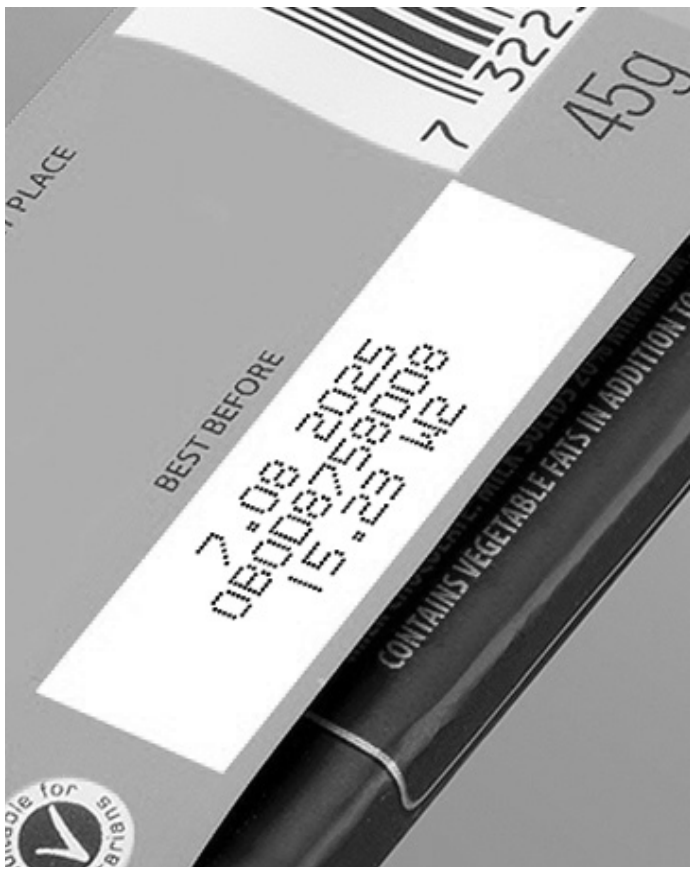
As more equipment becomes controlled over the IT network and applications increasingly reside in the cloud, IT security issues start to affect larger parts of the plant.

The SolarWinds attack drew attention to the new perils in a spectacular fashion. In this instance, hackers put malware on the software system of information technology firm SolarWinds. The company then unwittingly distributed the malware on to its 33,000 customers.[15] The uncomfortable question many asked themselves in the aftermath of the attack was – how do we know we can trust our business partners?

In a survey by data security company Splunk[16], 535 IT security professionals across the world were asked to identify the biggest security challenges in a cloud-native environment. Two issues stood out: 50% of participants spoke of maintaining and enforcing policies consistently across multiple data centers and clouds; and 42% referred to the cost and complexity of using multiple security tools.

Splunk concluded that the complexity of the cloud, remote workloads, new software development models, and the fragmentation of the public cloud, will be the next big security challenge.

Key recommendations were that companies need to modernize the security operations center by developing automation and analysis, adopting a zero-trust security model, and improve training and recruitment. Additionally, they should maintain the closer and faster collaboration between security, IT and business teams that has developed during the pandemic.



Systems move to the cloud

The sheer volume of large organizations' labeling needs has accelerated cloud-based deployment in recent times. The requirements can encompass millions of labels per day, from thousands of printers. The printing may need to be accessed from across multiple locations.[17]

The need for ongoing maintenance and software updates is eliminated by using cloud-based platform implementation. All supply chain participants can act in concert, using standardized datasets and global standards like GS1.

Invest for tomorrow's success

Coding and marking equipment has a high level of technology content and offers many opportunities for automation. This can bring significant advantages for companies that bring IoT into their processes.

But the equipment can also be costly, making it inaccessible for companies in developing countries and those working in low-cost applications. High cost can be an impediment to introducing modern coding technology.[18]

Another obstacle is that companies hesitate to upgrade because it is too disruptive. But in the long run, the reductions in total cost of operation delivered by simplification, standardization, and efficiency will help companies control costs.

Significant productivity improvements can be achieved through the implementation of up-to-date coding and marking equipment, by companies focusing on implementing industry 4.0 concepts.[19]

Compatible standards are key

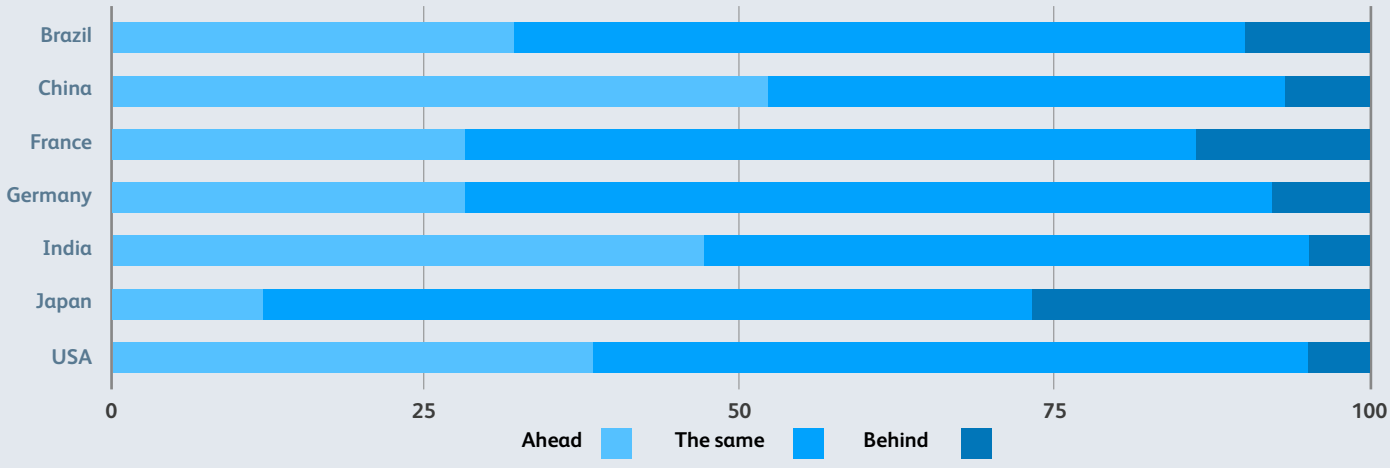
As manufacturers invest and adapt, the IoT will enable ever greater levels of horizontal and vertical integration.

Today, dozens of open and proprietary communication protocols exist side by side. But only two of them – Profibus and Ethernet IP – have significant market share in the packaging sector. These protocols play a key role in the running, maintenance, and upkeep of field devices and significant investment goes into ensuring they can continue to do so.

Compatible standards are vital for the upkeep of a viable IoT network. Connected devices need to speak to each other and share data with other systems. Efficient cooperation within the plant becomes difficult if islands in the factory run on different standards. Many of the advantages of the IoT will be lost. Proprietary systems are not compatible with the factory of the future.

Improved connectivity will also change who controls what. In some instances, supervisory systems may need to control coding equipment in real time. In other cases, coding equipment may need new functionality to control other, less capable devices, such as scanners or cameras. In addition, the shift towards flexible, on-demand manufacturing will require new functionality for real-time processing and communication.

Digital Manufacturing Global Expert Survey 2018: Nine out of ten companies believe that they are ahead of the competition on digitalization, or at least on par with it.



Source: Future-proofing a digital manufacturing transformation, McKinsey & Company, March 2019

A window of opportunity

The opportunity for implementing automation may have increased as a result of the COVID-19 pandemic.

Many companies now face less pressure from shareholders for short-term financial results, compared to before the pandemic, according to the Economist. [21] Many of them are taking the opportunity to reassess the way they work.

This has resulted in increased levels of automation in companies, particularly robotics. These are changes that are here to stay. The Economist puts it succinctly: ***"After years of dithering, companies are embracing automation".***

Technological changes gather pace

The pace of technology change is increasing rapidly. According to McKinsey[22] smaller companies have trailed large ones in productivity improvement over the last decade. But this seems to be about to change. A long list of technologies that will help make processes more efficient has been compiled by McKinsey. The technologies aim to provide higher levels of precision, complexity and speed.

The accelerating rate of technology change in manufacturing processes is illustrated by the growing number of patents. In the period 2001-21, the number of US patents registered on industrial manufacturing processes was 153% higher than the number during the previous 20-year period (see the table in the introduction on page 6).

Staying ahead of the competition

But how can an organization help ensure that it keeps up with the competition or, preferably, stays ahead of it?

A study by McKinsey[20] highlights the difficulty. According to its fourth Digital Manufacturing Global Expert Survey, more than nine out of ten companies believe that they are ahead of the competition or at least on par with them. This clearly cannot be right – it is not possible for 90 percent of companies to be performing better than average.

It is understandably difficult to gauge how your own company positions itself relative to the competition in a fast moving environment. Nor can companies afford to wait and see what happens before they make important investments to help them keep ahead of the competition.

To remain focused, McKinsey recommends that companies maintain a clear roadmap that extends from the present and into the future – not just to a destination that is visible from the starting point, but into a future that we cannot yet see.

Four ways to future-proof your organization

Future-proofing the development of the company, according to McKinsey, rests on four components. The first is a scaleable technology stack that makes the most of industry standards to make the equipment compatible with other systems. Secondly, companies need an agile mindset to foster innovative solutions. Thirdly, the organization needs access to external partners to fill capability gaps. Finally, it needs to develop skills to drive cooperation between different parts of the organization.

McKinsey has identified nine broad technology areas it believes will have a significant impact in manufacturing over the next few years. These are arranged in four categories – see table below.

The rapid evolution of these technologies means that early adopters have a significant opportunity to gain advantages over the competition.

Through four major digital levers, nine technology areas are poised to deliver value to manufacturers

Digital lever category	Main technology areas
Digital management tools and connectivity	• Enhanced ease of deployment and more secure IoT and secured information; • Increasing computational power and data collection.
Digital ways of working	• Advanced human machine interaction; • Design and simulation.
Advanced analytics	• Greater adoption of machine learning in industrial space; • Assisting human information discovery.
Advanced production method and material	• Automation of physical processes; • Human augmentation; • Printing and new materials.

Source: Future-proofing a digital manufacturing transformation, McKinsey & Company, March 2019

Chapter 3

Organizational challenges ahead

What stops companies from implementing the new technologies?

To run a successful business, operators in the packaging and coding industry have a raft of hurdles to overcome. These include – but are by no means limited to – fragmented communication; lack of collaboration between departments and across the whole supply chain; an aging workforce; needing to maximize aging capital assets; managing accumulation of systems; overcoming lack of interoperability; preventing or mitigating human errors; and dealing with unplanned disruption of production.

Overcoming these challenges can result in careful integration of technology, improved communication, across all levels, better visibility and access to data, and eliminated duplication. Startup and changeover times can be shortened. Flexibility for product varieties can be improved. The end result is a better functioning organization with positive impact on consumer safety and loyalty, staff morale, and the company's bottom line.

Improving collaboration between isolated sites

Many companies operate scattered islands of automation, with control room staff having different screens from different systems, presenting different data. While there is no shortage of information, answers are hard to find. A lack of a common view of the data leads to difficulty in making timely, effective decisions. As a result, the skill of the individual operator is often instrumental, as production scheduling is often done manually. The requirements of the overall supply chain are frequently not considered at all. Procurement and production operations are run independently at different sites and departments.

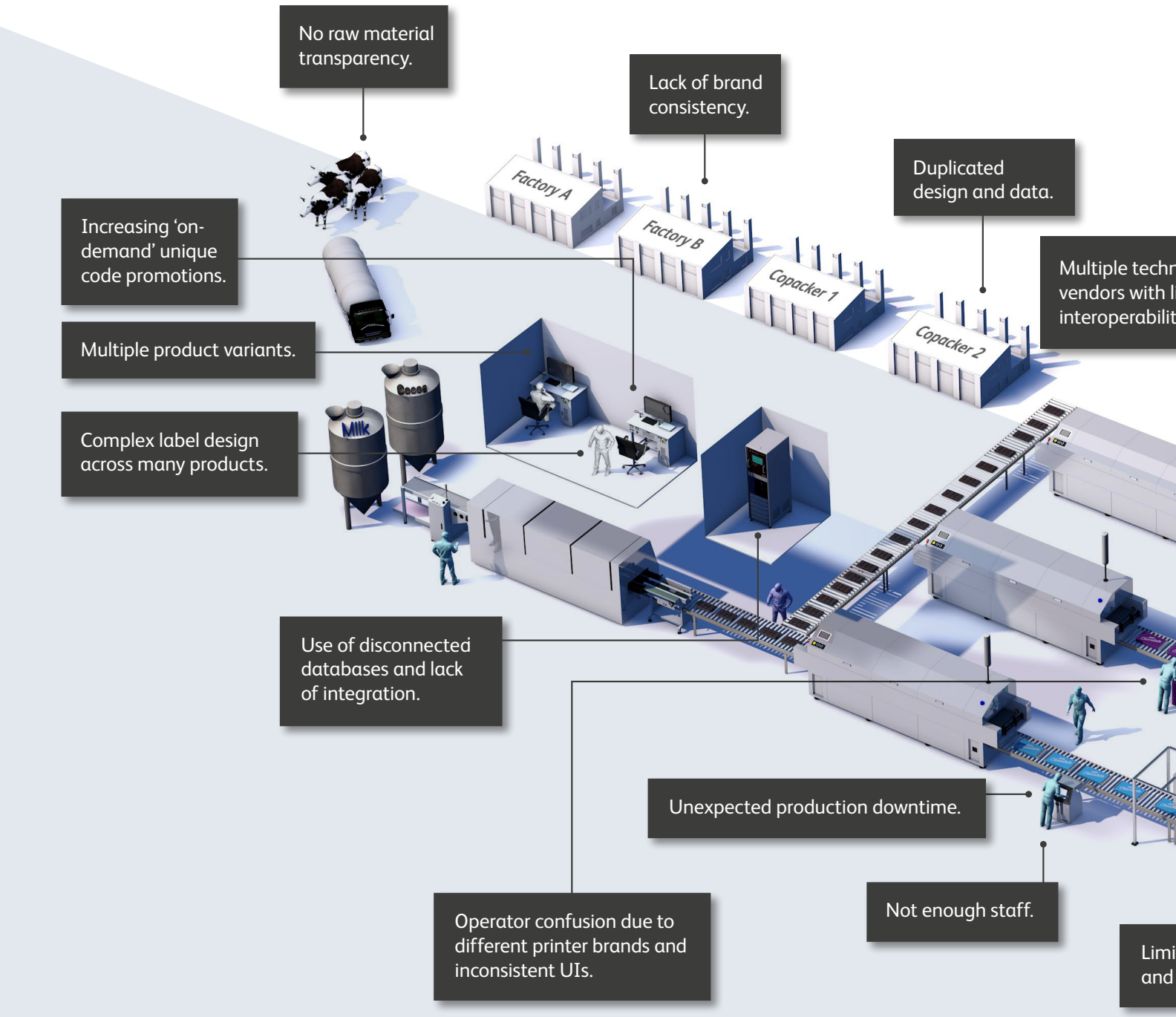
Increased communications can also improve collaboration between sites. Today, many sites work in isolation, with suppliers, customers, and partners rarely interacting. Plant teams from different sites talk to each other infrequently, with the result that many opportunities to develop effective responses to operational challenges are missed. The industry keeps reinventing the wheel, over and over again.

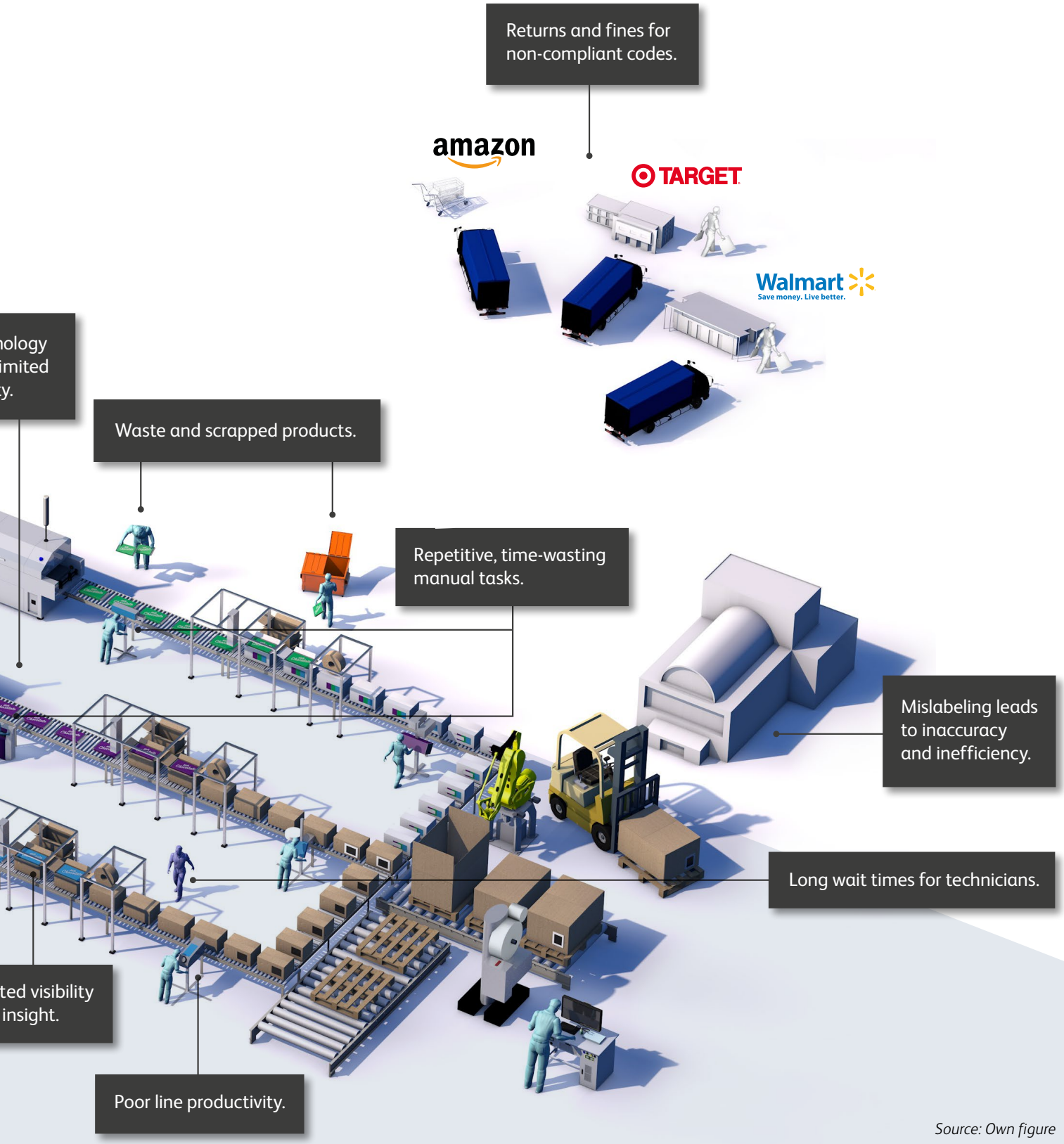
What are your priority challenges?

Do you need to support dynamic packaging requirements with mixed equipment and labor shortages?

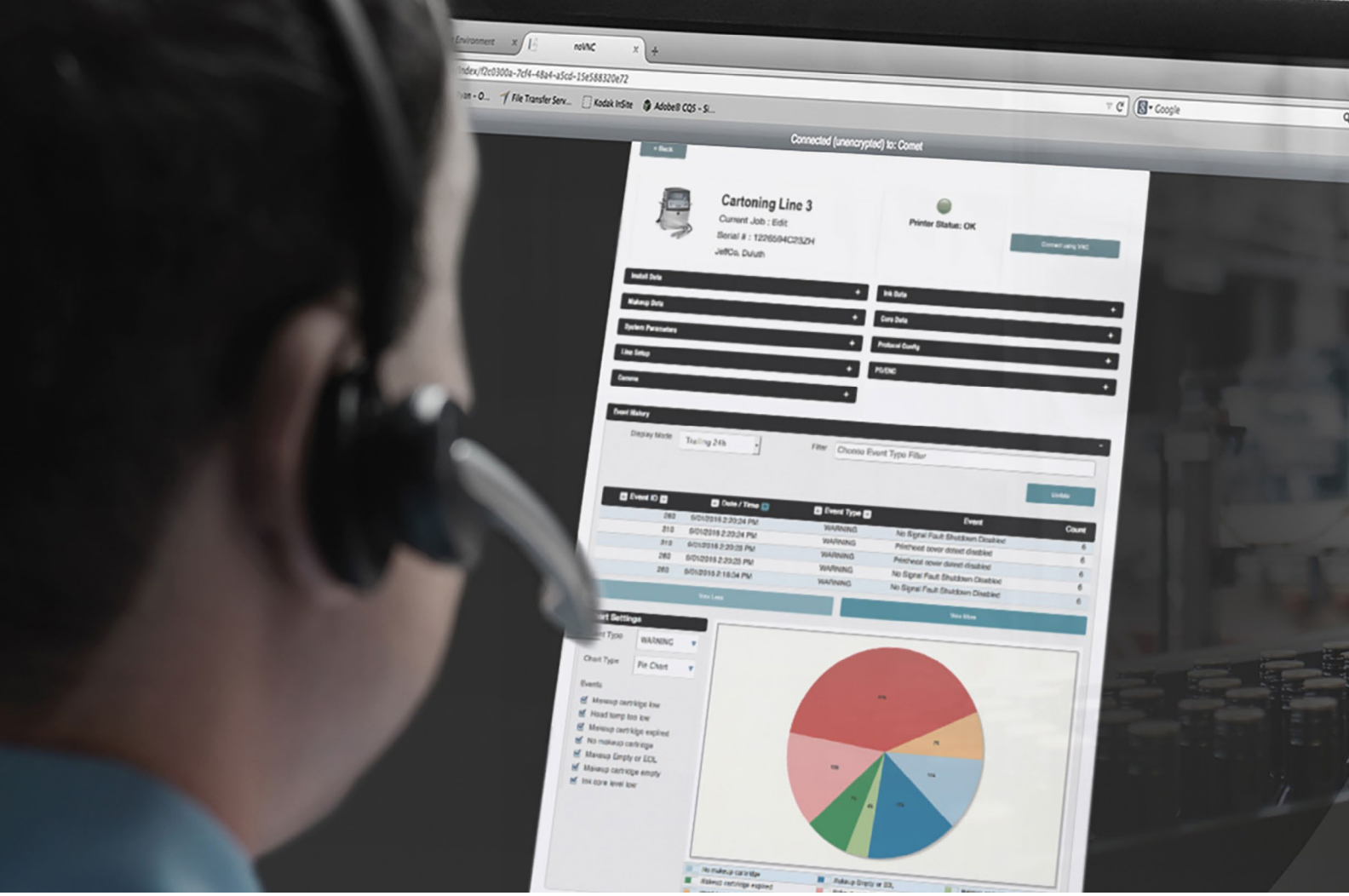
Increase production variability with multiple SKUs, various change-overs and rapid on-demand customer labeling?

Reduce manual processes leading to multiple opportunities for errors? Ensure product security and long-term customer engagement?





Source: Own figure



Reducing downtime through preventive maintenance

Uptime is critical to the profitability of any continuous process. While emergency repair in itself is costly, the greater damage to the bottom line is due to the time the asset is down and not producing revenue. In addition, prolonged stoppages can have a long-term impact on customer relations.

Preventive maintenance is far better than emergency repair. Despite this, reactive and time-based maintenance practices are still dominating maintenance strategies, resulting in a fragmented approach to asset management. OEE productivity software, such as VideojetConnect™, can help streamline the process of driving operational improvement.

Optimization of daily plant operations is frequently a challenge. These operations are often complex, with multiple disruptions. Effort is frequently expended on tasks of minor importance.

Unplanned downtime can be very disruptive, with significant impact on production flow. Frequently, the plant manager does not have the necessary data to develop insights into when or for how long unplanned downtime occurs, whether the trend is getting better or worse, or if there is a pattern to the disruptions.

It becomes very difficult to identify issues, implement measures, and improve productivity without this data. Many packaging operations simply lack the tools to implement lean manufacturing in a meaningful way.

There is no way to evaluate real-time data and make timely decisions in an easy fashion. Equipment from many different original equipment manufacturers (OEMs) is frequently combined to make up packaging lines. This may make it costly to monitor equipment as the machines may communicate using different software protocols.

For instance, MES systems have 11 different main functions, but nothing for print management. As a result, the vast majority of plant management in the packaging industry takes place using clipboards and spreadsheets, even in large companies.

This becomes a challenge during shift work, as it may not be possible to provide staff with a consistent overview across all the hours of a 24-hour cycle. It may also create inconsistencies in operational processes and gaps in access to expertise during late hours.

Because effective methods of automation are frequently lacking, many marking devices operate in standalone mode, to the detriment of productivity, reliability, and staff morale.

There is often no feedback on the quality of the printed code. This can be easily implemented in an automated system, but with machines in stand-alone mode, thousands of units can be printed before an error is discovered.

Frequently, there is also a certain inertia in the internal organization, where staff members have settled into their roles. Sometimes, automation can be seen as a threat. The key is to introduce automation as a complement that will help staff members to perform their tasks better and enhance the value of their work.

Automation then becomes an aid in supporting OEE improvement, which is the task all staff members need to be involved in.

Creating a more profitable plant

Using IoT, it will be possible to report consistently and implement standardized routines throughout all times of the day, week, and year.

The IoT will facilitate a move to condition-based maintenance, with each device having sensors that report on its performance. Assets can then be maintained on the basis of their requirement, long before they even begin to cause problems. Many line OEMs have introduced remote support – Bosch since 2015, Krones since 2018, Coesia since 2019 and Marchesini since 2020. Many more look set to follow in the future.

The industry is also over-reliant on an aging workforce for its operation. The industry is often seen as low-tech and can be difficult to recruit into. 75% of companies are reporting a shortage of qualified workers.[24]

Much of the information used is retained by long-serving members of staff, who one day will retire. Industries such as food and beverage, FMCG (fast-moving consumer goods) and CPG (consumer packaged goods) are also price-sensitive, which can make it difficult to retain margins and reward staff properly. A plant that functions better, with the help of IoT, will be a more attractive place to work, and a more profitable one, too.

Automation and artificial intelligence will make systems less reliant on the knowledge of individual members of staff. This will relieve challenges in finding, training, and retraining staff. It will also help reduce manual errors. The knowledge of staff members can then be more usefully engaged, for instance to help improve quality instead of solving mundane tasks that machines do better.

Assets can be maintained on the basis of their requirement, long before they even begin to cause problems

Chapter 4

Moving forward to a digital future

Developing the Digital Factory and moving to Industry 5.0

When reading about IoT, it's easy to get the impression that this is something that relates to big companies building extensive systems at major plants. But these are not typical examples.

The implementation of Industry 4.0 is happening right now, in thousands of smaller applications in all sorts of industries. Some even argue that we have already moved on to Industry 4.1 or even 5.0.[25]

Large as well as small consumer packaged goods (CPG) companies can – and will need to – find useful, effective advancements in technology that fit within their budgets and scope.

The recent wave of the IoT has driven down the price of wireless connectivity significantly. A project that might previously have cost USD 20,000 to hardwire, may now require less than USD 1,000 investment in wireless technology.[26] This minimal investment can rapidly pay back in savings from reduced downtime.

Recent advances in hardware and software allow manufacturers to collect operating data without extensive on-site IT involvement. Cloud-based software solutions are becoming the norm, simplifying implementation by dramatically minimizing IT involvement and requirements.

Less wiring, more data

Moving to a cloud-based solution eliminates dependency on plant-based PCs and servers and associated implementation and maintenance challenges. Data connections are simplified with common internet security protocols and standards.

With cloud-based solutions, remote data access can be achieved, freeing managers from the constraints of being on-site to review plant or line performance. Moreover, the improved access to data can be a significant help in reducing downtime. Automated alerts can help maintenance and operations staff to keep tabs on machine performance.

With remote monitoring, your equipment provider can see what might be causing downtime using IIoT sensors. With remote service, your partner has remote access to your machinery and can work on the issue for you. Downtime can be shortened and a significant share of service calls eliminated when experts support operations with 24/7 analytics and real-time repair.

The deployment of the IoT and smart technology means that manufacturers can potentially access any point of production through a connected device. With advanced predictive capabilities, many potential issues can be addressed before they actually happen.

Rapid diagnosis and recovery from issues that have the potential to bring production lines to a halt can be provided using remote servicing. On-site visits by a technician can be significantly reduced as many issues can be fixed remotely.

The Industrial Metaverse Industry 5.0

The Metaverse, the next generation of the internet, will be made up by immersive 3D environments, involving elements of virtual reality, augmented reality, and other aspects of interaction that are currently being developed. The Metaverse will be more similar to a computer game than the current version of the internet that we are used to.

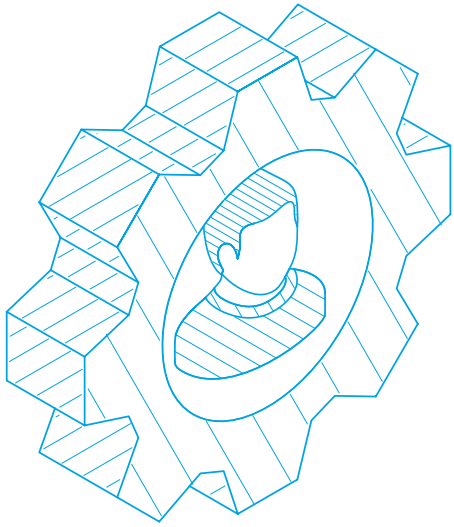
Some see this as the foundations of the next industrial revolution, Industry 5.0. In the Industrial Metaverse, we will be able to interact with digital twins of all the components in the industrial environment. The Metaverse will be persistent – objects continue to exist and interact with each other even when we are not watching.

This can be used to optimize any industrial system. Multiple versions of industrial installations or logistical chains can be running concurrently for evaluation. Complex industrial environments can be simulated before committing to them in the real world.

The opportunities that this presents for industrial automation are enormous. However, the Industrial Metaverse is still some way off. In fact, the Metaverse, as such, does not yet exist.

The Metaverse will be enabled by a putative next generation of the internet, known as web3. Unlike the current version of the internet, Web 2.0, this will not rely on a small number of tech giants, such as Google, Facebook, Apple, and Microsoft, to keep it going.

Instead, web3 will be based on decentralized networks using technologies such as blockchains, cryptocurrencies and smart contracts. These technologies have been developed to eliminate the need for a trusted intermediary in transactions, such as banks or brokers, by building the contract into the code. The expectation is that these technologies will be used to power the next version of the internet[32].



INDUSTRY **5.0**

Sharing data to create new opportunities

The need for on-site labor and travel costs can often be eliminated, as equipment suppliers will be able to continuously monitor their machinery. Performance data can be gathered and settings optimized to meet the specific requirements of the application. Companies will be able to share information with distribution partners, participating in a data-driven decision-making dialogue.

To realize the cost and efficiency savings that are available, companies need to develop an understanding of how to use data, along with capabilities to transfer and store it securely. OT and production control systems merge with IT systems, managing critical assets, logistics, operations, and planning. In the wake of this, new opportunities will emerge.

The benefits include smart production; intelligent response to critical asset conditions; demand-driven planning; as well as reduced energy consumption, waste, and recalls.

Many companies in the sector have little data integration across the value chain and still operate in silos, not sharing data with other departments. Spreadsheets backed up by human experience are still the basis for critical decision-making in many parts of the industry.

But signs of change are emerging. A growing number of plant operators realize that IT and OT cannot operate separately if they are to continue to deliver shareholder value in an environment that increasingly requires customized and on-demand production. A consolidated view of production assets will help enable companies to view and adjust operations across the value chain as they happen.

An integrated solution providing diagnostics, automation, and optimization is required to address the challenges.

Optimizing, securing, and connecting up the value chain

Operators running their own machines, without much communication or collaboration, is usually the norm in marking and coding operations. There is rarely any integration between these islands of automation. A complete and unified view of production, from raw materials via processing to delivery, is necessary to optimize the entire value chain. This includes the entire product coding and marking setup, from primary to tertiary packaging.

Gaps in the value chain can be closed by integrating IT and OT at each level. This leads to higher productivity and enhanced collaboration; a holistic commercial view of the whole enterprise; increased production efficiency; improved product safety; traceability of products; and assurance of genuine product origin.

Increasing requirements for legibility, more variable data, faster production lines, and more problematic flexible packaging are all factors that can make coding a challenge.[27]

Coding errors cause products to be scrapped or reworked – if they can be salvaged – as well as possible fines and damage to the brand reputation.

20% of coding errors are caused by selecting a wrong or out of-date template; 40% are caused by a human mis-entering code information; and 40% are related to the application of the code. Coding errors result in rework, scrap, rejected shipments, and retailer fines. Therefore, job selection and message creation have to be as foolproof as possible.

It may not be possible to recode or repackage the product once it has been coded. Scrapping may be the only option. Still, this is preferable to miscoded product ending up on supermarket shelves or in the homes of consumers.

In a survey of FMCG manufacturers conducted by Videojet, nearly half said they were having trouble with coding errors at least once per week, with one-quarter reporting coding errors at least once per day.[28]

Using reliable communication, the design and distribution of product codes can be optimized as they are sent to different printers, multiple lines, plants, or co-packers as required.

In the future, marking and coding will be achieved through automation systems that bring equipment, systems, and people together. Serialized data will be used to help pinpoint the specific location of products in the supply chain.[29]

Using blockchain technology, data can be safely transferred and follow the product as it moves through the value chain.

Managing information flows is often a challenge in today's supply chains. Typically, ERP systems are not integrated with the information flow, so emails have to be sent back and forth whenever the information changes. This could all become a thing of the past with the help of blockchain technology, as the information that flows through the system is validated and transparent.

At the moment, blockchain is an emerging technology.[30] Putting it into practical use will take some concerted effort, as a supply chain can contain several hundred organizations, all with their own goals and priorities. Such efforts are underway. One example is the Marco Polo Network, which provides digitized supply chain financing using distributed ledger technology. Another example is French supermarket chain Carrefour, which is gradually integrating blockchain technology into several of its product lines.[31]

Blockchains can help resolve complex issues in logistics, auditing, intellectual property rights, and operational efficiency. Software giants such as IBM, SAP, and AWS are all developing their respective offerings in this.

Regulation may also force change. For instance, in the United States, the Food and Drug Administration requires companies to trace their materials and products. This may speed up implementation in some sections of the industry. As blockchain technology comes into use, early adopters will benefit and others will then follow due to competitive pressure.

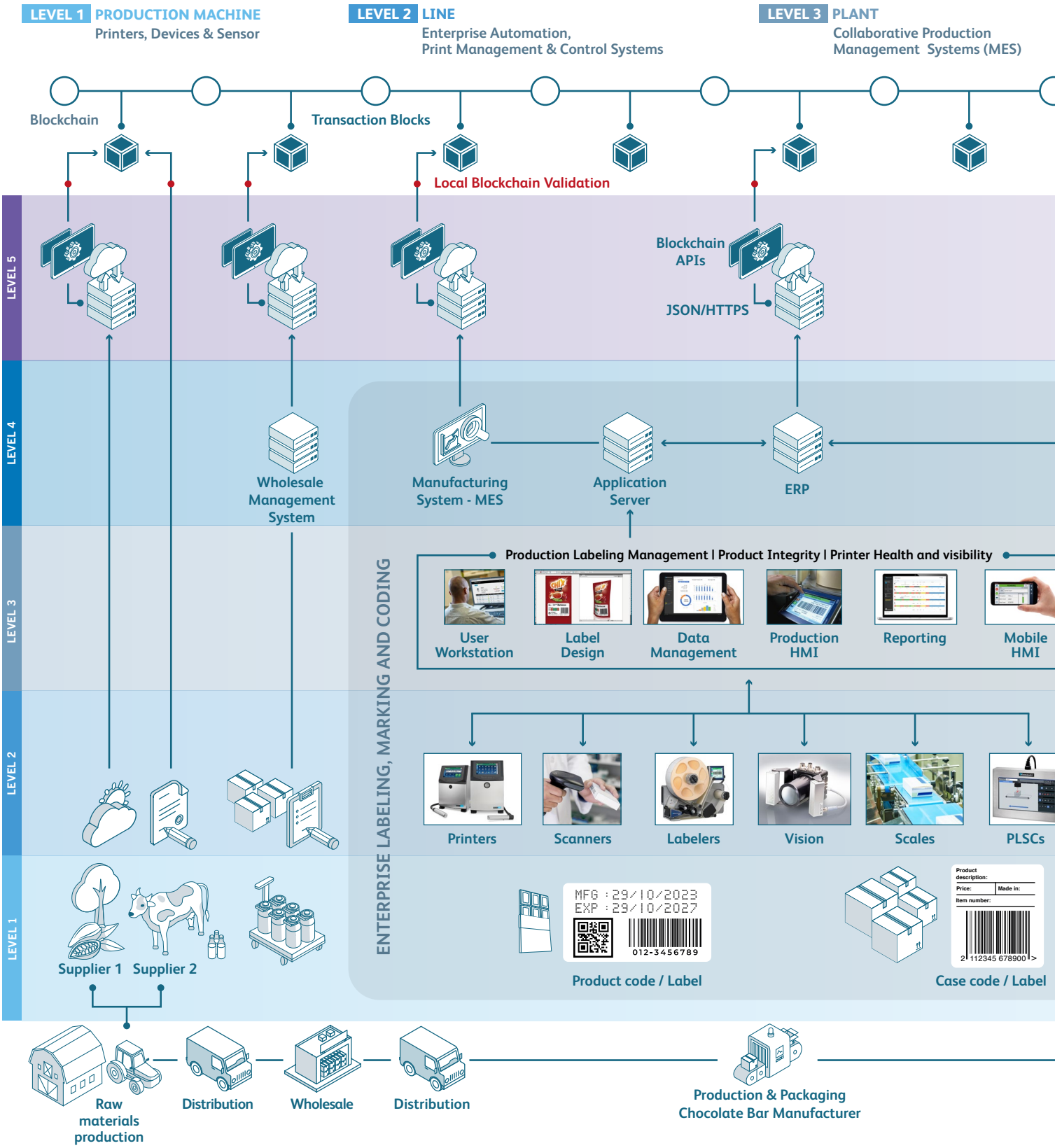
Pros and cons of centralized and decentralized networks

	CENTRALIZED NETWORK In a centralized network, there is a central authority that governs and handles the networks		**DECENTRALIZED NETWORK** In a decentralized network, there is no central authority that governs and handles the networks	
	ADVANTAGES	**DISADVANTAGES**	**ADVANTAGES**	**DISADVANTAGES**
	• Command chain • Reduced costs • Consistent output	• Not 100% trustable • Single point of failure • Scalability limitation	• Full control • Immutable data • High security	• Costly • Misuses of authority • Volatility
Third-party involvement	Yes		No	
Control	Full control stays with the central authority		Control stays with the user itself	
Hackable	More prone to hacks and data leaks		Less prone to hacks and data leaks	
Single point of failure	Yes		No	
Ease of use	Intuitive and easy to use		Not easy to use	
Exchange fees	Higher fees		Lower fees	

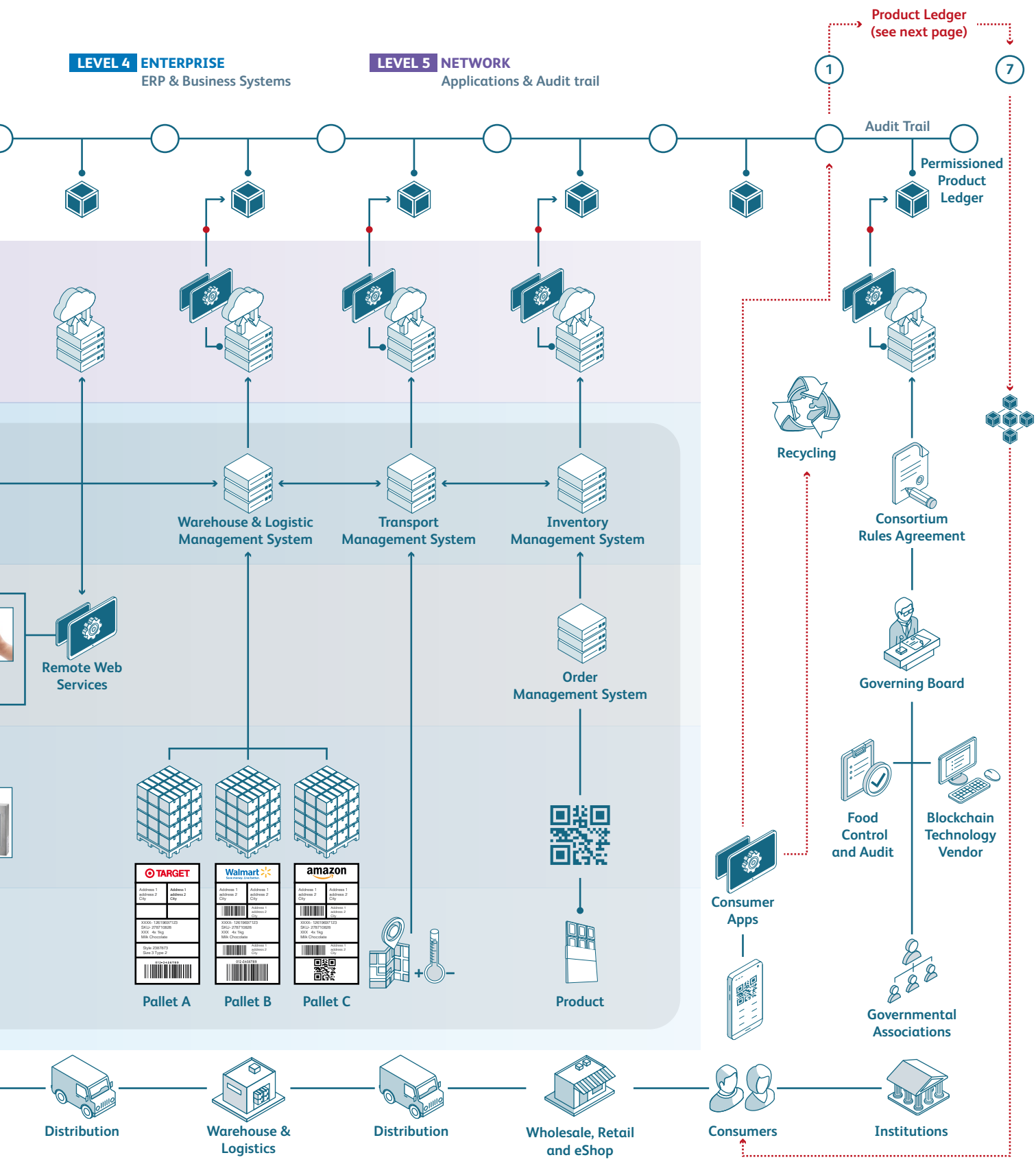
Source: Centralized Vs. Decentralized: What Are The Core Differences?, 101blockchains.com, August 2021

A decentralized blockchain solution creates, an independent, auditable data flow

All transactions in the blockchain are immutable – records can only be updated when all nodes record the event and are in consensus.

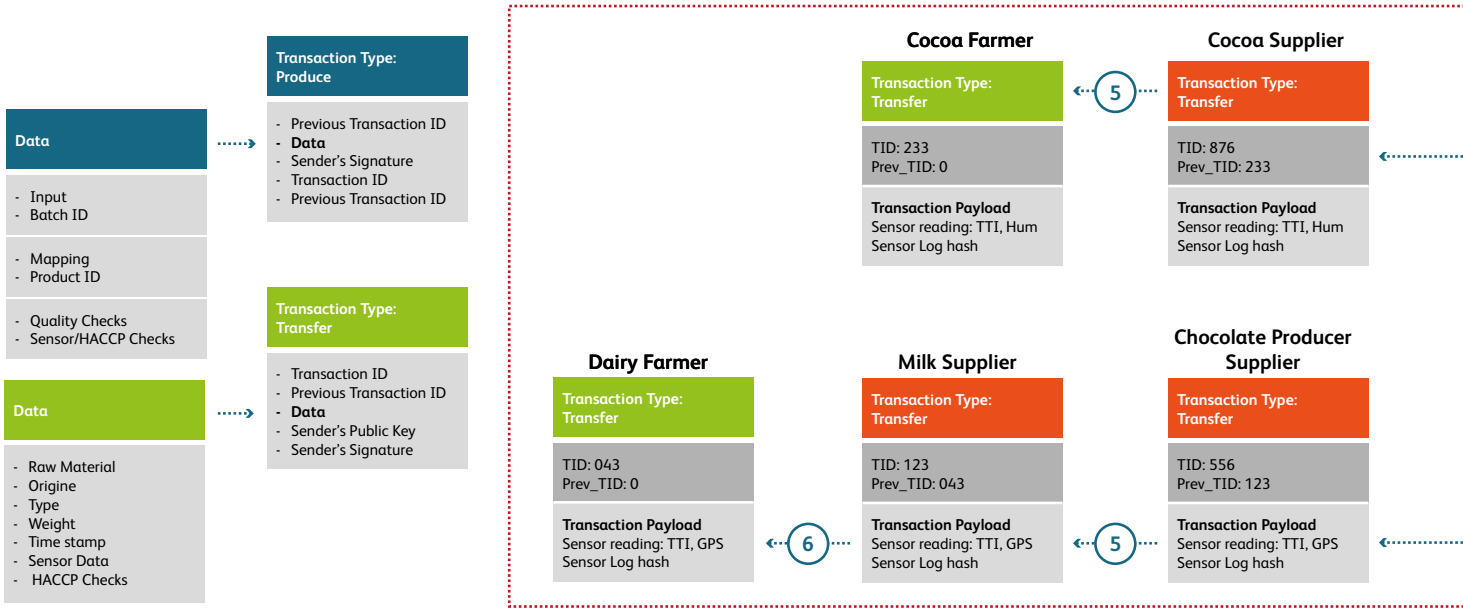


The system cannot be compromised by single point of failure and all data is encrypted – every transaction must be digitally signed using cryptography. A standard system using servers and clients is more vulnerable to error and malicious attacks, as records can be altered or deleted at any time. A blockchain, by contrast, will help ensure a secure data record, full product traceability, and transparency for the end user.



Product Ledger

Provenance information and Transaction flow from farm to fork.



Transparent ledger system	Tracking in real-time	Faster transactions	Trustless chain
Decentralized supply chain offers to trace every product movement using the transparent ledger system.	Blockchains supply chain supports real-tie tracking of any material within the system along with their current condition for quality control.	The supply chain blockchain platform is capable of transacting thousands of transactions per second, saving a lot of time.	The smart contact integration will create a trustless medium among manufacturers and vendors.

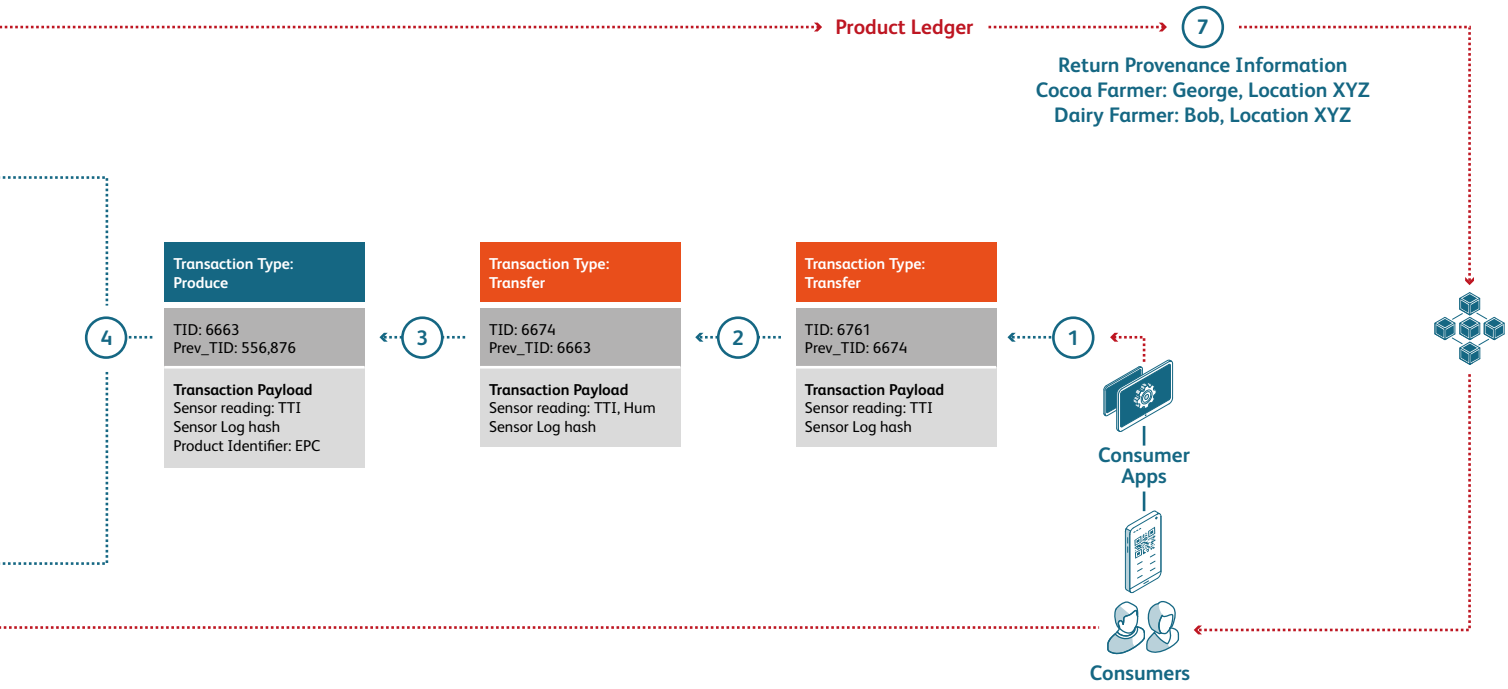
CASE STUDY

New European Digital Product Passport Scheme

A Digital Product Passport (DPP) scheme will help users in the European Union trace products through their lifecycle. This follows the adoption of the EU's Ecodesign for Sustainable Products Regulation (ESPR), which will enable the EU to set labeling requirements, for example on whether products can be repaired or recycled. The initiative is part of what the EU describes as the "Twin Transition" of digitalization and the move towards a more sustainable, circular economy.[23]

The new regulations aim to foster responsible supply chains, where product passports disclose the sustainability performance of products and prevent waste and inefficiency.

The digital passports will carry information about the composition of products circulating in the European market, enabling second-life operators, and recyclers to take better business decisions, plan their operations, and improve recycling effectiveness.



Source: Own figure based on ProductChain: Scalable Blockchain Framework to Support Provenance in Supply Chains, Sidra Malik - Salil S. Kanhere - Raja Jurdak, November 2018

Product certification	Greater security	Lower carbon footprint	Reduced costs
Everything will get certified on the blockchain, promoting a platform without human error and fraudulent activities.	Immutability of the blockchain for supply chain network ensures greater security and also improves accuracy.	It will decrease the need for returns, thus prompting a reduction in carbon footprint.	Gets rid of the middleman, offers greater accuracy, and no counterfeit products reduces the overall costs.

The digital product passport could also be used as a tool for supply chain compliance, providing transparency for stakeholders throughout the supply chain, as well as helping consumers and businesses to make informed choices when purchasing products.[24]

A key enabler of the project is a proposed blockchain solution, the European Blockchain Services Infrastructure, EBSI, which is intended to use distributed ledger technology to carry the information. A distributed ledger will provide a decentralized system that enables all participants in the value chain to update their records in the system independently from each other.

Product information will be available electronically when a unified blockchain is used. Unique digital identifiers will disclose information on hazardous content, performance, durability, and recyclable content. These will also contain information on carbon footprint and the origins of raw materials.[25]

Chapter 5

Technology to meet tomorrows print management challenges

How Videojet helps users to implement new digital solutions

Videojet has been working for more than a decade to develop and enhance marking and coding control systems, communications solutions, sensors, vision systems, and software for IoT. These technologies enable customers in manufacturing to analyze data more intelligently, optimize operations, boost productivity, and enhance flexibility.

Continued investment in research and development, combined with partnerships working to deliver more powerful and integrated systems, means that Videojet is ideally placed to help manufacturers take the next step, driving new levels of productivity, security, and operational efficiency.

Based on the premise that every product can be made unique with the help of the IoT, Videojet is now bringing together its solutions for operational efficiency, compliance, and brand management.

This shift will see Videojet move from a batch-based data creation and collection supplier, to a serialized unique code data management provider.

IoT-enabled hardware

Videojet has a wealth of experience for developing printing and coding solutions for the packaging industry using the power of the IoT.

VRS (Videojet Remote Service) was a ground-breaking IoT solution for the industry, enabling much of the service work to be carried out remotely. It still has a large installed base. Many experiences from the VRS program were used when developing the Videojet 1860 continuous inkjet (CIJ) printer, the first IoT-enabled printer, which was revolutionary when introduced. This is now being superseded by the SIMPLICiTY™ range of printers.

With the 1860, Videojet pioneered remote service technology, which collects and instantly shares printer data via email or smart devices to designated users. This real-time notification also provides access to plant dashboard reports.

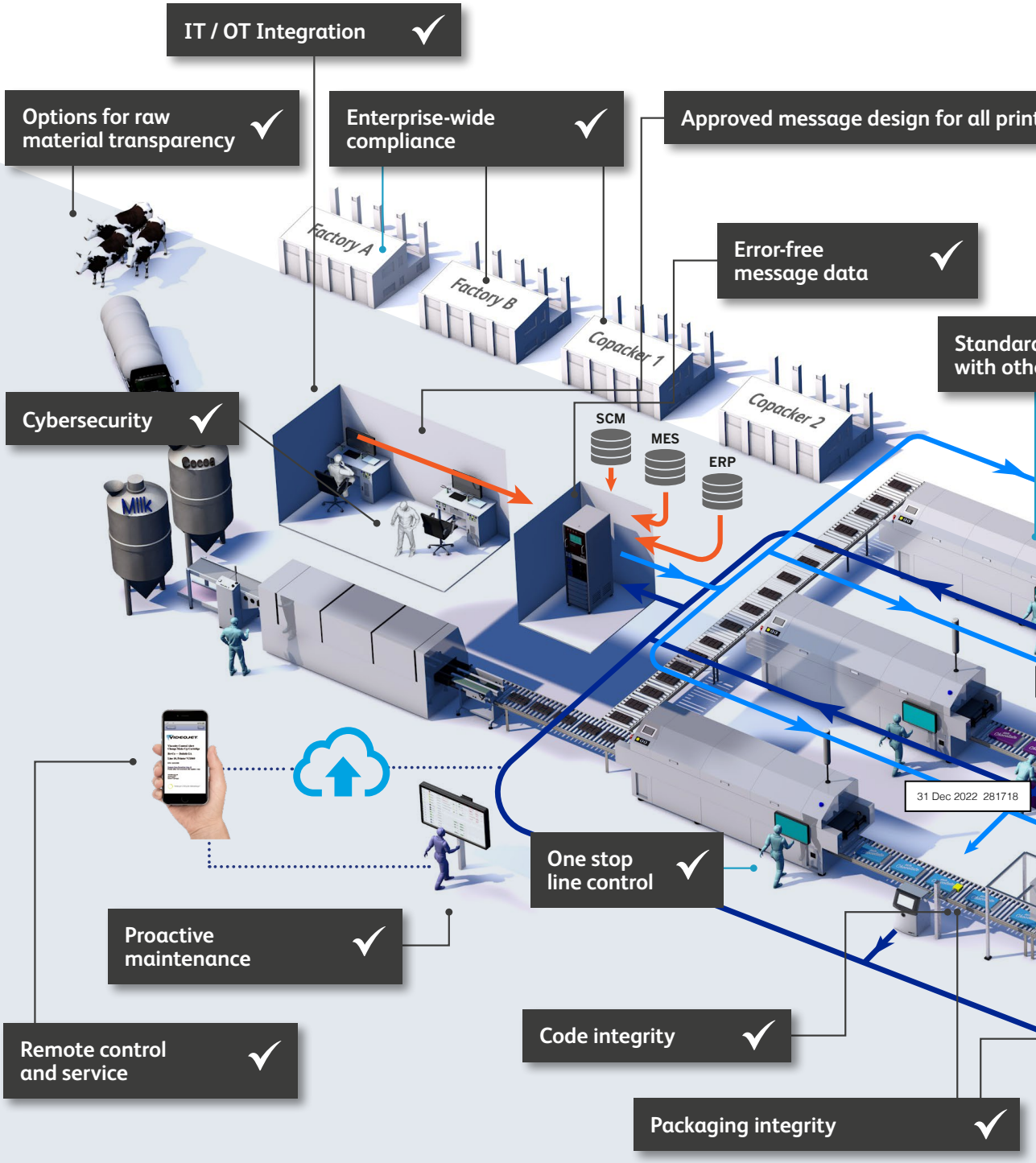
Understanding that unplanned downtime is sometimes triggered by a few simple things that can be easily addressed, Videojet also developed intelligent sensor technology to identify and immediately communicate many irregularities, faults, or maintenance needs.

The recently launched Videojet 1880 CIJ printer builds on this experience, harnessing the collective intelligence of 10,000 cloud-connected Videojet printers worldwide.

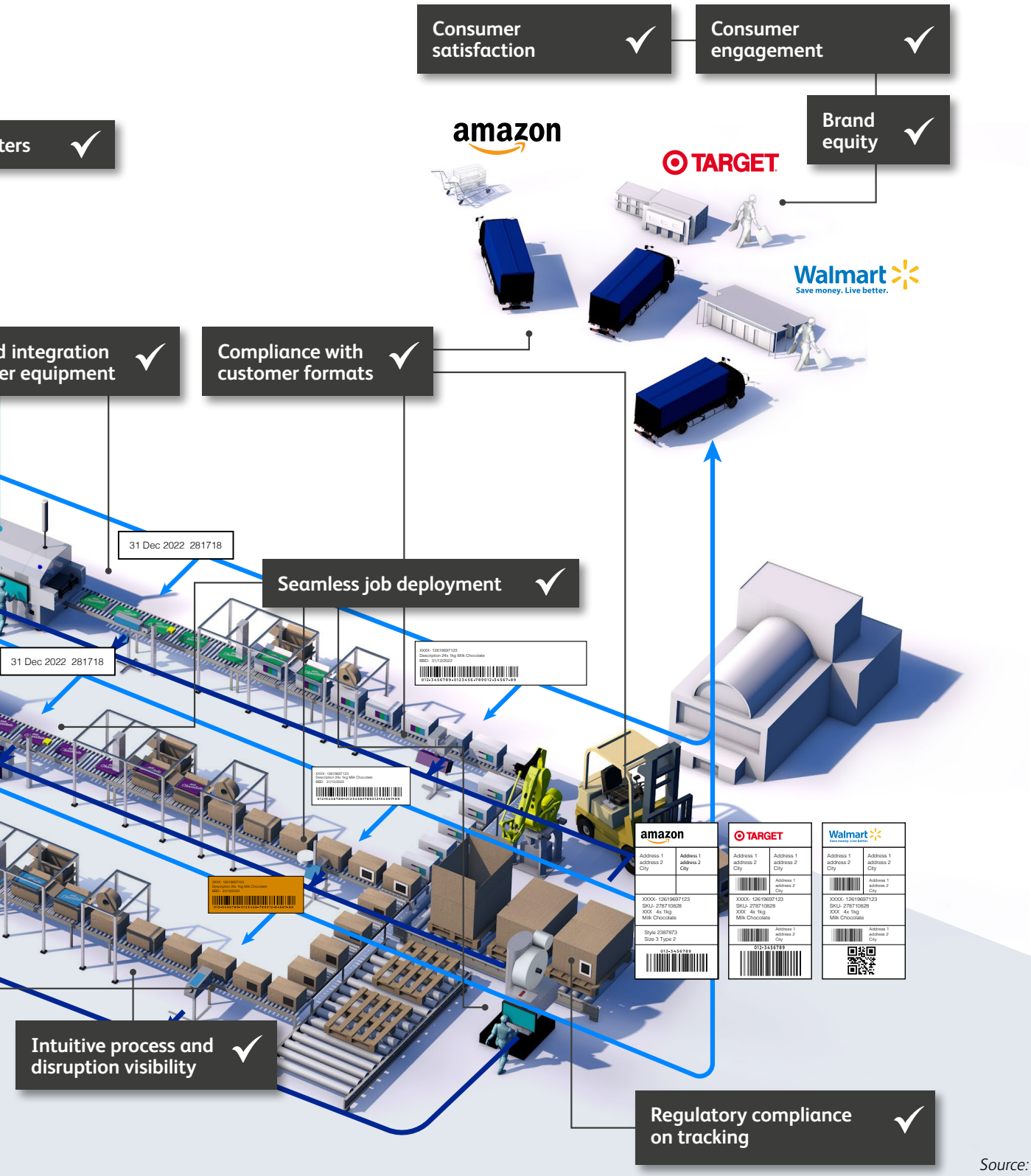
IoT helps to optimize the value chain and unite automation

Millions of hours of real-world printer data informed the 1880 design, resulting in an advanced, digitally enabled solution. The Videojet 1880 continuously monitors and tracks printer parameters so the user can proactively address potential printer issues and help ensure production lines operate without interruption.

With a built-in vital sign monitoring system, smart alerts, on-demand remote technical support, Wi-Fi connectivity, and an advanced automated troubleshooting program, the 1880 anticipates potential printer issues in time so they can be avoided and enables fast recovery should downtime still occur.



The accompanying Videojet MAXIMiZE™ advanced diagnostics suite continuously monitors printer health parameters to help operators easily identify if a fault is likely to occur. The printer provides on-screen notifications and the on-board videos walk a user through proactive maintenance routines. The goal is to reduce the main causes of unplanned printer downtime.



Source: Own figure

Connected equipment to improve information flow

Videojet enjoys a market-leading technical position for connecting marking and coding equipment via the internet. A new communications concept, named "Born Digital", is currently being developed. This is an evolution of VRS.

Further improving the information flow will help provide faster service at a lower cost, facility-wide printer and line-level visibility, order and code management, rapid fault recovery, as well as supplies management.

Videojet plans to build an uninterrupted information flow between its service organization and the printers on the packaging line; and from the printers, via the code, out into the distribution chain. By making the best use of the digital information that already is available, Videojet aims to work together with its customers to improve service provision, optimize produciton lines, minimize downtime, and fix the fault.

This effort starts at the drawing board. When the engineering team designs new printers, all possible fault modes of all components are mapped. This helps ensure that, when a fault does occur, the root cause can easily be traced. Sensors inside the machine track its performance and follow the sequence of events that develops into a fault. If a failure is anticipated, a message can be sent to the manager on the production line.

Wireless technology is used to send the error messages automatically to Videojet, where the service team can decide whether the fault should be addressed by the customer, by the service team remotely, or whether an engineer is needed on site.

This is a vast improvement on the traditional model of fault reporting, which is to stop the production line and display a message on the interface of the printer.

The objective is to avoid poor print quality, resulting in products being rejected or recalled, and to prevent downtime on the production line. Production lines are frequently stopped due to printing faults and this can be very costly. For instance, on a 24/7 bottling line that produces, 20,000 bottles per hour, 10 minutes of stoppage can have significant financial impact.

With all the digital information that exists, printers can be easily integrated in a track and trace system. When variable information is used, the code on the product can be tied to communicate with cameras further down the production line for verification. This way, the printer becomes more visible on the network and more integrated with the production line.

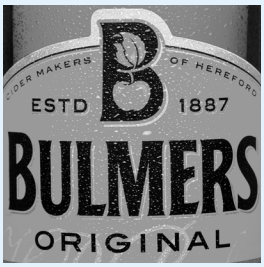
Several printers can be linked up to work in tandem, even across multiple sites. Different printer types can be synchronized on the production line, for instance if different printing technologies are used for printing onto primary, secondary, and tertiary packaging.

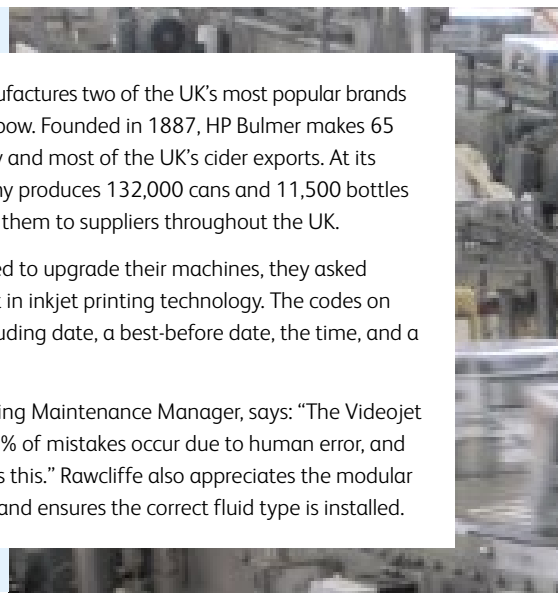
Reliable communications require robust connections of printers to the internet, as well as connection between the site and the Videojet cloud. Today, this is achieved with a mix of wired, Wi-Fi, and cellular connections.

The newer printers from Videojet primarily use cellular technology. This enables a direct communication line between the Videojet service organization and the printer, bypassing the customer's network and avoiding any data security implications. Using wireless technology also eliminates the need to run cable.
Going forward, Videojet's intention is to develop all future products to support a wide range of communications protocols, including wired ethernet via the customer's infrastructure, Wi-Fi, customer-independent wireless network using cellular technology, cellular radio for direct device-to-cloud communications, and cellular direct to cloud.

CASE STUDY

Cider maker improves production





English cider company HP Bulmer manufactures two of the UK's most popular brands of alcoholic cider: Bulmers and Strongbow. Founded in 1887, HP Bulmer makes 65 percent of the cider sold in the country and most of the UK's cider exports. At its Hereford, England, facility, the company produces 132,000 cans and 11,500 bottles of Strongbow per hour and distributes them to suppliers throughout the UK.

When HP Bulmer management decided to upgrade their machines, they asked Videojet to recommend the very latest in inkjet printing technology. The codes on the cans required two lines of text including date, a best-before date, the time, and a reference to the production line.

Andrew Rawcliffe, Packaging Engineering Maintenance Manager, says: "The Videojet printers are simple and easy to use. 80% of mistakes occur due to human error, and the intuitive operator interface reduces this." Rawcliffe also appreciates the modular ink system, which eliminates spillages and ensures the correct fluid type is installed.

Selecting the right template safely through automation

The information content of the code needs to be managed in combination with the printer in an effective way. Software is needed to ensure the code remains consistent throughout the system, but there are many different ways to use software.

The simplest, and perhaps the most common solution, is to keep coding information in a spreadsheet on a standalone computer on the production floor. The operator manually selects the template, which decides which information is printed and where, and matches the template and the information source with the product currently being produced.

However, there are many drawbacks with this method.

Each production line has three printers, for primary, secondary, and tertiary packaging, respectively.

In a plant with 10 lines and 20 SKU changes in a day, this results in 600 changes per day. This is too much for any operator to keep in their head, which is why the spreadsheet is used.

But even with the spreadsheet, there are many ways this can go wrong. The background data for the spreadsheet is often fragmented and comes from different places, making it difficult to use. Frequently, the wrong template is selected. Printing the wrong code may require substantial amounts of product to be reworked or scrapped.

Take, for instance, the case of an engine oil manufacturer – the same base product comes in a range of different grades and various language variations, resulting in 200 different SKUs. Printing the wrong label would be an easy mistake, but a costly one – this particular manufacturer makes nine tons per shift.

The process of template selection is frequently semi-automated, enabling the operator to select the code by scanning a bar code. But the safest way is to automate message creation as much as possible, using pre-defined rules to help prevent incorrect entries.

Accurate coding is based on quality data

The data should be fetched from authoritative data sources – such as MES, SCADA, ERP, or other enterprise IT systems – so that the appropriate information is pulled to the printer automatically when the operator selects a job.

Videojet software tools have been created to safeguard code accuracy and minimize the scope for human error. This enables code creation on the printer's operator interface, on a desktop computer, or in a system fully integrated with the control system for the line.

Continued investment by Videojet will see the development of its software packages to provide improved integration with production control systems and greater levels of interoperability with third party devices on production lines.

Videojet is already providing software with real-time functionality, big data management capabilities, and preventive maintenance solutions. This will deliver a step change in the levels of operational efficiency that manufacturers will be able to achieve.

Investment in coding and marking solutions, driven by the IoT, is also set to reduce downtime by eliminating coding errors and creating certainty around production integrity.

Product codes will be connected along the entire production line from primary and secondary to tertiary and pallet packaging. Optical verification of print quality and automated code printing will occur as standard. The changes will also see rework or scrap levels minimized and offer tighter control over finished product inventory.

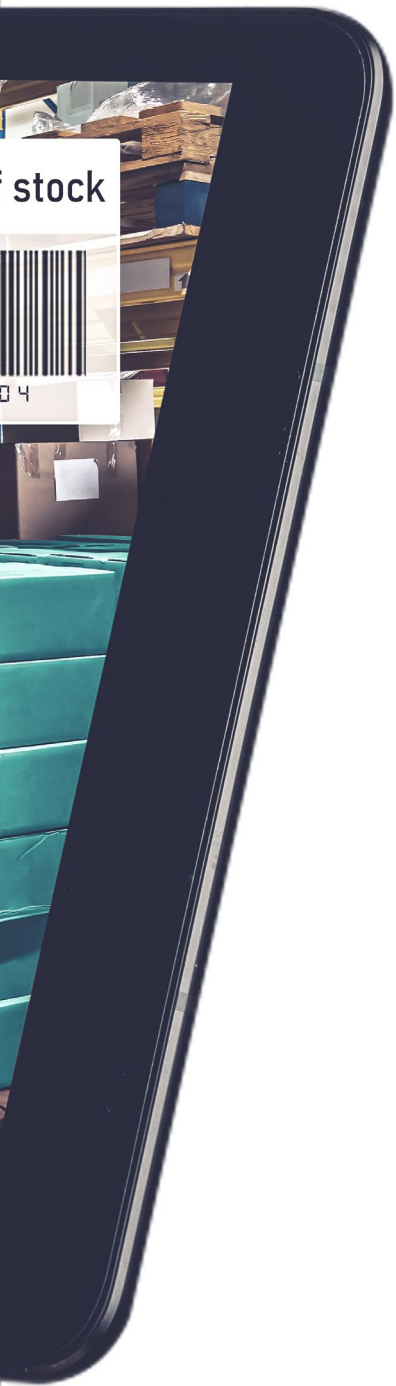
Videojet will help manufacturers strengthen their supply chains by reducing case variants and SKUs, cutting costs by facilitating late-stage customization, and minimizing waste by verifying the raw materials in each production batch.

As late-stage customization options become easier to implement, packaging companies will be better placed to support their customers with short-term promotions and packaging initiatives.

Chapter 6

Areas for integration with IoT

Creating joined-up operations by using connected equipment



The IoT is not a new innovation that has suddenly been introduced. On the contrary, it has matured gradually, with its emergence having been foreseen for a long time. For instance, as early as 2014, Videojet was working to combine IT and OT.

What has happened relatively recently is that technology has caught up with the ambitions, in particular with increased data processing power and close to limitless data storage in the cloud. This is what has enabled the realization of the IoT in recent years.

Today, more than 10,000 printers across 2,000 sites are connected to the Videojet cloud-based network. Terabytes of data has been collected across different print technologies.

Getting the right data

One of the challenges in the early days of the IoT was data completeness. When put to the test, it turned out that printers produced reasonably good data most of the time, but essentially a human operator was needed to interpret this. The level of data was not sufficient for a computer to understand. Significant investment has since gone into ensuring that complete data sets are provided.

The printer produces two sets of data – process data that describes what is going on at the production line; and operational data, that relates to the printer's own requirements. To help ensure that the operational data is communicated as fully as possible, Videojet has introduced cellular connectivity in addition to the networking capabilities. This solution is very robust and helps ensure full completeness of the data. It also eliminates the need to use the customer's IT infrastructure to communicate between the Videojet cloud and the printer.

Analytics is used across the population of printers, enabling Videojet engineers to draw conclusions from varying running conditions.

This information is used to to improve the reliability of printer hardware, as well as to provide performance data to help prevent unplanned downtime with the use of analytics and artificial intelligence (AI).

Your printer can generate useful data

AI can be used to make connections and spot relationships between information in otherwise separate data silos, much faster than any human can.

Vast amounts of data is collected by various cyber-physical systems (CPS), such as sensors, and stored. This information can be accessed and analyzed using AI.

The printer on the factory floor is a very useful device in this respect. It can be used as a sensor to provide a host of useful information with regards to production speed and production rate, in real time. It can also give advance warning of consumables running low, helping to improve uptime and increase overall equipment effectiveness (OEE).

Applications for optimized labeling

Consistent coding carries important information about the products through the supply chain, ensuring smooth cooperation between company sites, third party distribution partners, retailers and end users.

Package validation is also increasingly important. Putting the wrong product in a package can have serious consequences.

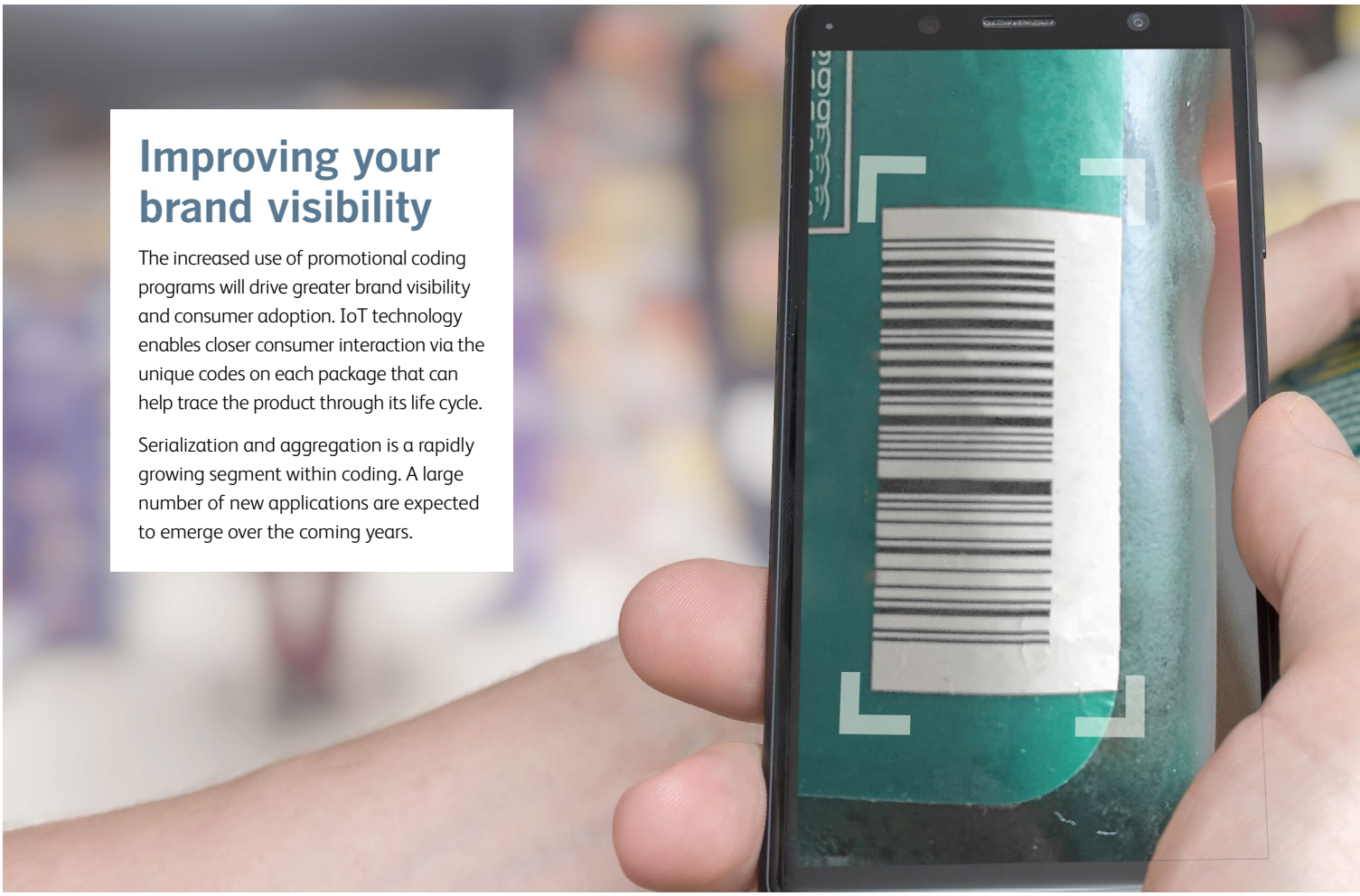
Raising OEE to improve production margins

Any adverse effects on production flow will affect OEE. This includes incorrect or faulty coding, reworking, scrappage, unplanned stoppages, and equipment failure.

Common issues that inhibit production include:

- **Missed prints due to photocell placement or delay setting**
- **Layout issues related to code change**
- **Incorrect job settings or changed job settings**
- **Misplaced codes due to encoder and speed settings**
- **Faults caused by improper shutdown practices**
- **Loss of viscosity control due to not replacing solvent**
- **High printhead temperature due to missed cleanings**

Manufacturing companies typically operate around 60 - 65% OEE. World-class OEE is 85% or better,[33] so there is clearly room for improvement. Raising the OEE will improve margins and will have a direct effect on the bottom line, without having to build a new facility or line.



Improving your brand visibility

The increased use of promotional coding programs will drive greater brand visibility and consumer adoption. IoT technology enables closer consumer interaction via the unique codes on each package that can help trace the product through its life cycle.

Serialization and aggregation is a rapidly growing segment within coding. A large number of new applications are expected to emerge over the coming years.

The importance of the batch number or serialized code

The code can indicate the batch number or be serialized to give each package its unique code. The code on the primary packaging is linked to the packaging on the secondary and tertiary packaging. Parent-and-child relationships are established.

This is known as aggregation. Individual packs are collected into cases and cases are loaded onto pallets. At any point it will be possible to scan the code on a case or a pallet to find out what is inside.

At each point, any batch or a particular item with a serialized code can be pinpointed in the supply chain. The pharmaceutical industry, in particular, uses serialization to link each item to a unique code. This is a legal requirement in many markets.

Reducing the risks to your reputation

While patient safety is the primary concern for the pharmaceutical industry, companies are also concerned about potential damage to their brand reputation. Up to 30% of all medicines sold in developing markets are estimated to be counterfeited.[34]

The risk to the brand reputation due to counterfeits also applies to industries other than pharmaceuticals.

Serialization can also be used to enable promotional coding on products. In this case, the coding adds value to the product, helping to offset the cost of serialization.

Faulty codes can cause significant scrap and waste

Once a code has been printed on a product, it needs to be checked. This is often done by visual inspection, with an operative walking down the line about every half hour. However, half an hour is a long time to print a lot of faulty code with high speed printing equipment, so this method can lead to significant amounts of scrap.

In addition, to just check the presence of the code misses the point of whether or not it is right. Common issues with the printed code include poor contrast, wrong dimensions, and insufficient area of the quiet zone around the code.

If products with faulty codes enter the distribution chain, this causes problems further down the line. Frequently, retailers with automated goods handling systems will issue financial penalties to manufacturers for goods that have to be handled manually because of poor codes.

TTO (thermal transfer overprint) printers can be equipped with a sensor that looks at the negative film to verify that the right image has been printed.

But the most flexible way is to use a vision camera to ensure the code has been printed correctly and in the right place.

The vision camera can also be used to read characters on the packaging using OCR (optical character recognition); check the presence of tamper-proofing or the fill level in bottles; confirm presence of all items in a tray; and a host of other aspects relating to the appearance of the product.

The camera is connected to a supervisory system such as ERP or MES and can help provide complete traceability on a batch or individual level. The code is checked at each step of the way through the packaging plant, on each item, case, and pallet.

This helps track progress and mitigate any problems that may occur at any stage of the process. At the end of the day, OEE depends on the final count of pallets at the end of the production line.

Three methods for checking the code

Three types of inspection are available – code presence, OCV (optical character verification) and OCR (optical character recognition).

In the simplest case, the system checks that the code has been printed. This may be all that is needed when the system performs reliably. The code detection system allows users to easily set a threshold for a code to be considered unacceptable, as well as set a limit for the number of bad codes that can be detected before a fault is indicated.

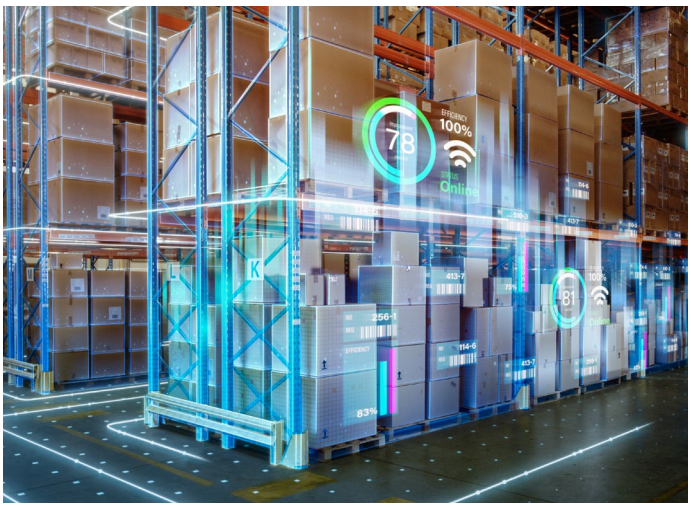
OCV technology checks what the code looks like and compares this to a master image. OCR deciphers the information in the code and checks that the content is correct.

While code presence and OCV systems are less costly than OCR to purchase, they can lead to a higher number of rejects, as images that are slightly out of position my be rejected even if they are correct. This means OCR may be more cost-effective in the long run.

Cameras can also be used to check the appearance of the product. For instance, in the case of filling cans with milk powder, it can check that the can is intact and without dents; that it is free from corrosion inside; that a scoop is provided inside the can; that the scoop has the correct color; and that no plastic fragments from the scoop are present.

A wide selection of cameras are available, but there are three broad categories.[35] The most common one is the ubiquitous bar code scanner, that can recognize black and white areas moving horizontally and converted into digital signals in real time, with no signal processing required.

Smart cameras, usually plug-and-play, can be used for reading 2D codes, OCV or OCR. Fully integrated smart cameras can provide the entire scope of inspection. These operate with up to 50 million pixels and can recognize shapes, colors, position and integrate with various software packages.



Predictive asset monitoring

One of the most effective ways to improve OEE is to avoid unplanned downtime. AI based analytics provide completely new ways to achieve this.

In the past, scheduled maintenance used to be the norm across manufacturing industries. Machinery would be serviced and parts replaced on a rotating basis, whether needed or not. But this inevitably meant that maintenance was performed on some equipment where it was not needed, or long before it was needed.

With AI, a system for predictive maintenance can be applied instead. This means collecting data on how the equipment performs, analyzing all data while looking for any signs that normally precede equipment failure and address the issue before failure occurs. In the event that failure occurs without being foreseen, the sequence of events can be traced back and the information used to prevent failures in the future.

Guidance for maintenance

This means that in-house and field service maintenance teams can be alerted as soon as the first signs of malfunction appear. Spare parts can be ordered in time and field service teams can arrive better equipped, with accurate information and the right tools for the job.

Even with currently available products, operators or maintenance personnel can receive immediate email notifications or warnings sent to a smart phone, tablet, or PC, with detailed information for troubleshooting through a link in the alert.

Guidance can be provided as to whether repair or replacement is the fastest route to recovery. If a swap is the preferred route, printer settings are automatically transferred from the current printer to the spare. Whether repair or swap is chosen, either path is designed to get production restored within 20 minutes.

At many companies, operators are not allowed to perform any maintenance on the printer, which can include replacing consumables. The printer's cloud connection allows Videojet to send alerts to qualified maintenance staff so they are automatically informed when consumables run low.

Integration with other systems

Looking ahead, future products from Videojet will be further enhanced for use with the IoT in terms of being easy to connect, providing rich data, and being simple to integrate and operate.

This will result in increased device availability, reduce the number of products that have to be scrapped or reworked, and enhance plant efficiency.

A library of industry standard data exchange mechanisms will be developed to exchange raw and processed data at all levels of the manufacturing process – ERP, MES, SCADA and PLC. While individual product offerings will be unique to Videojet, they will integrate seamlessly with other systems.

Each offering will help improve asset utilization and availability; reduce the number of rejected shipments; drive efficiency by automating data collection; or any combination of these three benefits.

A single user interface

The dashboards of Videojet equipment provide a host of useful information to the user. But on a production line with multiple equipment suppliers, a single dashboard for just one equipment manufacturer may not be that useful.

Videojet uses REST API to communicate with other systems. This is a flexible way to integrate applications, helping customers to integrate their solutions to the Videojet cloud.

The long-term objective is to develop a single printer interface that can control all leading production and warehouse printers, regardless of manufacturer.

The data will be shared with all systems in the manufacturing process, such as ERP systems, factory MES, SCM, PLM, and WMS systems. Integrating with other sensors in the manufacturing process, this will help ensure the right code is on the right product throughout the supply chain.

CASE STUDY

Recipe for labeling success

McCormick & Company is a global leader in spices, seasoning mixes and condiments to the food industry, including retail outlets, food manufacturers, and food service businesses.

The company evaluated the labeling processes for its industrial customers and realized the need for a centralized solution that could keep up with ever-changing, and growing requirements and still ensure the fast, accurate printing of more than 500,000 bar code labels a month.

Unlike the downstream relationship between manufacturer and grocer – where certain standards are established for the flow of goods and information (e.g., GTINs, SSCC labels, EDI) – the upstream supply chain is more wide open. As such, McCormick must deal with a wide range of customer-specific label requirements. This could include the addition of GS1-128 standardized bar codes and 2D bar codes as well as pallet-level labels to help with traceability.

This extensive variability of label data slowed production and required creating and managing literally thousands of custom label templates with no centralized oversight.

Food & beverage is one of the more heavily regulated industries. For McCormick, the FDA's Food Safety Modernization Act (FSMA) and the UN's Globally Harmonized System (GHS), in particular, posed a significant challenge to their existing labeling solution.

Loftware's Enterprise Labeling Solution enabled McCormick to optimize labeling and drive significant efficiencies in its supply chain. Loftware's enterprise-wide approach allows McCormick to integrate labeling with its existing SAP platform to trigger and execute production, receiving and shipping labels directly from upstream transactions.

This eliminates the need to manually replicate data from one system to the next and, more importantly, helps ensure end-to-end label accuracy. With the goal of centralizing global labeling, it was important that new plants could easily gain access to the solution. The initial project called for eight plants in North America to deploy standardized labeling, but now there are a total of 18 manufacturing plants, distribution centers, warehouses, and research facilities relying on enterprise labeling in North America and EMEA. McCormick is also looking to extend labeling outside its four walls to include supplies, co-packers, and other partners who can print labels locally. This will eliminate the costly, error-prone method of pre-printing and shipping labels to partners.

Two-way information flow

Information can also be passed the other way, with the printer providing information on production rate, in real time, to the control systems. In addition, it can provide information on upcoming maintenance needs and requirements for consumables, enabling management to make decisions and optimize equipment use based on accurate and up to date information. All devices on the line will be connected to one central control.

To draw the most benefit from the data collected, analytics using artificial intelligence is used.

Using data in real time

When working to improve productivity, finding relevant quantitative data to measure might have been a problem in the past. With the IoT, the quantity of data is rarely a problem. Rather, there is often too much data to make sense of.

This is where the concept of big data comes into play. Using artificial intelligence, information can be extracted from data volumes that would otherwise be far too large to examine profitably.

Line managers can use this real-time packaging line data to drive improvements, both immediately and over the long term, without being data experts.

This will help companies become more flexible and better able to meet today's requirements. A few years ago, production runs would be 8-12 hours. These days, they rarely last longer than 3-5 hours. Each time production settings are changed, time is lost. The value of the time lost varies between companies and applications, but the ROI on IoT implementation is often as little as just 12 to 18 months.

Smart labeling, marking and coding software

Labeling is also becoming more complicated, as more demands are placed on the labeling management solution. For instance, labeling solutions can extend into other organizations of suppliers and partners, such as co-packers. With a labeling solution that extends beyond organizational boundaries, relabeling costs can be eliminated.

Companies may also want to automate labeling across all their manufacturing sites, or integrate with the warehouse management system (WMS).

In many cases, several products can share the same images, warnings, translations, and phrases. In this case, the solution can also include artwork management. A smart labeling system can be implemented to meet all requirements for regulatory, distribution, and marketing puposes by producing the appropriate coding and documentation across the supply chain. By pulling current data from business systems, codes can be designed to meet variable and complex business needs. As your supply chain expands globally, accurate codes can be printed on demand wherever they are needed.

Improved overview, adherence to corporate standards, as well as rapid and universal label changes throughout the organization, can be provided by using a single coding solution across the organization.

A common set of labels, content, applications, and data sources, across the supply chain, can be achieved by taking a standardized approach.[36] This type of centralized approach also helps support business continuity in the event of supply chain disruption.

As your supply chain expands globally, accurate codes can be printed on demand wherever needed.

Leveraging existing processes for strategic benefits

Labeling requirements are becoming ever more demanding and organizations must ensure their labeling is up to date.

A range of strategic advantages can be achieved by integrating labeling with existing business applications. Greater levels of label accuracy and consistency are achieved, duplicate data eliminated, and there is no need to retrain users, when the labeling supports existing business processes and vital data sources. Labeling complexity is supported while the number of label templates is reduced, when labeling transactions are initiated from enterprise applications using data from a single source of truth.

Customer response times are improved and regulator requirements met as integration is used to help ensure accuracy.

One of the defining qualities of tomorrow's supply chain will be the ability to output labels and documents across a diverse set of print devices in the time required to meet shipping and production deadlines.

Enterprise labeling, marking and coding management solution overview

Looking ahead, businesses need to move to a proactive, cloud-based approach to reduce time and costs, increase traceability and compliance, and improve collaboration.

1
Message & Print Management
Powered by
Loftware Spectrum | Cloud
VIDEOJET

2
Printer health & Line visibility
Powered by
VIDEOJET
Digitally-enabled Services

3
Code Integrity
Powered by
VIDEOJET
Laetus
COGNEX vision

4
Warehouse Management
Powered by
Loftware Spectrum | Cloud

5
Consumer Transparency
Powered by
VIDEOJET
IMprints
Laetus

Options for raw material transparency ✓

- Options for easy-to-deploy farm-to-fork
- Options for sustainability, welfare labeling, consumer engagement programs

Enterprise-wide compliance ✓

- Centrally approved template database to avoid version control issues
- Extend solution outside of the plant walls to ensure brand consistency across own plants and co-packers

Approved message design for all print

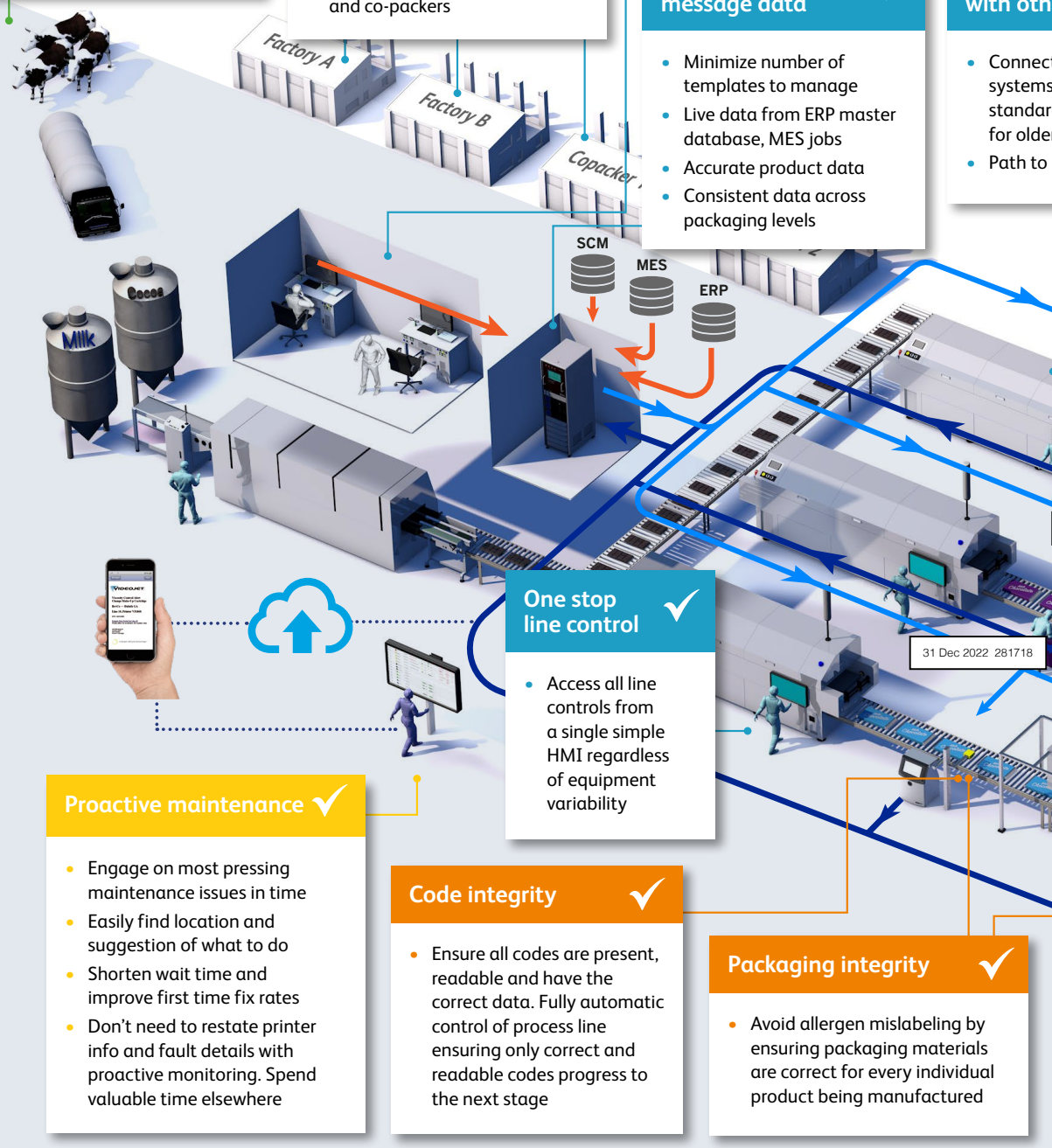
- Design text, logo, line and bar code messages
- Link messages to master enterprise systems to
- Manage design changes to design with approv

Error-free message data ✓

- Minimize number of templates to manage
- Live data from ERP master database, MES jobs
- Accurate product data
- Consistent data across packaging levels

Standar with oth

- Connect systems standar for olde
- Path to



One stop line control ✓

- Access all line controls from a single simple HMI regardless of equipment variability

Proactive maintenance ✓

- Engage on most pressing maintenance issues in time
- Easily find location and suggestion of what to do
- Shorten wait time and improve first time fix rates
- Don't need to restate printer info and fault details with proactive monitoring. Spend valuable time elsewhere

Code integrity ✓

- Ensure all codes are present, readable and have the correct data. Fully automatic control of process line ensuring only correct and readable codes progress to the next stage

Packaging integrity ✓

- Avoid allergen mislabeling by ensuring packaging materials are correct for every individual product being manufactured

The pandemic demonstrated how vulnerable companies are to disruption in the supply chain and in the labor pool. In addition, production runs will only become shorter in the future. Flexibility and collaboration will become the order of the day.

For this to become a reality, printers need to be connected to the line equipment, to the MES, and to the ERP system.

ers ✓

for all printer types in one environment
o automatically populate with correct data
val workflows and audit control

d integration er equipment ✓

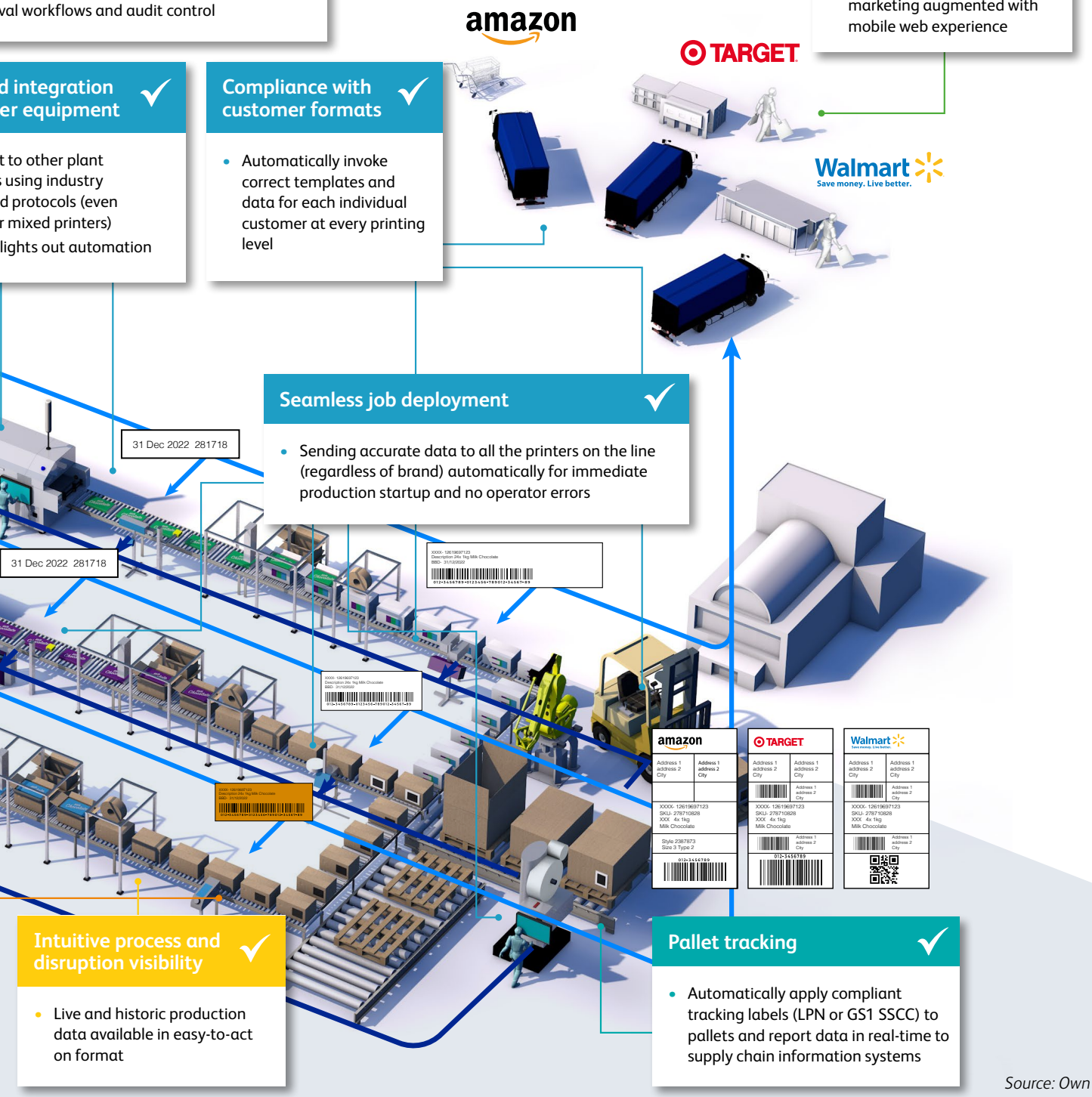
t to other plant
s using industry
d protocols (even
r mixed printers)
lights out automation

Compliance with customer formats ✓

- Automatically invoke correct templates and data for each individual customer at every printing level

Consumer engagement ✓

- On-demand unique code marketing augmented with mobile web experience



Seamless job deployment ✓

- Sending accurate data to all the printers on the line (regardless of brand) automatically for immediate production startup and no operator errors

Intuitive process and disruption visibility ✓

- Live and historic production data available in easy-to-act on format

Pallet tracking ✓

- Automatically apply compliant tracking labels (LPN or GS1 SSCC) to pallets and report data in real-time to supply chain information systems

Source: Own figure

Conclusion

Building the pathway to a more efficient and sustainable manufacturing industry

In many ways, we are at the dawn of a new era for the manufacturing and packaging industry. Videojet is committed to the manufacturing industry and has various research programs that aim to extend automation and integration to even more complex labeling, marking and coding scenarios.

Software that delivers real-time transparency for operators, supported by smart devices that help enable autonomous configuration and self-diagnosis, will provide a holistic view of the entire manufacturing operation.

This results in optimal response to critical conditions, and manufacturing based on insights of market conditions and product availability.

As IoT and standard industrial protocol adoption begin to mature, Videojet is ideally positioned to connect, monitor, and manage more devices on packaging lines across the globe, helping customers to address waste reduction and efficiency improvement challenges.

By bringing people, equipment, and systems together in a fully integrated environment, Videojet firmly believes that manufacturing companies can vastly improve productivity, workforce satisfaction, and safety.

The journey towards a more efficient and sustainable manufacturing industry has just began.

Glossary

Term	Explanation
1D code	Optical, machine-readable code that can be read in one direction, horizontally – i.e. a standard bar code.
2D code	Optical, machine-readable code that can be read horizontally as well as vertically, for instance a QR-code.
3D code	Optical, machine-readable code with raised dots embossed into a metal surface. Used in industrial environments where a white background is difficult to keep clean.
3D printer	Machine producing three-dimensional objects according to drawings.
AI	See *Artificial Intelligence*.
AI data mining	Knowledge discovery by an AI system.
Artificial Intelligence	Computer program designed to simulate human thinking.
Augmented reality	A technology that adds layers of computer-generated images onto real-world images in real time, providing additional information for the user.
Autonomous system	A system that manages its own routing of data.
Bar code	Machine-readable information in the shape of a series of stripes of different widths.
Big data	Very large volumes of unstructured data, requiring special analyzing techniques.
Bitcoin	A type of *cryptocurrency*.
Blockchain	A complete distributed list, arranged in blocks, over transactions relating to a digital object. See also *distributed ledger*.
Bluetooth	Technology for wireless data transfer over short distances, eliminating the need for a cable.
Chatbot	A computer program designed to respond to questions in a dialog with users.
CIP	See *Common Industrial Protocol*.
Cloud-native environment	Applications that take advantage of the distributed model provided through cloud computing.
Common Industrial Protocol	A protocol for industrial automation applications.
Consumer Packaged Goods	The same as *fast-moving consumer goods*.
CPG	See *Consumer Packaged Goods*.
CPS	See *Cyber Physical Systems*.
Cryptocurrency	Digital currency created using encryption. A *distributed ledger* is used to avoid its value being spent more than once.
Cyber Physical Systems	An intelligent system performing actions in the physical world, for instance an autonomous vehicle.
Digital Product Passport	A proposal from the European Commission from March 2022, aiming for products placed on the European market to be accompanied by a set of product-specific data.
Digital transformation	The switch to using and storing information in digital format rather than physical form, frequently associated with disruptive change to work practices and business models.
Digital twin	Computer program that models a real-world object so accurately that the model can be used for test and experimentation instead of the actual object.
Distributed ledger	A record of events distributed in identical copies across a large number of computers, making the information impossible to delete, alter or falsify without it being discovered.
DPP	See *Digital Product Passport*.
EBSI	See *European Blockchain Services Infrastructure*.
Ecodesign for Sustainable Products Regulation	A proposal from the European Commission, this framework aims to set ecodesign requirements for specific product groups to improve their circularity, energy performance and other sustainability aspects.
Edge computing	Processing data where it is created or captured, instead of using a central server.
EDI	See *Electronic Data Interchange*.
Electronic Data Interchange	The collective name for *GS1* standards relating to electronic trade.
Electronic Product Code Information Services	A global *GS1* standard for creating and sharing data.
EMEA	Shorthand for Europe, the Middle East and Africa.
Enterprise Resource Planning	Computer program designed to improve the efficiency of administration, control and analysis in a company by managing all its information as a single database. Changes to an object affect all instances of the object and the same information is available to all users.
EPCIS	See *Electronic Product Code Information Services*.
ERP	See *Enterprise Resource Planning*.
ESPR	See *Ecodesign for Sustainable Products Regulation*.
Ethernet IP	An industrial network protocol that adapts the *Common Industrial Protocol* (CIP) to standard Ethernet, where the abbreviation IP stands for Industrial Protocol.
EU	See *European Union*.
EU Green Deal	A set of policy initiatives by the *European Commission* with the objective of making the European Union climate-neutral by 2050.
European Blockchain Services Infrastructure	A program by 29 European countries (all EU member states plus Norway and Liechtenstein) to leverage blockchain in cross-border services.
European Commission	The executive branch of the *European Union*.
European Union	An economic and political union of 27 countries in Europe.
Fast-moving consumer goods	Items that sell quickly and often at low cost. Examples include food, drinks, toiletries and other consumables.
FDA	See *Food and Drug Administration*.
Fieldbus	A type of industrial computer network used for real-time distributed control.
FMCG	See *Fast-moving Consumer Goods*.
Food and Drug Administration	US federal agency tasked with protecting and promoting public health as well as controlling food safety.
Food Safety Modernization Act	Legal act that gives the *Food and Drug Administration* new powers to regulate food safety and to mandate product recalls.
FSMA	See *Food Safety Modernization Act*.
Gamification	Giving the look and feel of computer games to other applications.
GHS	See *UN Globally Harmonized System*.
Global Trade Item Number	A *GS1* number used to give products and packaging a globally unique identity.
GS1	International organization developing and maintaining standards for bar codes.
GS1-128 standardized bar code	A standard of bar code that can contain information enabling traceability.
GTIN	See *Global Trade Item Number*.
IIoT	See *Industrial Internet of Things*.
Industrial Internet of Things	*Internet of Things* applied in an industrial environment.
Industrial metaverse	The *Metaverse* applied in an industrial environment.
Industry 1.0	The first industrial revolution, introducing mechanical power.
Industry 2.0	The second industrial revolution, characterized by electrification and the production line.
Industry 3.0	The third industrial revolution, with widespread use of digital logic, transistors and integrated circuits.
Industry 3.5	Using elements of *Industry 4.0* in an *Industry 3.0* environment.
Industry 4.0	The fourth industrial revolution, with rapid change to technology due to interconnectivity and smart automation.
Internet of Things	Connection of devices, machines, vehicles, and other pieces of equipment that would not normally be considered as computers, to the internet.
IoT	See *Internet of Things*.
IT	See *Information Technology*.
LC	See *Letter of credit*.
Letter of credit	A payment mechanism used in international trade.
Machine learning	Training a computer program to solve a task by having it explore examples.
Malware	Computer program designed to disrupt somebody else's computer or IT system.
Manufacturing Execution System	A computerized system to track and document each stage of the manufacturing process, enabling decision-makers to optimize the process.
MES	See *Manufacturing Execution System*.
Mesh network	A web-like wireless network where each unit is in contact with its nearest neighbors in the network and can potentially contact any other node.
Metaverse	An alternative world of three-dimensional objects similar to that experienced in a computer game.
NFT	See *Non-fungible Tokens*.
Non-fungible Tokens	Digital asset copy-protected by a *blockchain*.
OCR	See *Optical Character Recognition*.
OCV	See *Optical Character Verification*.
OEE	See *Overall Equipment Effectiveness*.
OEM	See *Original Equipment Manufacturer*.
Operational Technology	Control and monitoring systems for industrial processes.
Optical Character Recognition	Automated reading of characters, with conversion into digital format.
Optical Character Verification	Checking the presence and quality of code as well as its its position.
Original Equipment Manufacturer	Manufacturer of equipment whose products may be sold under the company's own brand namne, or somebody else's.
OT	See *Operational Technology*.
Overall Equipment Effectiveness	A measure of how well a manufacturing operation is utilized compared to its full potential.
PLC	See *Programmable Logic Controller*.
PLM	See *Product Lifecycle Management*.
Predictive analytics	Using data, algorithms, and machine learning to assess what will happen in the future, and the likelihood of this happening.
Product Lifecycle Management	A solution that manages all of the information and processes at every step of a product or service lifecycle across globalized supply chains.
Profibus	Short for Process Field Bus. A standard for fieldbus communication in automation technology.
Programmable Logic Controller	Machinery control system.
Promotional coding	Printed variable code used for promotion purposes.
QR Code	Short for quick response code. This is a black-and-white checkered pattern representing a web address or other information. The QR code is a further development of the *bar code*.
REST API	REST – representational state transfer, a way of programming websites so that they can provide services for other websites. The websites are provided with standardized interfaces (application programming interfaces, or APIs).
ROI	Return on investment.
SCADA	Supervisory control and data acquisition – general term for computerized control systems for industrial processes.
SCM	Supply Chain Management – automatic organizing of a network of suppliers, transport, storage and other parts of the supply chain.
Serialization	Printing code with unique identifiers.
SKU	See *Stock Keeping Unit*.
Smart contracts	Contracts in the form of a computer program that executes the actions stipulated in the contract, which is based on a blockchain. The actions need to be approved by a number of persons that are party to the blockchain.
SSCC	Serial Shipping Container Code, an internationally recognized shipping code for containers and pallets.
Stock Keeping Unit	Number or other designation representing a product or item in stock.
UN Globally Harmonized System	The Globally Harmonized System of Classification and Labeling of Chemicals (GHS) is an international standard, managed by the United Nations.
Videojet Remote Service	IoT solution for the packaging industry that enables service work to be carried out remotely.
Virtual assistant	A computerized assistant that can perform tasks for a user in response to commands or questions.
VRS	See *Videojet Remote Service*.
Warehouse management system	IT system for managing warehouse storage and movement of goods.
Wearable technology	Electronic device intended to be worn on the user's body.
Web 2.0	The version of the worldwide web currently used, characterized by cloud computing, cloud storage and social media.
web3	A putative future iteration of the worldwide web, characterized by blockchains, smart contracts and cryptocurrencies.
Wi-Fi	Short for Wireless Fidelity. A common system for wireless communication in the home and in workplaces. Wi-Fi components need to comply with IEEE standard 802.11 and be certified by industry association Wi-Fi Alliance.
WMS	See *Warehouse management system*.

About

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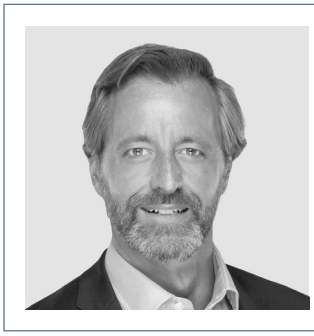

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Works cited

1. Videojet Technologies Inc., 2017, Optimizing production and profits with the Internet of Things (IoT).
Available at: https://global.videojet.com/wp-content/uploads/dam/pdf/NA%20-%20English/White-Paper/wp-optimizing-production-and-profits-with-the-internet%20of-things-us.pdf

2. Keith Shaw, Association for Advancing Automation, 2022, Five Ways the Industrial Metaverse Will Impact Manufacturers
https://www.automate.org/industry-insights/5-ways-the-industrial-metaverse-will-impact-manufacturers

3. Videojet Technologies Inc., 2017, Optimizing production and profits with the Internet of Things (IoT).

4. Videojet Technologies Inc., 2017, Optimizing production and profits with the Internet of Things (IoT).

5. Laetus GmbH, 2021, Track & Trace Solutions to support your business and improve customer engagement.
Available at: https://www.laetus.com/en/track-and-trace-solutions/

6. Rockwell Automation, 2021, A digital recipe for the future.
https://www.slideshare.net/softconsystem/a-digital-recipe-for-the-future-food-beverage-industry

7. Walmart, 2018. In Wake of Romaine E. coli Scare, Walmart Deploys Blockchain to Track Leafy Greens
https://corporate.walmart.com/newsroom/2018/09/24/in-wake-of-romaine-e-coli-scare-walmart-deploys-blockchain-to-track-leafy-greens

8. Rami Alkhudary, Université Panthéon-Assas Paris 2, 2020, Blockchain and Risk in Supply Chain Management.
Available at: https://www.researchgate.net/publication/340677204

9. Aura Blockchain Consortium, 2022. Authenticating Luxury Goods with Blockchain.
Available at: https://auraluxuryblockchain.com/insight/authenticating-%20%20luxury-goods-with-blockchain

10. IoT Analytics, 2019. Industrial & IoT Blockchain Market 2019-2023.
Available at: https://iot-analytics.com/wp/wp-content/uploads/2019/01/Industrial-and-IoT-Blockchain-2019-2023-vSample_.pdf

11. Rami Alkhudary et al. Université Panthéon-Assas Paris 2, 2021. A blueprint towards an integrated healthcare information system through blockchain technology.
Available at: https://www.researchgate.net/publication/355159135

12. Boston Consulting Group and Cisco Systems, 2018. Pairing blockchain with IoT to cut supply chain costs.
Available at: https://web-assets.bcg.com/img-src/BCG-Pairing-Blockchain-with-IoT-to-Cut-Supply-Chain-Costs-Dec-2018_tcm9-209846.pdf

13. Workd Economic Forum, 2018. Trade Tech – A New Age for Trade and Supply Chain Finance.
Available at: https://www3.weforum.org/docs/White_Paper_Trade_Tech_report_2018.pdf

14. Videojet Technologies Inc., 2015. Coding for promotional and loyalty programs
https://global.videojet.com/wp-content/uploads/dam/pdf/NA%20-%20English/Brochure/br-coding-for-promo-and-loyalty-programs-us.pdf

15. Business Insider, 2021, The US is readying sanctions against Russia over the SolarWinds cyber attack.
Available at: https://www.businessinsider.com/solarwinds-hack-explained-government-agencies-cyber-security-2020-12

16. Splunk, 2021, État de la cybersécurité en 2021.
Available at: https://www.splunk.com/fr_fr/form/state-of-security.html

17. Loftware, 2020, Enterprise Labeling Maturity Model – A Framework for Labeling Excellence.
https://www.loftware.com/resources/reports/enterprise-labeling-maturity-model-report

18. IndustryARC, 2020, Coding and Marking Market Forecast (2020-2025
Available at: https://www.industryarc.com/Report/18137/coding-marking-market.html

19. Industry ARC, 2019, Coding and Marking Market - Forecast(2022 - 2027)
https://www.industryarc.com/Report/18137/coding-marking-market.html

20. McKinsey & Company, 2019, Future-proofing a digital manufacturing transformation.
Available at: https://www.mckinsey.com/capabilities/operations/our-insights/operations-blog/future-proofing-a-digital-manufacturing-transformation

21. The Economist, 2021, After years of dithering companies are embracing automation.
Available at: https://www.economist.com/business/2021/01/16/after-years-of-dithering-companies-are-embracing-automation

22. McKinsey & Company, 2021, Manufacturing process innovation for industrials.
Available at: https://www.mckinsey.com/industries/advanced-electronics/our-insights/manufacturing-process-innovation-for-industrials

23. The European Commission, 2022, Communication from the commission to the European parliament, the council, the European economic and social committee and the committee of the regions, On making sustainable products the norm.
Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52022DC0140

24. The University of Cambridge Institute for Sustainability Leadership and The Wuppertal Institute, 2022, Digital Product Passport: The ticket to achieving a climate neutral and circular European economy?
Available at: https://wupperinst.org/a/wi/a/s/ad/7777

25. European Scientist, 2022, EU digital passport scheme: using blockchain to decentralise Europe's circular economy.
Available at: www.europeanscientist.com/en/big-data/eu-digital-passport-scheme-using-blockchain-to-decentralise-europes-circular-economy/

26. Boston Consulting Group and Cisco Systems, 2018. Pairing blockchain with IoT to cut supply chain costs.

27. Rockwell Automation, 2020, A digital recipe for the future.

28. Journal of Manufacturing Systems, Elsevier. Volume 61, October 2021. Industry 4.0 and Industry 5.0—Inception, conception and perception.
Available at: www.sciencedirect.com/science/article/pii/S0278612521002119

29. Videojet Technologies Inc., 2018, Digital transformation for packaging lines.
Available at: https://global.videojet.com/wp-content/uploads/dam/pdf/NA%20-%20English/White-Paper/wp-digital-transformation-for-packaging-lines-us.pdf

30. Videojet Technologies Inc., 2014, Preventing coding errors in your operation.
Available at: https://global.videojet.com/wp-content/uploads/dam/pdf/India%20-%20English/White-Paper/wp-preventing-coding-errors-in-your-operation-en-in.pdf

31. Videojet Technologies Inc., 2016, Avoid Package Coding Errors and Minimize Their Impact on Your Business.
Available at: https://global.videojet.com/wp-content/uploads/dam/pdf/India%20-%20English/White-Paper/wp-avoid-package-coding-errors-and-minimize-their-impact-on-your-business-en-in.pdf

32. Laetus GmbH, 2021, Track & Trace Solutions to support your business and improve customer engagement.

33. Rami Alkhudary, Université Panthéon-Assas Paris 2, 2020, Blockchain Technology between Nakamoto and Supply Chain Management: Insights from Academia and Practice.
Available at: https://www.researchgate.net/publication/343533074

34. Carrefour says blockchain tracking boosting sales of some products. Reuters, 2019.
Available at: https://www.reuters.com/article/us-carrefour-blockchain-idUSKCN1T42A5

35. Sam Gilbert, University of Cambridge and Bennett Institute for Public Policy, 2022. Crypto, web3, and the Metaverse.
Available at: https://www.bennettinstitute.cam.ac.uk/wp-content/uploads/2022/03/Policy-brief-Crypto-web3-and-the-metaverse.pdf

36. Laetus GmbH, 2021, Pharmaceutical solutions to comply with all regulations and fulfill quality Inspection and traceability demands of your production.
Available at: https://www.laetus.com/en/industries/pharma/

37. Laetus GmbH, 2021, Pharmaceutical solutions to comply with all regulations and fulfill quality Inspection and traceability demands of your production.

38. Cognex Corporation, 2021, Introduction to industrial bar code reading.
Available at: https://www.cognex.com/what-is/industrial-barcode-reading

39. Loftware, 2020, Enterprise Labeling Maturity Model – A Framework for Labeling Excellence.
Available at: https://resources.loftware.com/home-maturity-model.html?utm_source=Website&utm_sourcedetail=Home-Banner&utm_asset=Asset&utm_assetdetail=Report-Maturity-Model&hsCtaTracking=c9965609-28c9-4ddd-9203-2305ba6d90cd%-7C3aa65b93-22f3-4348-b5be-352274a95d44

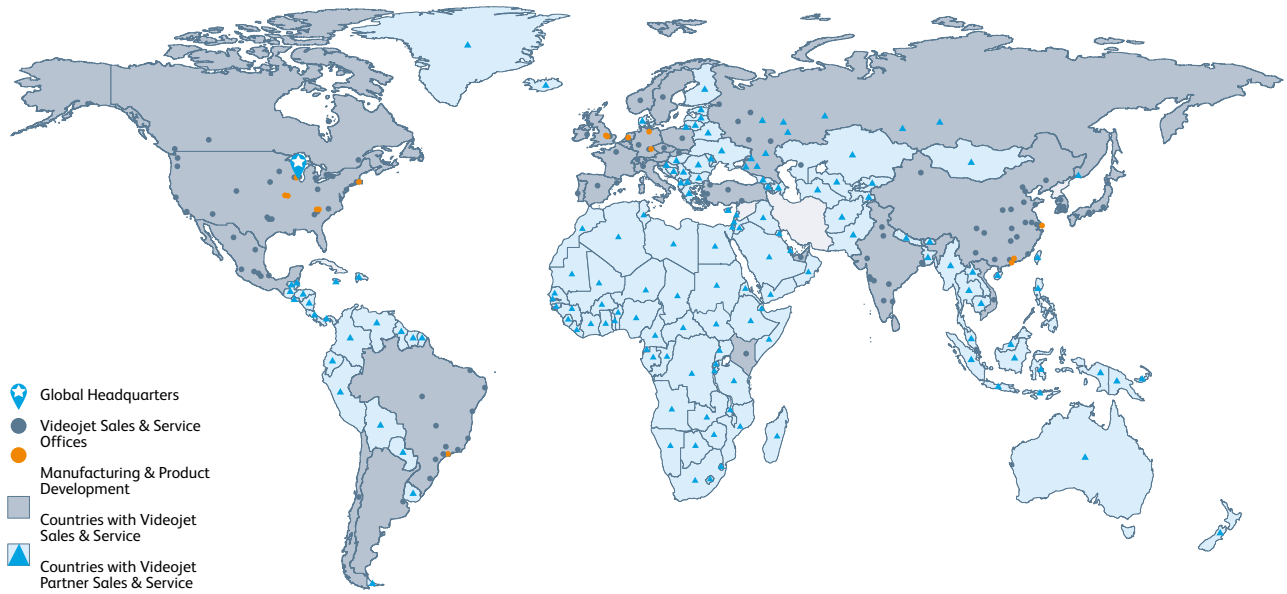
Figure on page 36 and 37, Provenance information and Transaction flow from farm to fork. ProductChain: Scalable Blockchain Framework to Support Provenance in Supply Chains, Sidra Malik - Salil S. Kanhere - Raja Jurdak, November 2018.
https://www.researchgate.net/publication/329292174_ProductChain_Scalable_Blockchain_Framework_to_Support_Provenance_in_Supply_Chains

Let us help you realize the digital factory 4.0 and streamline your print management operations towards a more sustainable future.

Videojet Technologies is a world-leader in the product identification market, providing in-line printing, coding, and marking products, application specific fluids, and product life cycle services.

Our goal is to partner with our customers in the consumer packaged goods, pharmaceutical, and industrial goods industries to improve their productivity, to protect and grow their brands, and to stay ahead of industry trends and regulations. With our customer application experts and technology leadership in Continuous Inkjet (CIJ), Thermal Inkjet (TIJ), Laser Marking, Thermal Transfer Overprinting (TTO), case coding and labeling, and wide array printing, Videojet has more than 400,000 printers installed worldwide.

Our customers rely on Videojet products to print on over ten billion products daily. Customer sales, application, service and training support is provided by direct operations with over 4,000 team members in 26 countries worldwide. In addition, Videojet's distribution network includes more than 400 distributors and OEMs, serving 135 countries.



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