GS1 US

The Global Language of Business

GS1 US Autonomous Retail: Frictionless Future

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Executive Summary

Consumer demand for convenience and safety has skyrocketed, and that trend is here to stay. In a 2020 whitepaper, GS1 US® took a close look at how the pandemic accelerated autonomous retail to address immediate changes in consumer behavior and emphasized the value of partnering standards with technology. Retailers continue to focus on creating frictionless commerce experiences for customers and are turning to automation technology to help. These benefits also extend to the stores and warehouses where operations must become more reliable and resilient against labor shortages.

In this follow-up paper, we focus on automation technologies facilitating frictionless customer experiences and improving efficiency for employees. It explores:

- Current and future automation technology trends, including computer vision and artificial intelligence (AI)
- How technology, processes, and standards combine to help create a frictionless shopping experience, such as cashierless checkout, and promote employee efficiency
- How 2D barcodes can streamline inventory management and improve customers' in-store buying experience

Key Takeaway

A frictionless shopping experience is like an ecosystem. It requires integration of process and technology, with the common language of standards to tie everything together. GS1 Standards provide the common business language required to facilitate precise product identification and share associated product and location master data. Use of 2D barcodes, such as QR codes, can then help empower cashierless checkout, augment in-store labor efficiency, and provide seamless consumer engagement before, during, and after point-of-sale.

Important: This whitepaper serves to document the analysis, impressions, and insights in order to support the ongoing industry efforts to identify solutions to the challenges. The information contained herein is voluntary, not mandatory. It should be noted that use of the words "must" and "require" throughout this document relate exclusively to technical recommendations for the proper application of the GS1 standards to support the integrity of an implementation. The information contained herein is for informational purposes only as a convenience and does not constitute legal advice or a substitute for legal counsel. GS1 US Inc. assumes no liability for the use or interpretation of the information contained herein.

Introduction

According to Pivotree.com, frictionless commerce is defined as "a set of technology and business solutions used to shorten the time, distance, and hassle (real or perceived) between customers and the products and services they desire."[1]

Consumers are increasingly seeking efficiency and convenience, and these factors are key drivers of frictionless commerce. Time is valued more than ever, and in-person service is less desirable than it was pre-pandemic. Customers got a taste of what frictionless could mean. Now shoppers are back in stores, particularly for groceries, and even omni-channel customers expect in-store improvements.

Today, different technologies offer benefits for enhancing customer experience and reducing demand for in-store labor. But the technology needs a solid foundation of standards and integration with retailer processes to achieve these goals.

Augmenting Labor With Technology and Standards of Today

Overview

According to the U.S. Bureau of Labor Statistics, a record 4.5 million people quit their jobs in November 2021, of which 686,000 were in retail.[2] The stresses of the pandemic resulted in a huge reduction in retail workers, with grocery being the hardest-hit industry. This prompted adjustments to brick-and-mortar processes. According to a recent retailcustomerexperience.com poll of senior retail executives, 74% indicated that the biggest impact of this labor shortage remains at the store level. The poll also indicates automation, transparency, and new partnerships as key focus areas.[3]

Even with some uptick in retail labor numbers in early 2022, offsetting staffing shortages to handle the heavy flow of in-store business is still a focus of current technology.

Solutions of Today

Stores are having to sacrifice their service levels to consumers due to current labor shortages. Retailers have cut operating hours to compensate, such as Macy's reducing its work hours by two hours, four days a week.[4] Others have closed pickup lanes and reduced windows for their buy online, pick up in-store (BOPIS) services. Technology is also being used, with some stores using livestreaming and 1:1 video chat platforms that enable remote customer service and engagement.[5]

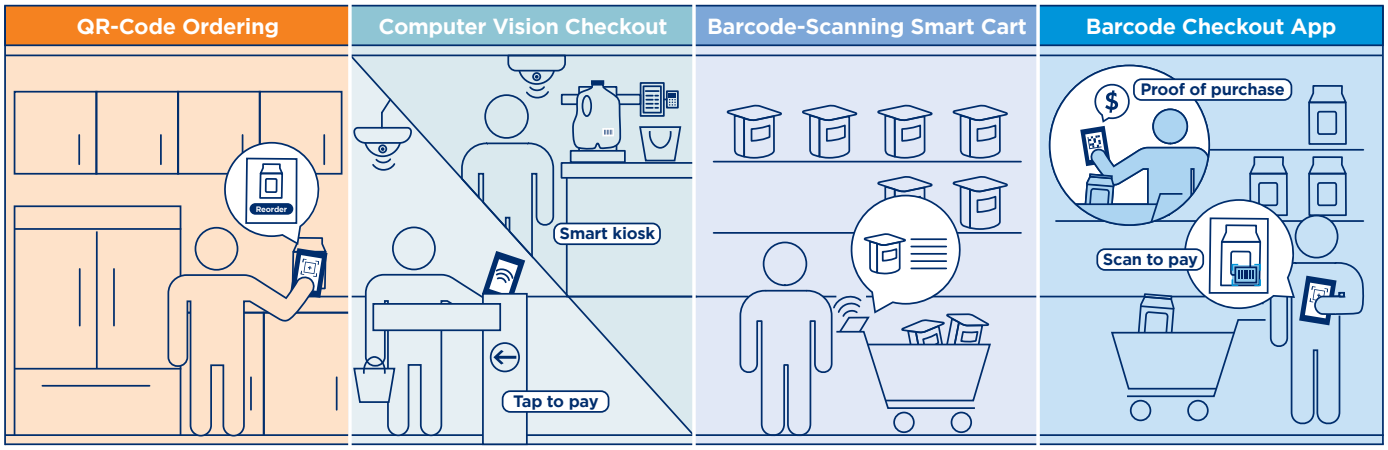
Increasingly, retailers are trying to alleviate the burden of labor challenges through automation. One current focus is the checkout counter, traditionally a bottleneck in the retail journey.

Cashierless Checkout

There are a variety of existing technical solutions used for cashierless checkout, where a human cashier is not needed to process purchases made by individual customers. Examples include computer vision systems and store apps to make the consumer's phone the cashier. These novel technologies depend on accurately and seamlessly recognizing products to automate the checkout process. To power that automated recognition, retailers are relying upon GS1 Standards, such as the Global Trade Item Number® (GTIN®), and emerging barcodes, like the QR code, Radio Frequency Identification (RFID), and product imaging/3D rendering tied to master data of individual products.

> Trigo's solution enables brick-and-mortar grocery retailers to integrate the efficiencies and insights of digital commerce into the physical world. To achieve that, we have built a sophisticated 3D engine designed for use in a retail setting: one that uses artificial intelligence and computer vision working together to digitize physical stores completely. Retailers receive real-time data, driving insights about how to reformulate operations and provide shoppers with a real omni-channel experience."
>
> **YOTAM ARONOVITZ,**
> Head of Partnerships, Trigo

Technologies of Today



Example: Batch[6]

On-product or in-advertisement QR codes for seamless ordering

Examples: Amazon's Just Walk Out[7],Trigo

Customer's mobile app links to the store; Computer vision detects selected items; Final bill is sent to app for resolution

Examples: Mashgin[8] and Caper[9] smart kiosks

Computer vision identifies and rings up multiple items at once

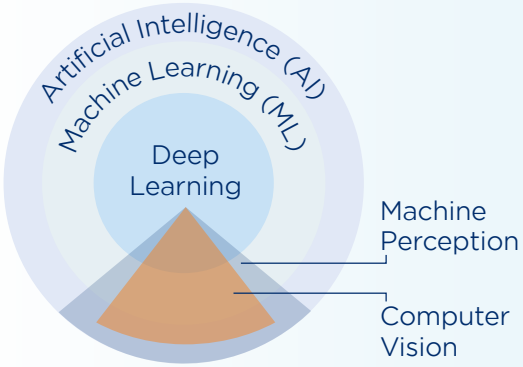
Examples: Shopic[10], Kroger, and Caper[9]

Shopic smart cart identifies products via sensors or customer scan; Supports on-cart payment

KroGO, a Caper smart cart, uses barcode scans; Has touchscreen for recommendations, wayfinding, and payment

Example: Sam's Club Scan and Go[11]

Customers use app to scan barcodes, select an item, or manually enter U.P.C. number and then pay; Customers present a QR code to associate for proof of purchase



Optical-Only Computer Vision:
Combines cameras and machine-learning (ML) algorithms to identify products by their image.

Hybrid System:
Augments optical-only with additional sensors, such as in-shelf weight sensors, to increase algorithm accuracy.[2]

For Employees:
Since "checkout-free stores do not need [as many] personnel working as traditional cashiers and merchants" employees can be reallocated to other, customer-facing tasks to enhance their shopping experience.[2]

The computer vision solution is growing especially quickly. These technologies require training data to support the machine-learning (ML) algorithms that run them. Algorithms need a large amount of product data, about 1,000 data points per item, to train their object-recognition protocols.[12]

They often come in the following forms:

- **Images:** Product images are labeled so the computer can understand how to properly identify and categorize the product.
- **3D Assets:** Fully virtual 3D copies of products can be used to train computer vision algorithms and accelerate the process by running it all within a virtual environment.

However, accurately labeling this training data is often done by human hands, which is time-consuming and prone to inconsistencies. GS1 identifiers, the most common of which is the GTIN, have a role to play here. If a GTIN were associated to the metadata for an image, the 3D asset that generates training data, or a combination thereof, then a system could take advantage of the rich item data in a Global Data Synchronization Network™ (GDSN®) to aid labeling, creating operational efficiency.

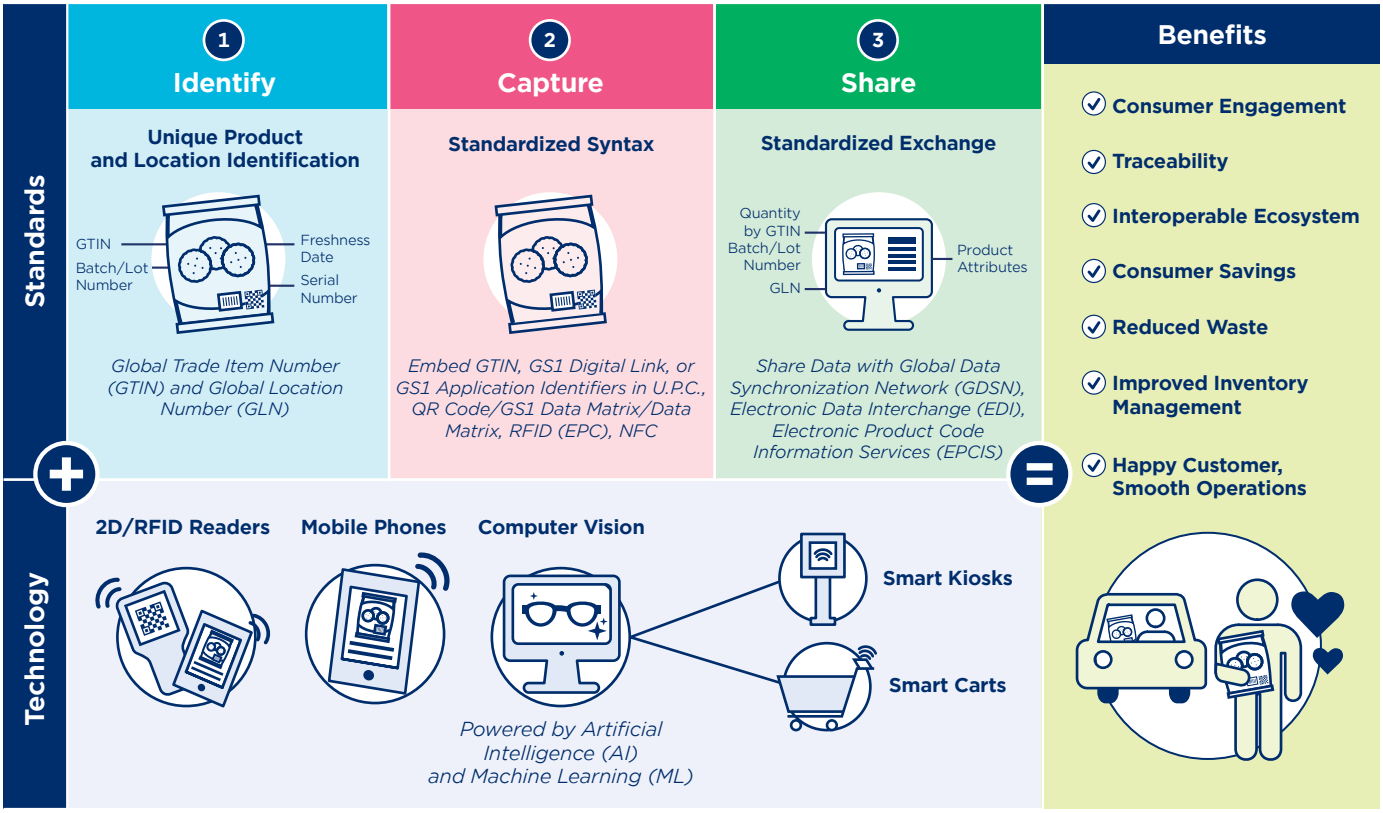
Object recognition is just one part of the product identification system contributing to frictionless shopping. Other technologies, such as scan-and-go apps, access product information through the GTIN encoded into the 1D barcode on-pack. Product information can also be accessed through use of a 2D barcode containing a GS1 Digital Link—this web-friendly barcode uses standards to enable everything a 1D barcode can, while also fluidly extending the experience to online resources.

Today's Technology—Benefits

- **Frictionless Customer Experience:** seamless checkout for speed and accuracy
- **In-Store Analytics:** analyzing which items are regularly purchased together, dwell times at shelves, etc.
- **Employee Efficiency:** eliminating the risk of manual errors, freeing employees to engage in other essential tasks
- **Higher Profitability:** reducing labor costs, enabling longer hours of operation[13]

Today's Technology—Challenges

- **High Up-Front Costs:** high initial investment, requiring either new construction or extensive retrofits
- **Dynamic Tech Market:** having to update solutions to conform with best practices
- **Limited Coverage:** not yet fully scaled; limits to number of SKUs or store size, currently 40,000 square feet[14, 15]
- **Limited Identification:** absence of additional information beyond the GTIN, such as expiration date and batch/lot



Customer Engagement

As retailers implement cashierless checkout, they must also consider customer engagement opportunities in pre-, during-, and post-purchase situations.

The ease with which a customer can engage with a product and trust the information before buying makes the sale. Consumers expect more and more product information at their fingertips to make decisions.

Convenience and speed for customers have been important drivers of the shift to cashierless checkout. But retailer solutions are still developing. Many use self-checkout systems, where customers scan and bag their own products. However, there are issues with these capabilities, such as theft as well as difficulty detecting low-weight items or use of personal shopping bags. Customers constantly hear, "Help needed," or "Please place your item in the bag." When an associate must get involved, customers get frustrated; cashierless checkout is not delivering on its promise. At the end of the day, it is important to take customer comfort levels with different technologies into account.[16] Many customers still want the option to check out with an associate.

As a result of customer expectations, personnel are still a critical part of customer engagement. Despite an uptick in online buying during the pandemic, customers prefer to buy in a physical store where they have access to an actual product. This can allow retailers to deliver fun, convenient in-person experiences. Happy, engaged workers are a crucial part of the overall consumer experience (CX).[17] Automation can free employees from mundane tasks and allow for customer-facing interactions where it matters most.

Post-purchase consumer experiences earn both brand and retailer loyalty. Ease of re-ordering a favorite product, finding

a better substitution, or being notified of an issue or sale based on personalization are all more important than ever. Today, many brands are using QR codes that customers can read with their phone cameras to provide details about nutrition, potential allergens, or promotions. By nature, these QR codes enable a single use case to resources, such as SmartLabel information.

Embedding a standardized GS1 Digital Link URL allows a single barcode to be used to access product information and support other use cases as well. But there is still work for brands, retailers, and solution providers to get there. The standards are available today. Adoption is underway!

Industry communities around the world are working with GS1 as it leads the Global 2D Migration effort. GS1 is bringing stakeholders together to develop the thought leadership, standards, and guidance that will help all industries transition to 2D together. As part of the global need for better data, GS1 US established the Sunrise 2027 initiative, supported by the industries and the GS1 US Board of Governors. Sunrise 2027 sets a milestone for all retailers to be able to scan a 2D barcode for price lookup at point-of-sale (POS) by the end of 2027. This is the first step to a 2D future. From there, product owners can move at their own speed to determine when and how to embrace 2D barcodes, using GS1 Standards.

Augmenting Labor With Technology and Standards of Tomorrow

Overview

In the future, there is potential for automation to complement in-store labor to improve operations and enable frictionless shopping experiences. For example, a computer vision system tied to overhead cameras throughout a store can serve a dual purpose: in addition to managing customers and their digital shopping carts, it can also improve inventory management. Companies like Trax are already using a combination of "camera installations, shelf-scanning robots, and computer vision to monitor products on store shelves." Images are sent to the "system to analyze and identify when inventory is low on store shelves, or when items are misplaced."[18]

The greatest benefit from this technology in the future will not be the complete replacement of labor, but instead leveraging technology to augment labor. According to Analytics Insight, "In the future, humans will collaborate with machines to exchange and share information, working towards a common goal to fulfill individual and organizational needs."[19] The synergy between human and machine will be additive, with the proper integration of collaborative automation technology serving as a major component of how well stores operate in the future.

Sunrise 2027

- **WHY:** Soaring consumer expectations and business needs for more data require advanced barcodes. U.P.C. only holds basic product identification.
- **WHAT:** Industry wants to transition to 2D barcodes for POS by 2027.
- **HOW:** Work with GS1 US to test barcode capabilities; and pilot, educate, and understand industry plans for a 2D future in retail.

Click or scan for more information

Solutions of Tomorrow

As companies progress from today's technology, there are data-related considerations that should not be overlooked. Although computer vision technology can identify what a product is and relate it to a unique identification number such as a GTIN, it cannot pick up other relevant identification about the product. For example, computer vision can recognize packaged broccoli and distinguish it from cauliflower. However, the same technology would not be able to determine the batch/lot, expiration date, or serial number of the broccoli. Integrating a 2D barcode or other type of machine-readable data carrier would increase accuracy and ease employee workloads for processes such as recalls and freshness management. Without this ability to extract additional product data in a more automated way, progress toward workforce efficiency and frictionless customer experience will be limited.

The findings of a GS1 Digital Link proof-of-concept suggest retailers should consider the following return on investment (ROI) factors for fresh-food management:

- **WHAT** is the average number of hours spent per store, per year on current fresh-food management processes?
- **HOW** much of this time is due to manually checking freshness dates or batch/lot numbers printed on the product?
- **HOW** many hours per day could associates save by scanning a 2D barcode and immediately knowing the freshness date?

A potential formula to use might be:

- Number of stores * Potential hours saved per day with a 2D barcode * Hourly wage rate
- 300 stores * 1 hour per day * 365 days * $18 = $1,971,000/year

Frictionless Experience—How Future Tech Will Work With Standards

Technology continues to evolve, becoming more efficient and accurate. Today's efforts to reduce customer friction have focused on going cashierless. Future automation technology will overcome the challenges that hold it back today and offer benefits and experiences beyond those it provides now. Integration between technology and standards will help improve functionality by providing richer data via carriers like 2D barcodes. Standards can enhance the functionality of these technologies in the following ways:

- **Serialized Identification:** Serialized identifiers (GTIN + Serial number) can supply a wealth of knowledge about a particular instance of a product, from batch/lot information in the case of recalls to expiration dates for automated discounts. A serialized GTIN may be encoded during the manufacturing process; the key consideration is that additional data alongside a GTIN provides a more precise identity. When more data is integrated into a product's packaging via a barcode or QR code, whether by serialization or specific attribution, it can be read by a computer vision system to access that additional data.[20]
- **Tech Market Resilience:** Standards for product, location, and entity identification ensure that store data is interoperable across different business units and technologies. Since GS1 Standards are technology agnostic, they can serve as the data backbone, offering resilience to ever-changing retail automation technology. The principles that enabled GS1 Standards to power the conversion to scan-based checkout are the same ones powering today's frictionless shopping.
- **Employee Efficiency:** Standards can help enhance the employee-efficiency gains of automation technology by providing a single source of truth for brand data, helping ensure that quality data is being entered into these systems and therefore minimizing errors.

Freshness Management With 2D Barcodes Helps Support:	Recall Management With 2D Barcodes Helps Support:
Labor Augmentation: Reduce workload by expediting and improving accuracy for expired-goods rotation.	**Labor Augmentation:** Improve in-store manual recall processes, reducing the amount of impacted product and waste.
Customer Savings: Offer customer price-point choice by automatically discounting nearly expired products.	**Customer Safety and Confidence:** Track additional data and notify impacted customers at point of purchase, instead of relying on news and social media.
Waste Reduction/Sustainability: Delight customers and reduce waste, with automatic discounts based on product freshness.	**Increased Loyalty:** Gain trust, increase brand loyalty, and reduce widespread fear by managing recall messaging.
Improved Inventory Management: Drive inventory management efficiency, particularly for produce, meats, and seafood.	

- **Reduced Up-Front Cost:** As technologies advance and see wider adoption, economies of scale will drive down the cost and expand usage. For example, as RFID tags support more use cases, their cost could become a fraction of what they are today, and computer vision systems should become available to companies at a much lower cost. Through integration with standards, solutions partners can deploy their technology in a more repeatable manner, which should further drive down costs.

> Kroger is working on evaluating and implementing RFID technology in our stores and Distribution Centers to track and safeguard products through our supply chain. GS1 Standards, such as the Electronic Product Code (EPC), will help ensure that trustworthy products are available to our customers and their families, with the added benefit of automation helping relieve labor issues."
>
> **BRIAN HECHT,**
> Supply Chain Strategist, Kroger

In addition to the technologies of today, there are other solutions on the horizon that can improve the frictionless shopping experience and benefit from integration with standards.

As technology evolves, it will be bolstered through integration with standards, allowing for large-scale interoperability, richer data, and technological resilience. Retailers will have an easier time integrating new technologies with in-store operation if they have a strong foundation built on standards. A few companies are already working on these types of solutions today, and the most optimized, scalable ones are likely to spread and revolutionize the retail ecosystem.

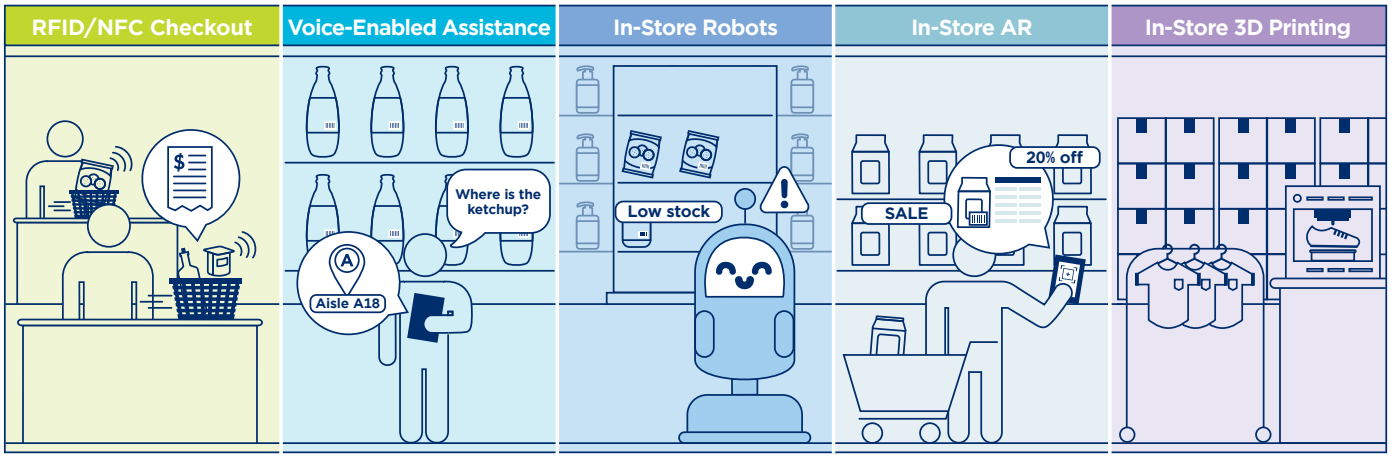
Consumer Engagement—How Future Technology Will Help Customers

No matter what future technology retailers select to augment labor and offer seamless shopping experiences, access to accurate, relevant, and timely data will always be needed. This starts with standards.

Customers are driving the demand for trustworthy pre-purchase product information, not only for accurate descriptive and pricing information, but also for ethical sourcing, carbon emissions, and confirmation of certificates. To provide transparency to customers, trading partners across the supply chain must be able to share critical tracking events from the manufacturer to the end consumer. In a world where brands and retailers choose different systems to store their relevant business information, interoperable exchange of data is paramount and only possible when those systems use a common language, GS1 Standards.

The post-purchase experience is equally important. An important example is that food-safety risk grows exponentially every second that a product cannot be recalled. A retailers' ability to directly contact a customer who purchased a recalled product will help increase customer safety and brand protection. One way to achieve this is when more data can be tracked at POS through 2D barcodes. There may also be additional opportunity for 2D barcodes to help meet regulatory requirements.

Technologies of Tomorrow



Examples: Stark RFID[21], Harting[22], and NXP[23]

Self-checkout counters instantly read RFID- or Near-Field Communication (NFC)-tagged items; Do not need line of sight.

GS1 Electronic Product Codes (EPCs) embedded in RFID and NFC tags uniquely identify a product.

Example: GS1 US Pilot Study

Digital assistant uses voice technology at an indoor location to find products.[24]

GS1 US completed a 2021 pilot with a major grocery retailer for voice wayfinding that resulted in reduced search time for users.

GS1 Global Location Number (GLN) maps store locations alongside a GTIN.

Example: Sam's Club[25]

In-store robots monitor on-shelf inventory; Floor-scrubbing robots at Sam's Club use computer vision to scan shelves and tie the data to **GTINs**.

In the future, some robots may pick center-aisle grocery, while customers only select items like produce, meat, or seafood.[26]

Example: Philips

Customers look at products with augmented reality (AR) tags through their phone cameras to get all kinds of product information.[27]

Verified by GS1 can help ensure product data authenticity.

Example: H&M

In-store 3D printing can empower customers to order and manufacture customized products.

An H&M and Unspun pilot envisions a future "world in which brands can produce their collections using waste-free 3D-weaving machines" in store.[28]

GS1 GTINs can be assigned and physically or digitally embedded at the time of 3D creation, enabling persistent identity for resale and recycling.

How the Barcode Will Change and GS1 US Plans for the Future

As mentioned earlier, GS1 US is developing a plan for the future that accounts for technical advancements. The rise in use of 2D barcodes is complemented by GS1 Digital Link, a standardized syntax for web-enabling barcodes to help brands, retailers, and customers access the information they need more easily. But, to access that information in more complex use cases like tracing a product from farm to table, retailers will still need a firm foundation built upon GS1 Standards.

GS1 US is leading the way with the Sunrise 2027 initiative to ensure industry is prepared to scan a 2D barcode at point-of-sale. This is a critical first step to the future for all supply chain stakeholders: brands, retailers, technical providers, and most importantly, customers.

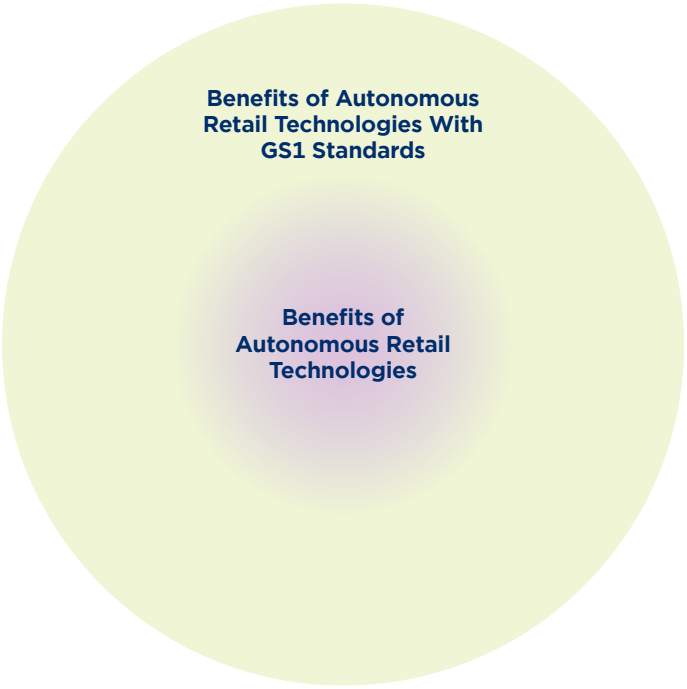
> GS1 Standards complement automation, and GS1 US is working to ensure solution providers, including startups, understand the strategic value of those standards. Following industry standards can help us take a holistic approach to our innovation. It is important to ensure that the process of solving one business problem does not have unintended consequences when bringing that solution to scale. This is critical for our key systems, such as point-of-sale, when adding new functionality."
>
> **CHARLES J. MCWEENEY,** VP of Technology, Innovation, and Strategy, Wakefern

Wakefern FOOD CORP.™

Conclusion

Frictionless shopping is more than a single technology: it is an entire ecosystem of integrated technologies, standards, and processes. GS1 Standards are the foundation that ensures technical solutions are interoperable, scalable, and benefit customers and employees. By leveraging 2D barcodes, automation solutions can expand beyond frictionless shopping experiences at checkout and enable greater customer engagement throughout their purchasing journey, as well as automate key tasks that enhance in-store labor. The future of automation is collaboration, with artificial intelligence (AI) and other technologies being used to make workers' jobs easier or removing the burden of dull, dirty, or dangerous tasks so employees can focus on more important, customer-facing tasks. Sunrise 2027 is an important stepping-stone. Enriched data have the potential to unlock the future of automation performance. Automation solutions built to work in concert with standards and processes will help ensure scalability for retail stores and interoperability throughout their supply chains.

GS1 US is currently investigating a myriad of promising automation technologies through pilots and partnerships. In addition, there are ongoing discussions about supply chain visibility to support traceability, inventory management, and sustainability. Please reach out to us at innovation@gs1us.org to learn more or to take part in exploring the future of retail.



Growth of Automation in Retail Over Time | GS1 Standards Relevance Today and Tomorrow

Manual Improvements		Automating the Future	
Pre-1974	**1974-Today**	**Ready Now**	**Tomorrow**
Manual intervention			
• Pricing guns, hand-keyed checkout and inventory	• EAN/U.P.C. product labels, ITF-14/ GS1-128 case labels • Hand scanning for price lookup and case receipt	• 2D, RFID, EPCIS, GS1 Digital Link • Computer vision, robotics, micro-fulfillment, drones • Cashierless checkout, smart cart/kiosk, automated receiving picking	• Increased use for 2D, RFID, EPCIS, GS1 Digital Link • Autonomous checkout with auto discounts • Smart recall management, real-time inventory management • Digital assistants, 3D printing, augmented reality, voice
Burden on humans			

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