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RFID JOURNAL

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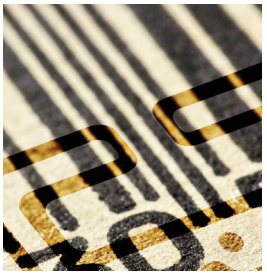

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Warehouse and Inventory Management, September 13

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Food Industry, Oct. 26

RFID Connect

Find products that can help you deploy RFID successfully, such as MonsoonRF's RFID Lantern, designed to make EPC UHF reader installations cheap, easy and invisible. The system consists of an RFID reader built into a canister for an LED light bulb.

Top 10 Search Terms in July			
1	Retail	6	Harsh environment
2	RTLS	7	Automotive
3	Impinj	8	Library
4	Bar code	9	Printer
5	Enterprise resource planning systems	10	Hospital

Most-Read Stories in July

- IKEA Canada Engages Customers With RFID at Pop-up Store
- Impinj Hopes to Raise $60M From IPO
- McDonald's, Other Companies Test TAG Sensors' RFID Temperature Loggers
- Can RFID Pinpoint a Moving Object's Location?
- What Is the Read Range of a Passive RFID Tag?

Ideas Exchange

RFID Journal maintains an Ask the Experts forum, where you can submit questions about RFID technology and its applications. Your questions will be answered by RFID Journal editors or outside experts. Recent questions include:

- Are any companies using RFID to control HVAC equipment?
- Could RFID stop motel towel theft?
- Are application programming interfaces available for a Tibero database?
- Can RFID tags be integrated with a retail point-of-sale system?
- What affects a UHF RFID system's read range?
- Is tag collision a problem with Near-Field Communication?

The Inside Scoop

What are end users saying behind the scenes? Why should the RFID community be optimistic about the industry? Who's spreading misinformation? Get insight and perspective at the RFID Journal Blog.

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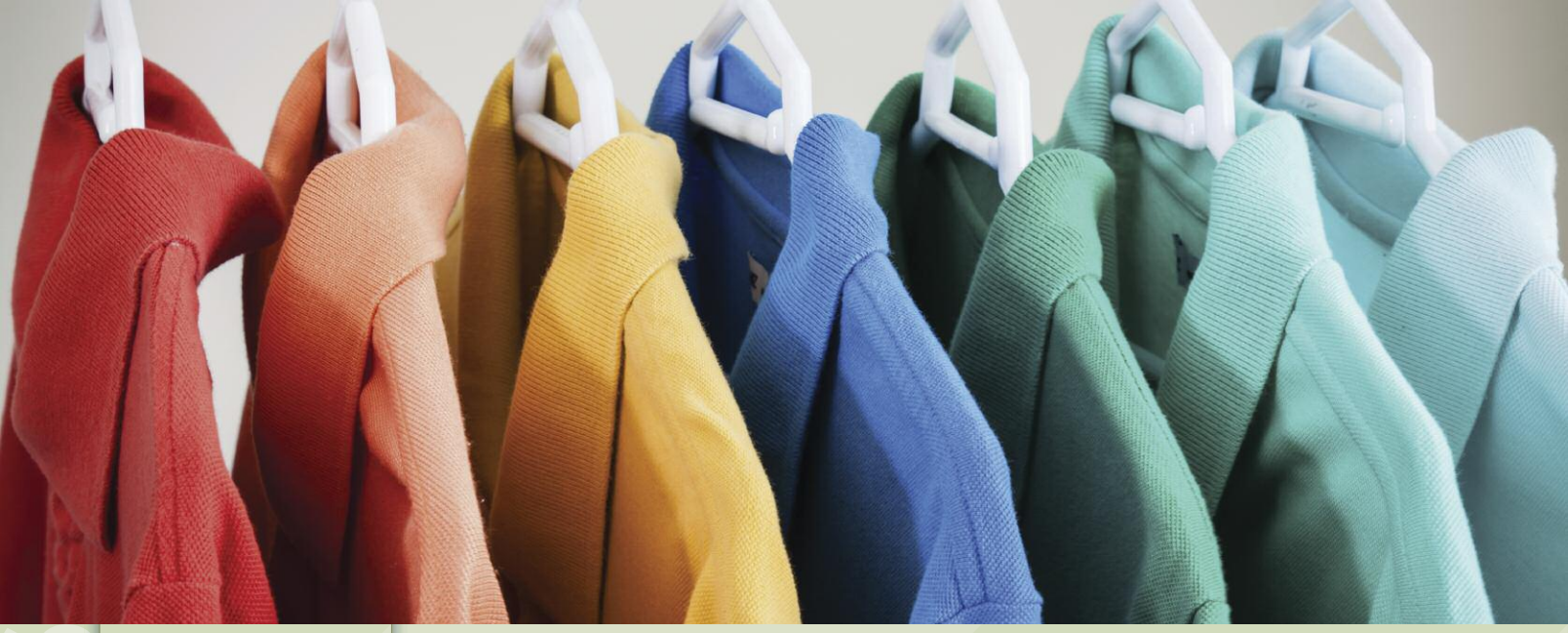
Volvo's Global RFID Initiative
The auto manufacturer shifts production into a higher gear, driving improvements and cost savings.

Belgian Company Gets an ROI From Its Warehouse-Management Solution
ENGIE Fabricom RFID-tracks nearly 90,000 assets at eight locations within the country.

Community Hospital Finds RFID Is a Good Fit
Wayne HealthCare uses the technology to lower the cost of managing IT assets and improve patient services.



2016

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The Return of Productivity

PHOTO: TOM HURST

Productivity in the United States and other industrial countries has been down for the past six years, and economists have been debating the reasons. Pessimists say technology has delivered all the big benefits, and most of the recent digital innovations—Facebook, Twitter and Snapchat, for example—provide no economic value. Optimists say there is still plenty of room for technology to deliver gains.

No one will be surprised to learn that I fall into the latter camp. As we reveal in our cover story, RFID and Productivity Growth: Behind the Economic Statistics, big productivity gains are being achieved by organizations in health care, logistics, manufacturing, retail and other sectors.

It's not just that RFID can reduce the amount of time required to count items by upward of 98 percent. It's that being able to capture data so much more efficiently allows companies to do so more often and in more places without raising costs or disrupting normal business operations.

Why is that important? Consider Delta Air Lines, which is using RFID to check expiration dates on oxygen generators aboard a 757 aircraft. It used to take eight man-hours to do the job, which meant the airline could capture the information only when a plane was in for maintenance. Now, Delta can capture that data in less than a minute, which means one person with a handheld reader can check expiration dates while a plane is being cleaned and readied for its next flight.

That means Delta can plan how many oxygen canisters it will need in the future to replace those nearing their expiration date. It can inform its supplier, so the supplier can have the canisters ready for delivery when they are needed, and Delta can send them to airports via the most cost-effective means and install them just before the expiration date. All this increases productivity throughout the supply chain.

Restaurants and food-service outlets have been among the laggards when it comes to investing in new technologies, but RFID is beginning to have an impact in that sector (see Vertical Focus). K&N Management, for example, is using RFID at its four Mighty Fine Burgers, Fries & Shakes fast-casual restaurants, in Austin, Texas, to speed delivery of food to tables and increase table turns, and therefore revenue. Other restaurants are using RFID sensors to ensure food freshness without investing a lot of labor in checking manual data loggers.

Food retailers in the United States and Europe are beginning to track totes in the supply chain and perishable items in stores (see Product Developments). The pilot programs indicate RFID can improve inventory productivity, margins, store-operations execution and overall customer experience.

Of course, RFID doesn't automatically—or magically—make an inefficient company efficient. But it does provide a means to cost-effectively collect the information needed to dramatically boost productivity.

Mark Roberti, Founder and Editor, RFID Journal

TECHNOLOGY

Creating Smaller, Cheaper Passive UHF Tags

Researchers at North Carolina State University have applied a new technology called RF-only logic to create passive RFID chips that are 25 percent smaller than today's integrated circuits.

A smaller, less expensive microchip is the holy grail of the radio frequency identification industry. An inexpensive chip would reduce the total cost of a transponder—and cheaper transponders would enable companies to track and manage more assets, including low-cost items. Researchers at North Carolina State University may have discovered a way to reduce the cost of a passive ultra-high-frequency RFID chip by 25 percent.

Paul Franzon

The researchers have applied a new approach called RF-only logic. They eliminated a circuit called the rectifier, which takes the alternating current (AC) signal received from a nearby RFID reader and turns it into direct current (DC) to power a chip's logic circuits.

The biggest challenge was overcoming the fact that energy could only be delivered to the chip during half of the RF wave cycle. The circuits the researchers developed prevent the energy from leaking away until more energy is delivered, so the chip gets a steady stream of electricity.

The innovative approach was the result of a "curiosity-driven project," says Paul Franzon, a professor of electrical and computer engineering at NC State. "A group of us were brainstorming a circuit that could run off of harvested RF power. We speculated that you could have a distributed power rectification system. Then, we thought about where such an approach might be beneficial, and we realized RFID was a good application."

Several Ph.D. students are working to build a prototype and ensure it can comply with existing RFID standards. If successful, the approach could lead to smaller, less expensive ICs, which would lower overall tag costs.

The one downside of this approach is that tags will likely have a shorter read range than conventional RFID transponders, but they could be useful for applications in which read range is not critical. And over time, Franzon says, techniques could be developed to store more energy for longer reads.

Franzon has filed for a patent and expects to license the RF-only logic approach to RFID chip producers. "If it doesn't work out," he says, "we might be interested in starting our own venture." —*Mark Roberti*

INNOVATION

The Internet of Clothes

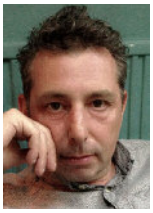
A research project aims to link clothing to the internet so items can be shared or donated automatically to charities when they are no longer being worn.

Back in the 1930s, the typical American woman owned nine outfits. Today, she owns 64, and some of those garments are rarely, if ever, worn. Mark Brill, a senior lecturer in future media at Birmingham City University in the United Kingdom, hopes to help people—men as well as women—use clothing more efficiently and consume less by tracking garment usage and linking it to the internet with radio frequency identification. "Your clothes should remind you that you aren't using them," he says.

The concept was sparked by an artistic project called Brad the Toaster, by Italian designer Simone Rebaudengo, Brill says. "Brad was linked to other toasters via the internet. He could compare himself to how often other toasters were used, and if he wasn't being used enough, he put himself on eBay."

PHOTO: NORTH CAROLINA STATE UNIVERSITY

Brill was familiar with Near-Field Communication, a short-range form of RFID, because he'd used it in some of his commercial marketing work. It seemed a natural way to track how often clothes were being worn, so he built a prototype system using off-the-shelf NFC tags and readers. With the help of a commercial software firm he'd worked with previously, he created an online database for tracking and sharing information about how often each item is worn.



Mark Brill

Brill hung an NFC reader in his closet and put NFC laundry tags, which are encased in plastic to protect them during washing, on some of his garments. He tags and enters via the web application any new clothes he buys and indicates how often he expects to wear them. Each time he puts on an item, he waves the tag near the reader. If he hasn't worn an item or has donned it far less frequently than he expected, the system sends an alert to his mobile phone.

The project is one of 12 that has been short-listed for a Network for Innovations in Culture and Creativity in Europe Award, which is organized by the European Centre for Creative Economy. Brill hopes to be among the four winners so he can use the modest prize money to purchase more hardware.

The next step is to improve the hardware and software and share it with beta testers. Brill would like to create an ultra-high-frequency RFID version as well, since many clothing items are already being tagged with passive UHF RFID tags for inventory-tracking purposes. "If the clothing manufacturers put a tag in permanently, then you could put a UHF reader above your bedroom door and it could automatically track what you wore each day," he says. "Our goal is to have beta testers use both the NFC and UHF versions and give us feedback."

The long-term goal is to create a network of people sharing information about their clothing, and exchanging or donating items they don't wear very often. "If we can reduce wasteful consumption of clothing and encourage more ethical production and use of clothing," Brill says, "then ultimately, that's good for individuals and society as a whole." —*M.R.*

An NFC reader monitors garments identified with NFC laundry tags.

PHOTOS: MARK BRILL

ILLUSTRATION: ADOBE STOCK: DIMASHIPER; ARGUS

The Clothes Off Our Backs

Amount of one's clothing the average **U.S.** citizen actually wears:

20 percent

Amount of one's clothing the average **U.K.** citizen actually wears:

44 percent

Amount of clothing that ends up in **U.S.** landfills annually:

11 million tons

Amount of clothing that ends up in **U.K.** landfills annually:

350,000 tons

Amount of used clothing **American** citizens recycle or donate annually:

15 percent

Amount of used clothing **British** citizens recycle or donate annually:

57 percent

—Rich Handley

Experts Weigh In on RFID's Tipping Point

A survey of more than 800 technology professionals found that most believe more than 1 trillion objects will be connected to the internet by 2022, using RFID and other technologies.

Last year, the World Economic Forum's Global Agenda Council on the Future of Software & Society launched the Technological Tipping Points survey, which asked respondents for their views on 21 "tipping points"—moments when specific technological shifts hit mainstream society. The aim was to provide insights into the expectations of information and communications technology experts on key emerging technologies.

The survey asked respondents for their perception of when these tipping points have occurred or will occur. Choices included "It has already happened," "20+ years" and "never."

The World Economic Forum received 816 responses, which were aggregated and analyzed. The results showed that, on average, the experts believe that by 2022, more than 1 trillion objects will be connected to the internet via radio frequency identification, Bluetooth, Wi-Fi, ZigBee and other wireless technologies.

"With continuously increasing computing power and falling hardware prices (still in line with Moore's Law), it is economically feasible to connect literally anything to the internet," the report states. "Intelligent sensors are already available at very competitive prices. All things will be smart and connected to the internet, enabling greater communication and new data-driven services based on increased analytics capabilities."

It's not clear, of course, what the experts meant by Internet of Things technologies. Some people don't consider RFID an IoT technology (even though the term emerged from the RFID industry). If you discount RFID, then it is hard to imagine 1 trillion items being linked to the internet by 2022. Here's why.

ILLUSTRATION: ISTOCKPHOTO

Most IoT technologies except passive RFID require a power source, usually a battery. There are several things that will inhibit wide-scale use of these technologies to connect everyday objects to the internet. First, not everything in the world has a power source to tap into. Even with some items that do have batteries, such as power tools, you might not want to connect to the internet using the object's battery power because that could shorten battery life.

Another issue is maintenance. Batteries eventually die and must be replaced. This means that connecting hundreds of billions of objects to the internet with battery-powered radios would require armies of people to change batteries.

A third issue is cost. An inexpenisve Bluetooth device costs roughly $10. That's too expensive to put into billions of objects. Of course, the cost of the electronic components will come down as volumes ramp up. But the cost of batteries could remain an issue. A three-volt lithium coin battery costs roughly a dollar, and it might not provide enough energy to power a Bluetooth device for very long (though manufacturers are continually improving radio devices to reduce power consumption).

A final issue is size. Devices with batteries tend to be larger and bulkier, which makes them harder to integrate into—or stick onto—some objects.

So it's likely that passive RFID will be used for the majority of items connected to the internet. And it's highly likely that there will be more than 1 trillion passive tags used on—or in—objects. Clothing is one area in which RFID adoption is quickly gathering momentum. The global market for clothing, textiles, footwear and luxury goods is roughly $3 trillion. If each item sold costs $10 on average, that would mean 300 billion clothing items, shoes and accessories are sold each year.

If all retailers are using RFID to track apparel, footwear and accessories, it's likely that books, cosmetics, jewelry, electronics, health-care products, home improvement, liquor, pharmaceutical, sporting goods and other retail categories will also adopt RFID as the technology improves and prices come down. Whether all these categories will be using RFID en masse by 2022 is an open question. But if the experts are off, it is likely to be only by a couple of years. *—Mark Roberti*

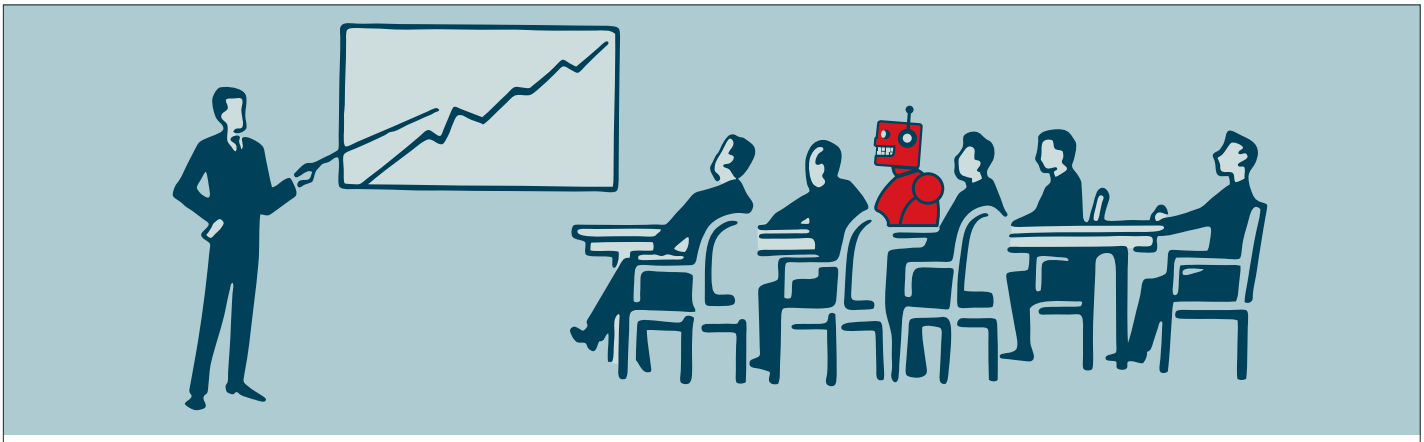


ILLUSTRATION: ISTOCKPHOTO

Other Tipping Points Expected by 2025

Here is a list of technological milestones and the percentage of the 816 professionals surveyed by the World Economic Forum's Global Agenda Council on the Future of Software & Society who expect each one to happen by 2025.

10% of people wearing clothes connected to the Internet	91%
90% of people having unlimited and free (ad-supported) storage	91%
The first robotic pharmacist in the U.S.	87%
10% of reading glasses connected to the Internet	86%
80% of people with a digital presence on the Internet	84%
The first 3D-printed car in production	84%
The first government to replace its census with big-data sources	83%
The first implantable mobile phone available commercially	82%
5% of consumer products printed in 3D	81%
90% of the population using smartphones	81%
90% of the population with regular access to the Internet	79%
Driverless cars equaling 10% of all cars on U.S. roads	78%
The first transplant of a 3D-printed liver	76%
30% of corporate audits performed by artificial intelligence (AI)	75%
Tax collected for the first time by a government via blockchain*	73%
More than 50% of Internet traffic to homes for appliances and devices	70%
Globally more trips/journeys via car sharing than in private cars	67%
The first city with more than 50,000 people and no traffic lights	64%
10% of global gross domestic product stored on blockchain technology	58%
The first AI machine on a corporate board of directors	45%

*A "blockchain" is a distributed trust mechanism used to track transactions in a distributed way.

Can Passive UHF RFID Get Any Better?

The technology has made great strides—and there are innovations on the horizon that will advance it even more.

During the past five years, passive ultrahigh-frequency radio frequency identification systems have improved markedly. The read range has increased significantly due to the development of more sensitive microchips and better antenna design. Security features have been added to prevent cloning and eavesdropping on tag-to-reader communication. And innovations have enabled tags to be read on metal products and even to be embedded in metal for tracking items such as medical devices. In fact, a recent report from the European EPC Competence Center, a Germany-based provider of RFID services, found that on-metal tags are becoming smaller and increasing in sensitivity and reliability (see EECC Benchmark Study Finds UHF Tag Performance Better Than Ever).

This raises two important questions: Do passive systems need further improvement and, if so, can they get any better?

The answer to the first question is certainly "yes." Passive UHF RFID technology works well for many applications, but

ILLUSTRATION: ISTOCKPHOTO

there are some things end users would like it to do or do better. These things would dramatically boost adoption levels.

1. CAPTURE TAG DATA MORE CONSISTENTLY

RFID systems are great for reading tags quickly. A single store associate can take inventory of 10,000 apparel items in two hours with a handheld RFID reader. It would take the same associate approximately 50 hours with a bar-code scanner, and the accuracy would not be as high.

Still, retailers would like to move to fixed RFID readers in stores and read all the tags on all the items on their shelves. Today's overhead readers are typically able to read only 50 percent to 90 percent of the tags. That's because tags on densely packed items often block the reader signal from reaching tags on other items behind or below them. Getting the read accuracy on overhead fixed readers up to 95 percent accuracy levels or higher would boost retail adoption.

2. EXCLUDE EXTRANEOUS READS

In some cases, passive RFID readers are too good at capturing tag data. Often, a forklift truck reader will read tags on items on shelves, rather than just those on the forklift truck. And handheld readers sometimes capture tags on items on shelves the associate does not intend to inventory. Many end users say they would like to see the passive UHF read field be more defined or have readers use other methods to exclude tags they do not want to read.

3. MAKE THE TECHNOLOGY MORE PLUG-AND-PLAY

At an RFID Journal event in 2003, Linda Dillman, then CIO of Walmart, showed a photo of the back of a smart shelf the retailer was trialing in one store; in the picture, a jumble of boxes with wires and cables was going in every direction. "This is not deployable in stores," Dillman said. The technology has improved since then. Readers come in neat little boxes and can have integrated or external antennas. Sleek portals often hide all the hardware.

But passive UHF systems frequently require some tweaking of power levels and careful positioning of reader antennas to optimize the read field. Most end users would like to be able to place a reader in a ceiling, doorway or wall and begin collecting data.

4. REDUCE THE COST

Tag prices have come down significantly over the years. Passive UHF inlays are now available for 7 or 8 cents in large volumes. This helps make the technology ideal for tracking high-value goods, such as clothing and pharmaceuticals. But there are many low-cost, low-margin items, particularly in the food and grocery sector, that cannot support the cost of a 7-cent tag.

Are any of these areas likely to improve? A great deal of research is being conducted at universities worldwide and in the research and development departments of RFID companies.

In the May-June 2016 issue of RFID Journal magazine, for example, we wrote about a research project by Shadi Ebrahimi-Asl, a Ph.D. student at the Missouri University of Science and Technology, in Rolla, Mo., that could have a profound impact on the ability to read tags in close proximity to one another (see 'Invisible' Antennas). Ebrahimi-Asl realized that energy from the reader antenna reflects off the antennas of passive tags even when they are not communicating with the reader. This creates interference that makes it harder for the reader to receive a signal from the tag with which it's communicating.

Ebrahimi-Asl knew that the induced electrical charge on an antenna can be reduced to reach the antenna's minimum backscatter state (a theoretical state known as an "invisible" antenna). She built a backscatter antenna in the lab and changed the load on it to make it remain invisible to the reader. She demonstrated that by doing so, she could more easily read a tag close behind it. This capability, if built into passive UHF tags, could make it easier to read tags spaced closely together. It would also increase the read range of passive UHF readers by reducing interference from multiple tags in the read field. In this issue, we write about research being conducted at North Carolina State University to develop chips that would be 25 percent smaller and, therefore, cheaper to produce (see Out in Front).

Extraneous reads are likely to be addressed with both hardware and software. A number of vendors have introduced antennas for fixed RFID readers that more tightly control the read zone. It's also likely that improvements in algorithms will enable software to filter out unwanted reads more effectively than it can today.

Intel has been one of the first to market with a reader designed to be easier to install. Its Retail Sensor Platform consists of UHF RFID readers with integrated antennas, wired to an Intel Gateway device that forwards the data to a server. The platform also includes an Intel application programming interface (API) that allows RFID systems integrators to write software for linking the RFID data to a store's existing software. Intel says the system is up to 40 percent faster and easier to install than a conventional reader and antenna deployment.

Expect passive UHF RFID systems to improve in all these ways during the next five years. —*M.R.*

Advances in Passive UHF RFID Systems

During the past five years, manufacturers of passive ultrahigh-frequency RFID tags and readers have invested heavily in improving their offerings. Here are some of the key innovations RFID Journal has written about.

2016

Alien Releases New IC With Longer Read-Write Range, Error Protection

Smartrac, RFMicron Release Passive RFID Temperature Sensor Technology

Alien Releases New IC With Longer Read-Write Range, Error Protection

Ubisense Introduces AngleID to Provide Low-Cost, Real-Time Zone Location

Sensing New Opportunities: **Phase IV Engineering**'s RFID Sensor Reader

2015

View Technologies Launches Long-Range RTLS for Passive UHF Tags

NXP Releases IC for Secure Encrypted UHF Reads

With ItemSense, **Impinj** Aims to Simplify "Always On" RFID Deployments

Intel Unveils RFID System for Retailers

New **Omni-ID** Passive UHF Tags Endure 225 Degrees Celsius

Inlay Companies Testing **EM Micro**'s Dual NFC and EPC Chip

Smartrac's New Passive Sensor DogBone Transmits Moisture Levels

2014

Impinj Announces Commercial Availability of Its xArray UHF Reader

Kathrein RFID Announces Beam-switching UHF Reader Antenna, Handheld UHF Reader

Alien Markets Small EPC Tag With Long Read Range

New **Impinj** Chip Promises Higher Sensitivity, Read Range and Flexibility

Omni-ID's View 10 Tag Aims to Replace Paperwork at Detroit Diesel, Other Factories

U Grok It Releases UHF RFID Reader for Phones, Tablets

Harting's LocField Reader Antenna Promises Flexible Read Range

2013

GS1 Ratifies EPC Gen2v2, Adds Security Features, More Memory

Impinj Unveils New UHF Readers for RTLS Applications, Embedding in Other Devices

NXP Releases Ucode 7, a Faster and More Sensitive Chip

Tego Releases 8-kilobit Dual-Memory RFID Chip and Tags

2012

Mojix Announces Availability of Its Next-Generation RFID System

Impinj Launches New High-Performance RFID Chips

Hitachi Chemical Markets Tiny UHF Tag

Omni-ID Introduces Printable On-Metal RFID Labels

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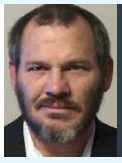

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RFID and Productivity Growth: Behind the Economic Statistics

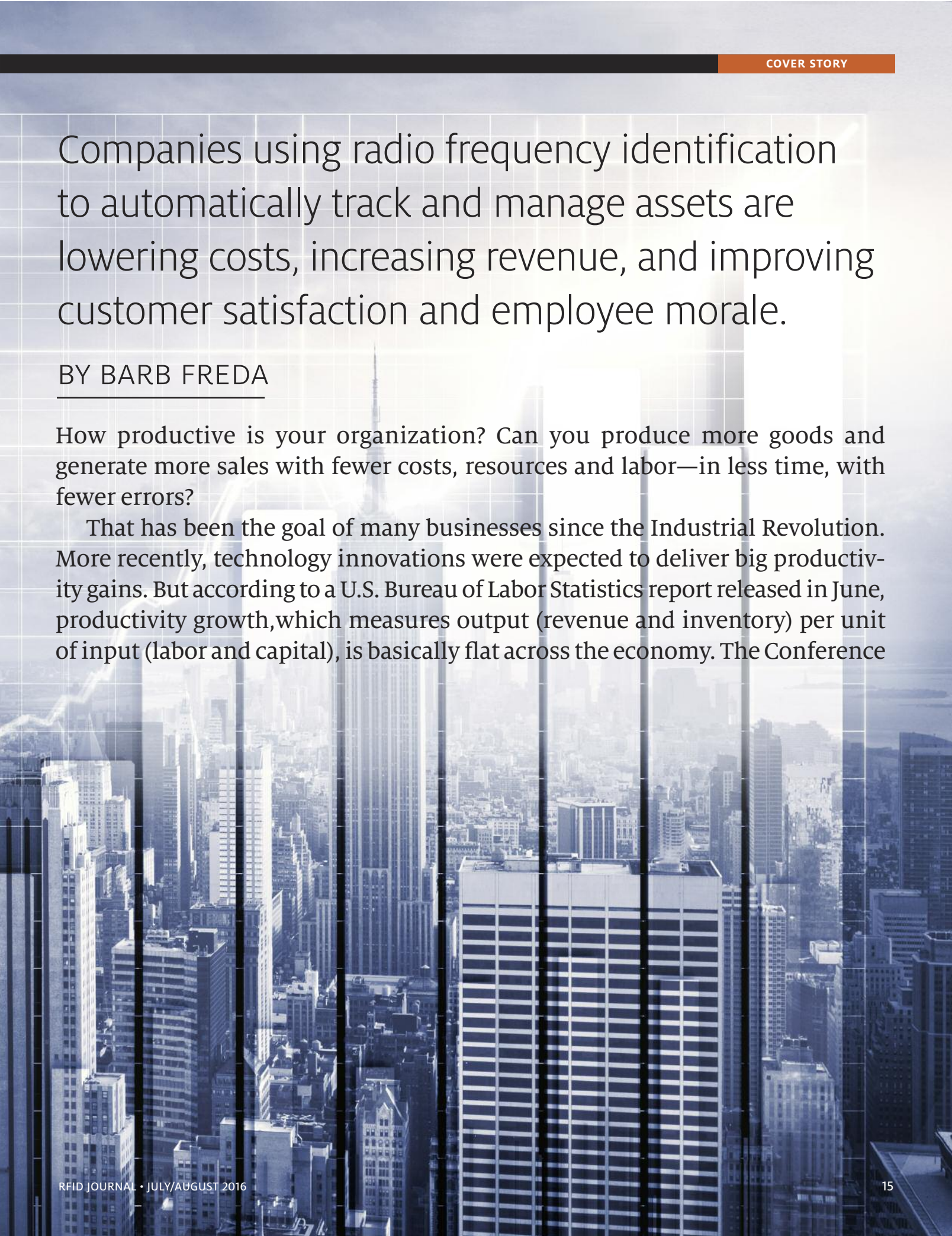
ILLUSTRATION: ISTOCKPHOTO

Companies using radio frequency identification to automatically track and manage assets are lowering costs, increasing revenue, and improving customer satisfaction and employee morale.

BY BARB FREDA

How productive is your organization? Can you produce more goods and generate more sales with fewer costs, resources and labor—in less time, with fewer errors?

That has been the goal of many businesses since the Industrial Revolution. More recently, technology innovations were expected to deliver big productivity gains. But according to a U.S. Bureau of Labor Statistics report released in June, productivity growth,which measures output (revenue and inventory) per unit of input (labor and capital), is basically flat across the economy. The Conference



"Most of the economy operates much the way it did years ago. My emphasis is on how gradual the change is, how our economy is like an ocean liner taking a long time to turn."

ROBERT GORDON, NORTHWESTERN UNIVERSITY

Board, a global business membership and research association, reported in May that it sees modest global economic growth for the remainder of 2016 with little upside for 2017.

Yet, for several years, RFID Journal has been reporting that companies in health care, manufacturing, retail and other sectors that have adopted RFID have been achieving outstanding gains in productivity. Why the discrepancy?

It seems broad economic statistics show just part of the story. First, economists say, there is the "lag" effect—it takes time for new technologies to be harnessed, and RFID is still considered an emerging technology. Erik Brynjolfsson, director of the MIT Initiative on the Digital Economy and co-author with Andrew McAfee of *The Second Machine Age: Work, Progress, and Prosperity in the Time of Brilliant Technologies* (2014), coined the term "productivity paradox" to explain the lag between the introduction of new technology and the implementation that makes productive use of the technical changes.

Robert Gordon, professor of economics at Northwestern University and author of *The Rise and Fall of American Growth* (2016), says there is plenty of innovation and technical change, but it is having very little impact on the economy at large. "Most of the economy operates much the way it did years ago," he says. "My emphasis is on how gradual the change is, how our economy is like an ocean liner taking a long time to turn." Gordon acknowledges that a technology such as RFID will improve productivity, because it improves inventory management without hand counts.

Second, economists aren't looking at individual technologies such as RFID when they discuss broad gains and losses in productivity, says Ygal Bendavid, a professor in the department of management and technology at the Université du Quebec à Montréal. "RFID is a data-capture technology. Economists look at composite indicators too large to discriminate the RFID role," he says. "They are missing the big changes at this level."

Sanjay Sarma, VP for open learning at MIT and co-founder of the Auto-ID Center, says it is a matter of scale—with so much innovation, productivity growth is difficult to measure. The noise of other variables must be stripped away, he says. When you do that, and look at just one technology such as RFID, it is much easier to see the benefits and real growth.

Economists who are pessimistic regarding the impact of technology on productivity "don't understand retail that much," says Bill Hardgrave, dean of Auburn University's Harbert College of Business and founder of the RFID Lab. "RFID presents opportunities to squeeze efficiencies out of the way we do retail, with less handling of product, a reduction of logistics and better ways to handle counting."

To understand how RFID delivers productivity gains today, Hardgrave suggests using the basic accounting approach, in which you consider direct and indirect benefits. "The beauty of the basic accounting approach," he says, "is that everything eventually manifests itself in either a variable cost, a fixed cost or revenue."

Direct Benefits

Direct benefits from RFID include lower variable costs to businesses (labor reduction, lower picking costs, and lower transportation and supply-chain costs) and increased revenue, Hardgrave says. In retail, RFID can improve inventory accuracy and reduce out-of-stocks, but those are not the direct benefits. In terms of productivity gains, they enable increased sales, fewer cycle counts and faster inventory counts, he says. The time made available by those efficiencies leads to time for employees to sell more or produce more, he adds.

In manufacturing, improving operations can result in lower variable costs, such as more efficient labor use and holding less inventory, Hardgrave says. "Improved output from manufacturing means higher output per employee," he says, "which means less variable cost per unit, which means higher margins."

Here is a sampling of the companies RFID Journal has profiled that have achieved direct productivity benefits from employing RFID.

American Woodmark, which manufactures and distributes kitchen cabinets and vanities, deployed an RFID solution to track cabinet

doors and drawer fronts. The company reports that the initiative reduced the labor for cycle counting by 66 percent, while supporting additional counts when errors are discovered. More importantly, count accuracy has improved from roughly 80 percent to 100 percent. "The system has helped us become far more competitive, cost-efficient and profitable," says David Johnson, American Woodmark's materials technology and product manager.

Delta Air Lines is employing RFID to improve the visibility of oxygen generators installed within its aircraft, and thereby reduce the amount of waste associated with discarded generators, as well as the time required to check the devices' expiration dates. It used to take approximately eight man-hours to check expiration dates on oxygen generators aboard a 757. With its RFIDAeroCheck solution, it now takes 45 seconds to complete the check on a twin-aisle aircraft.

Bell Helicopter, a civil and military aircraft manufacturer, has brought its on-time delivery of parts used during the production of helicopters to 99.81 percent since installing an RFID solution to track the internal movements of parts and containers in 2011. Bell Helicopter estimates it recouped its investment within a year, according to Aaron Druyvesteyn, the firm's manager of logistics. The financial return comes from reducing the number of labor hours employees spend searching for missing parts, as well as performing associated stock adjustments. In addition, the high traceability of parts has dramatically reduced the potential for disruptions to the production schedule.

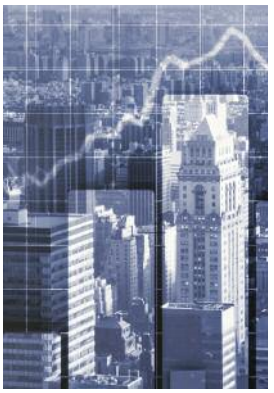
Decathlon, the French sporting goods retailer, is RFID-tracking most products throughout its supply chain—from factories to warehouses to stores. Today, RFID is improving efficiencies in all Decathlon facilities—1,030 stores and 43 warehouses. The retailer, which began a global rollout in 2013, saw an 11 percent increase in sales from July 2014 to July 2015, and the company attributes part of that growth to the RFID deployment. In addition to increasing product availability on store shelves, the RFID solution decreased product shrinkage by 9 percent in 2014.

Hospitals worldwide that have adopted RFID real-time location solutions to track equipment have been able to reduce the number of assets they buy or rent. The Medical University of South Carolina, for example, is using RFID to track and maintain 6,000 vital assets, including bladder scanners. The system ensures that the devices are available, clean and easy to locate whenever nurses or doctors need them. The solution also resulted in significant cost savings. Once the RFID system was in place, the hospital needed to purchase only 38 bladder scanners rather than the 100 originally requested—a savings of more than $750,000.

Northwestern Memorial Hospital adopted an RFID solution to track and manage medical supplies. The facility has improved cost efficiencies by reducing product loss due to unused or expired items, and by ensuring patients are billed for the products used during their stay. "We caught $4 million in charge costs over two years," says Brian Stepien, who was director of supply-chain distribution and logistics at Northwestern Memorial HealthCare, parent company of the 900-bed teaching hospital in Chicago, during the RFID deployment. "That's a really nice ROI, Stepien adds.

Bantrel, a Canadian subsidiary of U.S. construction giant Bechtel, deployed an RFID material-tracking solution to locate 70,000 parts during the construction of a multibillion-dollar tar-sands project in northern Canada. Bantrel estimates that the average time spent locating parts in the field decreased by two-thirds, from 15 minutes on average per part down to just five minutes. That's time workers used more productively in other ways.

Cisco Systems developed an RFID solution to manage fixed assets in 70 U.S. data centers and R&D labs. The networking firm has slashed its cycle count time for conducting inventories from several weeks to just a few hours, reducing inventory labor and cost, says Maryanne Flynn, Cisco's director of operations. The system has also reduced the audit cycle count for a typical-size lab from more than one week to less than two hours—a 95 percent improvement in the time it takes to comply with and supply reports for mandatory audits.



"RFID presents opportunities to squeeze efficiencies out of the way we do retail, with less handling of product, a reduction of logistics and better ways to handle counting."

BILL HARDGRAVE, AUBURN UNIVERSITY

Businesses must understand the data they collect and have a plan to use that data to improve operations. "That data allows me to make a more intelligent decision for business productivity."

TIMOTHY ZIMMERMAN, GARTNER

Indirect Benefits

Indirect productivity gains include customer satisfaction and employee morale, Hardgrave says. These benefits may be hard to measure, but they impact an organization's reputation. In retail, for example, a customer frustrated by an out-of-stock situation just one time may never come back, he says. Once the sale is lost, the merchant may never see that customer again.

"Customer service is a great driver for RFID," says Timothy Zimmerman, research VP at Gartner. "Those merchants who give customers satisfaction in finding an item and giving good service are the ones who complete the sale."

Boosting employee morale helps companies maintain a productive workplace and reduce turnover rates. The costs of hiring a new employee include loss of work after someone leaves and before a new person is hired, advertising costs for the open position, training costs, and productivity loss while a new employee gets up to speed.

Decathlon's main goal in adopting RFID was to improve customer satisfaction. The RFID solution has increased product availability on store shelves, which has had a direct impact on the customer experience and sales, says Jean-Marc Lieby, the retailer's RFID project coordinator. "The first source of dissatisfaction of a customer is failing to find a product on the shelf," he adds.

Macy's rolled out its RFID inventory-management solution to all 850 Bloomingdale's and Macy's stores. RFID enables Macy's to address changing shopping habits and become a successful omnichannel retailer. It's meeting consumer demands for an anytime, anywhere shopping experience, whether in a store, on a mobile device, on a home computer or by phone. And that, in turn, let's Macy's better compete with online and brick-and-mortar retailers.

To improve customer service, Kuehne + Nagel, a global transportation and logistics firm, developed an RFID solution to monitor the temperature of sensitive pharmaceutical and health-care products in transit on a near-real-time basis. "There is an ever-increasing desire to know where a shipment is when it is in transit and the physical conditions at any given moment," says Jon Chapman, Kuehne + Nagel's global pharmaceutical product manager. "There is a growing expectation that this information is available at the touch of a smartphone or tablet screen."

Sunnybrook Health Sciences Centre, in Toronto, deployed an RFID solution that tracks surgery patients to reduce bottlenecks and keep family members and friends informed of the patient's status. The solution also helped to foster more collegial relationships among peers in different surgical-related units, says Ellie Lee, business manager of Sunnybrook's OR Information Management Services department. Hospital staff members working in surgical areas awaiting the transfer of surgical patients have better insight into what is happening elsewhere.

Ruby Memorial Hospital, largest of the West Virginia University hospitals, installed RFID-enabled cabinets to automatically track tagged tissue and medical devices. Error rates tracking products that were implanted in patients during procedures dropped from 3 percent to lower than 1 percent, says Kimberly Cheuvront, Ruby Memorial's perioperative quality assurance coordinator. Waste fell from 10 percent to 8.9 percent over 24 months, with an increase in patient flow. In addition, nurses were freed from the time-consuming job of monitoring these items. "We want the nurses to be able to function as nurses and not wandering around trying to find product," Cheuvront says. "The level of nursing satisfaction here is great, and you can't put a price on that."

At Lufthansa Technik, which overseas logistics and services for German airline Lufthansa, RFID has revolutionized the way in which employees work, as well as their attitude toward managing inventory items, says Kathrin Stromann, RFID project manager. The system, which has approximately a 97 percent accuracy rate, helped the company trim the amount of time it spends monitoring supplies by 80 percent. "In the past, nobody wanted to the do the job," she says. "Touching dirty, smelly and sticky containers was annoying."

RFID End-User Case-Study DVDs

RFID Journal has created a series of DVDs containing presentations by end users, recorded at various live and online events.

UPDATED WITH NEW CASE STUDIES

RFID Journal holds several face-to-face conferences every year, as well as a number of online virtual events and webinars. These events feature end users speaking objectively about the business reasons that they deployed an RFID system, the technical hurdles they overcame in doing so and the benefits they now achieve as a result, as well as presentations by academics, vendors and other experts. Many of the sessions were recorded, and we have compiled these recordings into seven DVDs that are available for purchase for only $99 or free with a one-year premium membership to RFID Journal.

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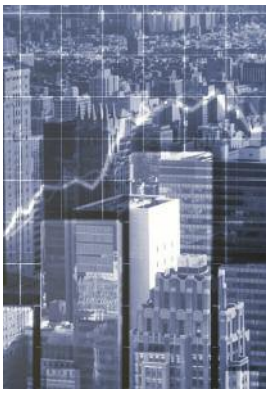

"The implication is that for society as a whole, as automation and technology increase, we are moving to an innovation economy. If you don't innovate, productivity growth passes you by."

SANJAY SARMA, MIT

Now, workers are reporting that they enjoy the task, she adds. "It has created a high-tech approach and a far more pleasant and desirable way to handle these items."

A Sea Change

Clearly, RFID enables companies in myriad industries to track and manage assets automatically, accurately and cost-effectively—and delivers big productivity gains. But it is the smart use of data that will power bigger and sustainable productivity growth. Businesses must understand the data they collect and have a plan to use that data to improve operations. "That data allows me to make a more intelligent decision for business productivity," Gartner's Zimmerman says.

Hardgrave is "bullish on data." But, he admits, the amount of data RFID generates can be overwhelming. Companies don't always know what questions to ask or what questions the data can answer. "If a company is not embracing the data and trying to understand the data, it is at a disadvantage," he says. "They need to know how to process the data and how to make decisions about the data. They have to harness the data in ways others are not. Going forward, data will be the way a company creates or maintains a competitive advantage, and if they don't do that, they are going to be in trouble."

Companies must learn how to use all the data they collect to identify trends, Sarma says, adding that trends don't just leap off the computer screen. Once trends are identified, he says, companies need to understand what they mean. Then, he says, organizations can implement or adjust systems or operations to take advantage of the trends, with expected increases in sales and/or productivity.

Sarma notes that now is the time for companies to take stock of the data at hand and make decisions about how to move forward and remain competitive. "They will hire employees who are innovative, people who can give insights and look for patterns," he says. "The implication is that for society as a whole, as automation and technology increase, we are moving to an innovation economy. If you don't innovate, productivity growth passes you by."

Productivity growth also will be impacted by use—both an increase in the number of companies adopting RFID and an increase in the way firms that have deployed the technology put it to work. "Some analysts' numbers suggest that only about five percent of retail inventory utilizes RFID, and I think that is probably accurate," Hardgrave says. "We have a long way to go. We are just seeing the tip of the iceberg here."

Lower costs are opening the door for more companies to adopt RFID. "When tags were 60 to 80 cents each, the business case to use passive UHF technology was more difficult," Zimmerman says. "But now, less expensive tags are available, and in some cases it is cheaper for a source manufacturer who may be providing products to multiple clients to put tags on every item, rather than separate it out and run two lines. Now, the tags [in these cases] are available at zero cost to retailers or others in the supply chain." When supply-chain partners receive tagged assets, he says, it encourages them to use the technology to optimize processes.

"RFID is a technology such that the more you use it, the more efficiencies you gain," Hardgrave says. "For the retailer, in particular, much of the cost of RFID is in infrastructure. Once in place, the infrastructure ROI improves with every tagged item. If you install a dock door RFID reader, for example, it costs the same to read 100 tags as it does 100,000 million tags." Higher volumes result in quicker payback, he says, and increased sales, which come with the new RFID efficiencies, will be sustained moving forward with no additional resources. Also sustainable are the lower inventory held and reduced shipping costs (since fewer items are being shipped).

"Early innovators in RFID who began with inventory management are now seeing some really novel ways to create efficiencies and improve customer experiences," Hardgrave says. "We will see even more."

It may take several more years for RFID to impact economic statistics, but there is certainly opportunity for businesses in any industry to achieve productivity gains today.

See the complete table of contents at
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ON THE MENU: RFID

BY JENNIFER ZAINO

Casual, fast-casual and quick-serve restaurants adopt wireless technologies to enhance the customer experience, ensure food safety and improve operations.

ILLUSTRATION: ISTOCKPHOTO

Mighty Fine Burgers, Fries & Shakes, a chain of four fast-casual restaurants in Austin, takes pride in its Texas hospitality, so parent company K&N Management was looking for a way to replace its practice of calling out customers' names when their orders were ready. Guests were afraid they wouldn't hear their name, explains Gini Quiroz, K&N's director of team member engagement, so instead of waiting comfortably in the dining room or on the patio, they milled around the counter, further congesting a high-traffic area.

"We want people to enjoy every single touchpoint, and the after-order/before-pickup touchpoint was causing angst and frustration," Quiroz says. "We really like cutting-edge technology, and we thought Table Tracker could be a good solution for guest satisfaction."

Long Range Systems' Table Tracker solution helps eateries like Mighty Fine "cut time out of their day, turn tables faster and create a better experience," says Michelle Strong, LRS's chief marketing officer. A high-frequency RFID tag with a unique ID number is attached to the underside of each table. When customers place an order, they receive a Table Tracker device, which has a built-in RFID reader and a ZigBee device for transmitting the tag ID number and its own identifier to the local Table Tracker software. The software alerts restaurant employees to order status and customer location. (Restaurants can also integrate the software with their point-of-sale and kitchen display systems to create one seamless system.)

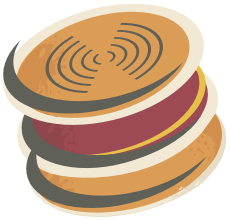
The solution's ability to get employees quickly and directly to the customer's table is a key strength, Strong says. A table tent or zonal-location system "that only gets you halfway there could cause confusion," she says. Speedy delivery keeps patrons happy and results in faster customer turnover, which, she adds, is a revenue plus.

In 2012, K&N tried Table Tracker at one Mighty Fine location and, a few months later, rolled it out to the three other restaurants in the chain. The solution shaved roughly a minute off guest wait time for food and hospitality scores increased. Patrons can enjoy the music without worrying that they'll miss their order. "As soon as food is ready we bring it out," Quiroz says, "and that means food quality is also better." Fries, for example, diminish in quality the longer they sit, so speed is essential, she explains.

Employees like the solution, too, Quiroz says, because they can concentrate on upcoming orders rather than on calling customer names to pick up food. The four restaurants compete on how quickly they get food to tables. The information is available in reports provided by the software, which records data such as the time an order is placed and when the order is closed based on a server clearing a Table Tracker unit once he or she has delivered the food. The local Tracker system can be cloud-connected to store data for analysis. In the past, such data was entered manually and was not necessarily accurate, Quiroz says. "Now, we can know if things are out of our standards for service," she says.

Mighty Fine is ahead of the RFID adoption curve in the restaurant sector, an industry that isn't known for technology innovation. The findings of Hospitality Technology's 2016 Restaurant Technology Study show that IT budgets represent just 2.5 percent of revenue, with allocations heavy on core system maintenance. Nearly 30 percent of survey respondents—who have IT decision-making involvement for 32,796 restaurant locations across quick-service, family-casual and fine-dining brands—believe they lag behind when it comes to overall IT innovation. The respondents represented regional (51 percent), national (24 percent) and global (25 percent) brands.

It appears there's plenty of opportunity for restaurants to distinguish themselves by using technology in new ways. And Hospitality Technology's 2016 report indicates that restaurants have a growing awareness of possible technology benefits—87 percent of respondents said tech projects will be driven to improve operational/process efficiency, and just more than



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Hospitality scores increased after Mighty Fine Burgers, Fries & Shakes adopted the Table Tracker solution at four restaurants.

half cited improving customer experience/guest loyalty. Increasing employee productivity, ensuring a high degree of security/compliance and improving business insights had the attention of roughly one-third of respondents in each case.

Pizza Ranch franchises in the Midwest, Jason's Deli, which operates in 30 states, and Zinc Café in Southern California are also using Table Tracker to improve the customer experience. Other casual, fast-casual and quick-serve restaurants are proving the business case for using wireless technologies to maximize their workforce productivity, achieve food-safety compliance, improve operations and gain business insights.

"From the corporate or regional manager perspective, the number one thing is how we perform against goals," Strong notes. "Last year, Table Tracker customers were more interested in the utility of using this to find people and get them their food faster. But more people are beginning to ask about the analytics they are able to get." Restaurant managers can use the data, for example, to analyze delivery times by day or hour, which could be helpful in determining whether additional staff members are needed to prepare food for specific shifts. "You'll always need staff in the restaurant environment," she says, "but there are a lot of conversations now about how to optimize them to apply to the most useful things, and let technology make their lives easier in addition to making the customer experience easier."

ENHANCING GUEST SERVICES

Theme parks are beginning to offer apps that allow guests to preorder meals at restaurants, to reduce long wait lines. Walt Disney World, for example, lets customers order online and then pay at a kiosk at its Be Our Guest restaurant. Then customers use their MagicBand

PHOTOS: LONG RANGE SYSTEMS

access pass or receive a Magic Rose (both have an embedded high-frequency passive RFID inlay) to identify their location. "Cast members kindly instruct you to find a table and have a seat, so your food can 'find' you," reports a blogger who valued the service.

RFID solutions integrator Strategic Systems and Technology (SSTID) is working with an organization on a similar application, but one that takes advantage of the Bluetooth-enabled smartphones most guests bring with them, says Steve Walsh, the company's director of professional services. Guests would make a reservation and place their orders online via a downloaded app. Upon arrival at the restaurant, they'd be seated at a table near a Bluetooth beacon. The app would detect the beacon, confirming the customers had arrived. Then, the beacon would send a message to the restaurant system to have a server bring out the orders.

This type of solution is appropriate for theme parks with multiple dining sites, Walsh says, because customers are more likely to download the required application when it's part of an entire experience. "You can see why companies like Disney have looked at this [RFID solutions to help get food to diners]," he says. "Outside of a venue that has multiple facilities, its potential is not going to be as attractive."

To boost sales, McDonald's introduced the Create Your Taste program. In-store kiosks let customers design their own burger, including a choice of bun, cheese, sauce and other toppings. At hundreds of McDonald's restaurants in Canada, customers will find Table Tracker devices right next to the kiosks. "Now they grab their tracker, enter its number with their order and sit down," Strong says. Their location information is communicated via the Table Tracker software so their specially made orders are delivered as soon as they're ready.

ENSURING FOOD SAFETY

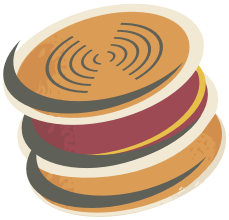
Restaurants know that one customer complaint linking them to food poisoning will spread like wildfire via social media—and they've all witnessed the damage last year's *E. coli* outbreaks at Chipotle Mexican Grill have done to that company's business.

"Our belief is to stay off the radar, to do things the right way and be ahead of the curve about that," says Jim Gibson, VP of food safety and quality assurance for Five Guys Enterprises, parent company of the handcrafted burgers and fries chain, with some 1,000 locations nationwide. Five years ago, Five Guys adopted CM Systems' ComplianceMate solution for its corporate Five Guys Burgers and Fries restaurants and new franchises. As of Nov. 1, all restaurants—including older franchises—will be mandated to use the system, Gibson says.

ComplianceMate is a temperature-monitoring solution that helps restaurants comply with the U.S. Food and Drug Administration's voluntary Hazard Analysis Critical Control Point (HACCP) guidelines for the identification, evaluation and control of food-safety hazards. The solution uses active 900 MHz wireless sensors to help ensure that food is stored in coolers at safe temperatures. The sensors transmit the temperature data to a gateway, which forwards the data to a cloud-based server hosted by CM Systems. The software issues alerts if temperatures are either too warm or too cold.

Employees can also use ComplianceMate's Bluetooth temperature probe and Android tablet running an app with a restaurant's own HACCP checklists to ensure products meet the restaurant's food-safety requirements. (The company is developing Windows and iOS versions due in the fall.) If, for instance, a reading shows the temperature of coleslaw is too high, they can request advice about how to fix it and record the action taken, such as icing it down. All this information goes from the tablet into the ComplianceMate cloud, so store, district and regional managers can review and analyze report data daily. They can assess, for instance, whether the problem was just a one-time incident or recurs during certain shifts, says CM Systems COO Thom Schmitt. If it's the latter, they can take steps such as retraining employees in how to maintain appropriate product temperatures.

The advantage of performing these checks



Restaurants know that one customer complaint linking them to food poisoning will spread like wildfire via social media.

electronically is that it provides real accountability, Schmitt says. "I've seen many instances where you walk in at 10 at night and an employee is filling out the time and temperature lists for the whole day at that point," he says. "A chain may spend a lot of money to develop a food-safety program and tout that great food-safety program, but that doesn't matter if the people in the stores are not doing what the program says. This helps to ratchet things up a notch to make stores more compliant."

At Five Guys, each store has one tablet, two Bluetooth probes and sensors in every cooler. The sensors are a huge time-saver for restaurant managers who otherwise would have to manually take temperature readings every couple of hours, Gibson says, adding that it's no small thing amid the hustle and bustle of the food-service business. Five Guys also has optimized station-walking paths, so food-temperature readings can be taken with the Bluetooth probes in just two minutes.

"Products not being temperature-controlled can get a lot of people sick very easily," Gibson says. In the unlikely event Five Guys receives a call from a state health department regarding a consumer complaint about getting sick from eating at one of its restaurants, he says, "We have data to pull up and say these are the cooler readings for the past week and the product temperature readings for every two hours. We have the documentation to prove our stance on the situation."

Five Guys is now working with ElectroFreeze, the company that makes its milkshake machines, and with CM Systems to put a remote sensor into those machines with an attached Bluetooth probe to monitor that the milk inside them stays at the correct temperature while the machine is running. It plans to deploy the sensor to its 600 stores that sell milkshakes by the fall.

City Barbeque also uses the ComplianceMate system in its 25 restaurants in Kentucky, Indiana, Ohio and North Carolina, says Randy Potts, the company's market leader. Each location has a walk-in cooler sensor, a freezer sensor and two other sensors in salad

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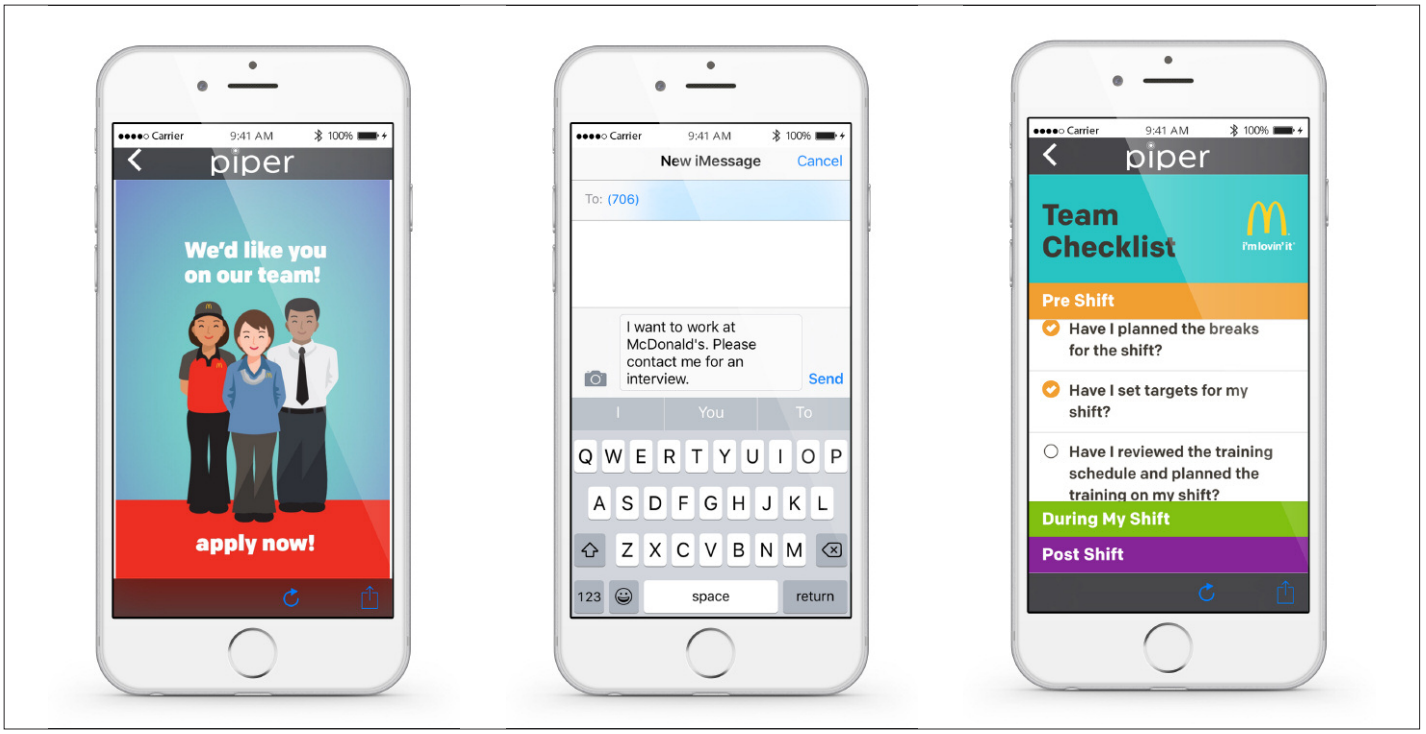


A McDonald's franchise, in Columbus, Ga., uses Piper's Bluetooth LE beacon technology to improve operations and marketing.

coolers. "We have 24-hour monitoring in case something goes down, so we can throw the product out if we know it was outside the safe zone," he says.

Each City Barbeque restaurant also has one tablet and one Bluetooth probe to take product temperature twice a day. "I think it provides guests who see our employees using it a reassurance that this restaurant cares about their safety and making sure they don't get sick," Potts says. City Barbeque has never had an incident, but ComplianceMate ensures it is well-prepared for dealing with potential complaints. "Everything is recorded and accurate," he says. "It provides a security blanket."

IMPROVING OPERATIONS

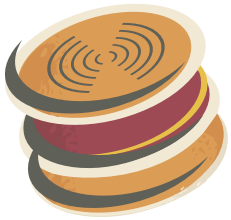
In Columbus, Ga., John Pezold is a McDonald's franchisee whose restaurants are part of a 26-store co-op that uses Bluetooth LE beacon technology from Piper to improve operations. Piper provides a proximity-based messaging platform to deliver contextual information to smartphone users.

"Proximity-based messaging was built around the idea of value-based promotions," says Robert Hanczor, Piper's founder and CEO. "The early promise was to distribute inexpensive beacons and send coupons or messages to customers while they were in range of a restaurant or store. That still works, but many restaurant and retail customers say they have 1,000 ways to give away free items. What they need is improved operational efficiency, and many are beginning to deploy proximity technology with this objective."

The co-op originally used Piper's mobile app with the beacons to provide offers and drive sales, Pezold says, but McDonald's then came out with its own app that has offers and loyalty components to move sales. "So we utilize Piper for more operational and marketing benefits," he says. On the marketing front, the stores are part of a proximity network composed of other local retailers, a university, tourism sites and a public safety program that use the Piper app. That enables the franchises to connect with a large user base without having to spend a lot of ad dollars.

But the greatest benefit from Piper probably is the operational aspect, Pezold says, "in the form of training employees and communicating with them at a more relevant time when

PHOTOS: PIPER



The top challenges include justifying return on investment, lack of sufficient IT budgets, lack of skilled resources and company philosophies that don't embrace technology innovation.

they arrive to the store instead of trying to reach them on their personal time." Piper's multiplexing beacon technology and web-based dashboard lets Pezold create discrete private groups—one for crew members and managers and another for customers—and send messages to their smartphones.

He also uses this technology at his McDonald's franchises to tie into a training system Piper built for its station observation checklists (SOCs). Managers guide crew members through training steps at each station and catalog their progress. "Piper sends tips to crew members about various stations and also reminds managers to conduct training throughout the day," Pezold says. "We've seen an uptick in SOCs completed each day. We're also looking to integrate this system into employee rewards with Piper in the future."

Pezold has three beacons in each restaurant. Recently, he says, there has been "a strong push for recruiting, so we brought the recruiting message back. Managers get notified via text once a customer gets the message and applies. They're then able to communicate with the prospective employee, and we've had a few good hires as a result."

GETTING INNOVATIVE

For now, RFID is mostly on the menu at casual, fast-casual and quick-serve eateries. "Table Tracker is designed for situations where speed of service is a high priority," Strong says. "Therefore, quick-serve and fast-casual concepts are attracted to this solution to help improve delivery times while also improving the guest experience." But providers believe RFID has appeal for other restaurants, as well as food-service operations.

Any operation that serves food, including fine-dining restaurants, is a potential customer for ComplianceMate's temperature-monitoring solution, says CM Systems' Schmitt. In fact, he adds, it should be a priority for institutional operations, such as hospital cafeterias and retirement homes, that serve people with compromised immune systems. All these environments "have to monitor the temperatures of the product they potentially serve their customers," he says. But the larger chain restaurants have the most to lose, he adds, noting it will take Chipotle years to recover from its food-safety troubles. "A single store will not be as inclined to use our system," he adds, "because the owner is in the store every day, and he or she believes they know their operation."

Piper's Hanczor says there's opportunity for beacon technology in fine-dining establishments, which have been experimenting with tablets at tables for menu descriptions and wine recommendations. In this case, he says, the focus for proximity messaging would be more on the guest experience. "Proximity technology can help these restaurants create greater loyalty connections with preferred guests in the form of specialized messages upon arrival, countdown messages for table availability, customized chef's recommendations and other points of engagement that enhance the experience," he says.

No doubt restaurants face obstacles in moving forward with technology initiatives. The top challenges, according to the 2016 Restaurant Technology Study, include justifying return on investment, lack of sufficient IT budgets, lack of skilled resources and company philosophies that don't embrace technology innovation. They're also grappling with managing legacy systems even as they try to deliver new technology projects faster. On the plus side, two-thirds of restaurants will spend more on technology this year than last.

The restaurant industry is also impacted by new minimum-wage and overtime requirements introduced in several states and under discussion at the federal level. Many restaurants are increasingly interested in how they can apply technology to optimize staff usage and allocate labor costs most efficiently.

"In the last couple of years, the restaurant industry, and the hospitality sector in general, has started to see the potential for RFID and other location technologies to provide ways to enhance the guest experience, to do what competitors can't," says SSTID's Walsh. "They are just beginning to leverage that in ways they feel comfortable with."

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BY BOB VIOLINO

IN THIS ISSUE: • FRESH FOOD RETAIL • FASHION RETAIL • SECURE VEHICLE ID

Reducing Food Waste in Groceries

Retailers can use Avery Dennison's tags to track totes in the supply chain and perishable items in stores.

The AD-229 tag (pictured at right) is designed for item-level tracking. The label is accurate at low temperatures and in the presence of foods with high water content.

FOOD RETAILERS FACE many challenges when it comes to keeping their shelves well stocked with a wide variety of fresh perishable items, including dairy, meat and produce. Managing inventory and rotating stock—including tracking sell-by dates—are labor-intensive processes. Expired foods must be discarded, which impacts a store's bottom line.

Most food retailers use bar codes to manage inventory, says James Stafford, global head of food RFID development at Avery Dennison Retail Branding and Information Solutions (RBIS). But manual processes are inefficient, he says, and packages that need to be moved can be inadvertently overlooked when a store is busy or during shift changes.

To automate tracking perishables in the supply chain and within stores, Avery Dennison RBIS developed three passive ultrahigh-frequency EPC RFID tags specifically for the food industry. The company is working with several major food retailers in the United States and Europe on pilot programs to confirm the benefits of RFID's use on fresh foods at both the distribution and item levels, Stafford says.

In the supply chain, Stafford says, "We needed an RFID tag that could be used on disposable delivery cartons and also a waterproof encapsulated version that could withstand multiple washing cycles over many years when placed on returnable totes." Both versions are based on the AD-237 inlay incorporated into a label.

"Totes are a very efficient way of managing the inventory of cheaper fresh foods with a short shelf life, such as dairy products or produce," Stafford says. Attaching a permanent RFID tag allows totes to be tracked accurately

PHOTO: AVERY DENNISON

and quickly throughout the supply chain, he says, and helps ensure 100 percent delivery accuracy to the final destination. Because the same tag is used on multiple journeys, he adds, this is a cost-effective way of deploying the technology.

The AD-229 tag is designed for item-level tracking. The label is accurate at low temperatures and in the presence of foods with high water content, such as meat and poultry, Stafford says. "For higher-value perishable products, such as meat, each individual package can benefit from its own RFID tag," he explains, "so we needed to design tags that could be attached to the existing food packaging by the manufacturer and would work well in a refrigerated environment.

"A further consideration is that a customer may accidentally forget to remove the food packaging and place it in a microwave," Stafford says. "We are refining our AD-229 design to ensure it is safe in these circumstances."

A secondary benefit of item tagging is that the same RFID tags can be used for loss prevention of individual items. RFID scanners at store exit points can detect tags that have not been read at the point of sale and create alerts for store staff, Stafford says. This saves the labor cost of applying conventional electronic article surveillance tags in store, he adds.

The unique information within an RFID tag, which is far more detailed than the data contained in a bar code, will create new opportunities to improve inventory productivity, margins, store-operations execution and overall customer experience, Stafford says. The pilot programs have already yielded key benefits for the retailers involved, Stafford says, though he declines to identify any of the customers or discuss specifics of how the retailers are using the tags. The benefits include enhanced supply-chain visibility of stock, increased speed and accuracy of receiving, reductions in food waste through increased visibility of expiration dates and increased item-level availability.

Food retailers can create rapid reports of both product availability and residual life throughout the supply chain, Stafford says. "First, the information helps them improve their stock rotation techniques and offers early visibility of overstock situations," he says. "This visibility enables them to take price action to clear excessive stocks and help minimize waste.

"Retailers deploying the technology should be able to reassure regulatory authorities that all reasonable precautions are being taken to avoid the sale items that are past their use-by or sell-by dates," Stafford says.

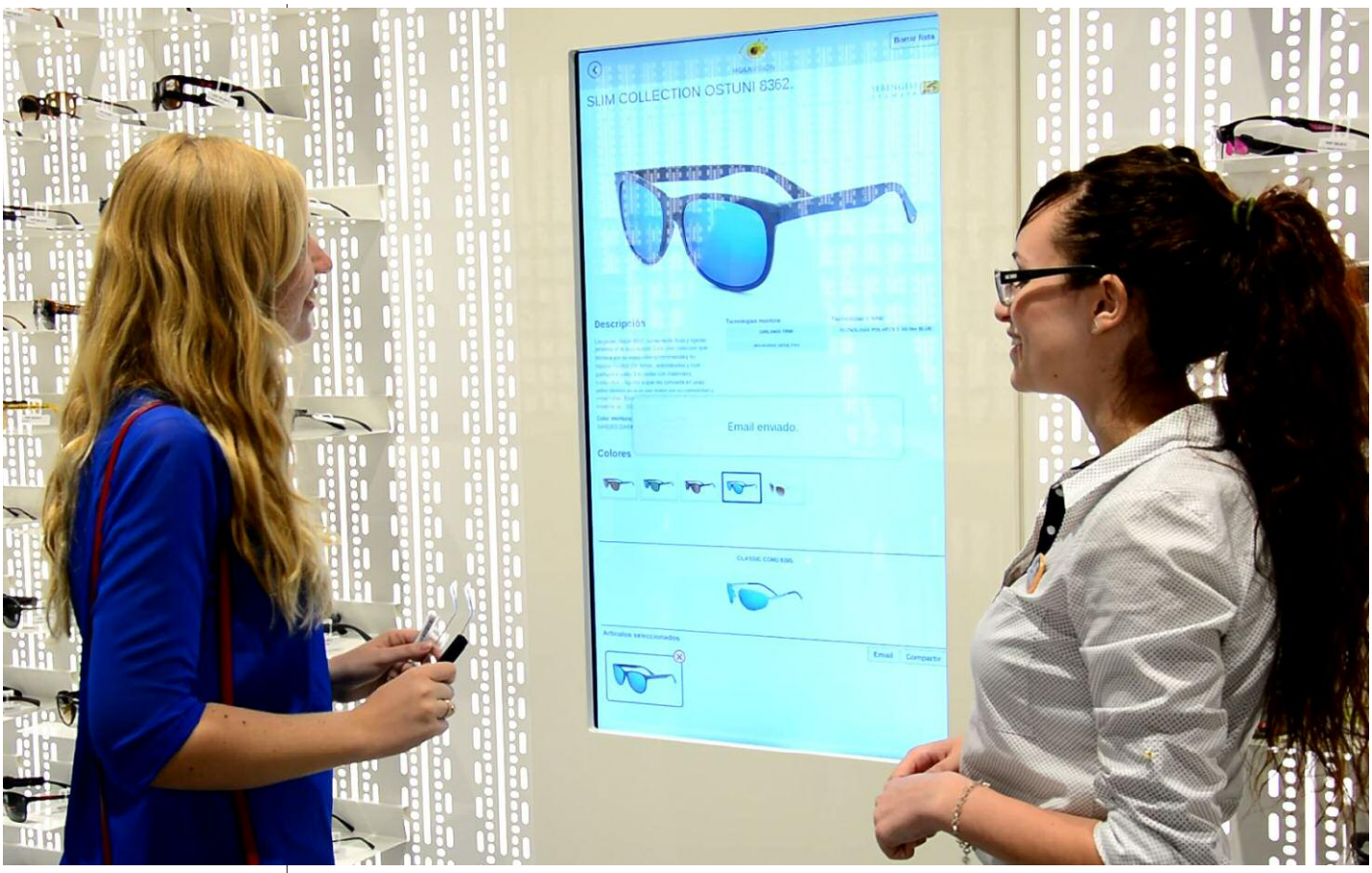
"We're helping to reduce the labor cost to inspect foods," he notes. "You can get up to 100 percent accuracy reads in food distribution. We're reducing food stock management costs by about 50 percent and food waste by around 20 percent.

"The old compromise between speed and accuracy disappears," Stafford says. "Now retailers can get real-time information on inventory at a speed that was impossible in the past. We believe this will create a paradigm shift in the management of fast-moving consumer goods such as foods."

PRODUCT DEVELOPMENTS

A waterproof encapsulated version of the AD-237 inlay incorporated into a label is designed to withstand multiple washing cycles over many years when placed on returnable totes.

PHOTOS: AVERY DENNISON



PRODUCT DEVELOPMENTS

Making In-Store Shopping Fun Again

Keonn's interactive AdvanLook solution engages customers and provides the information they need to make a purchase.

A Holavisió customer can take a pair of sunglasses to a 42-inch AdvanLook touch screen to quickly get information about the lens and frame technology.

AS MORE CONSUMERS turn to online shopping, brick-and-mortar retailers have been trying to differentiate their stores from the competition and lure people back inside. One way is to use item-level RFID to improve inventory accuracy and ensure products are on the shelves when customers want to buy them. Another way is to make shopping easier and more fun, and Keonn Technologies' interactive AdvanLook solution is designed to do just that. "Typical stores sell products to customers," says Ramir De Porrata-Doria, Keonn's co-founder and CEO. "With AdvanLook, stores also sell an experience."

Holavisió, an eyewear store in Barcelona, is one of 10 retailers in the United States and Europe that has adopted the AdvanLook solution since it was introduced in 2014, De Porrata-Doria says. The solution includes an encoding station, which Holavisió uses to identify each pair of sunglasses with a passive ultrahigh-frequency EPC Gen 2 RFID tag.

When a customer is interested in a particular pair of sunglasses, he or she can take them over to a 42-inch AdvanLook touch screen. The wall-mounted screen has an integrated RFID reader and antennas to identify the tagged frames. A local AdvanCloud software agent sends the content request to the system's

PHOTO: KEONN TECHNOLOGIES

cloud-based software platform. Within fractions of a second, the screen displays information about the lens and frame technology, as well as available colors and sizes.

The software agent also manages touchscreen requests. For instance, once the product information appears, a store associate uses the touch screen "to show the customer the different colors available for that specific model and the different frame and lens technologies," says Ricard Puig, Holavisió's general manager. "In eyewear retailing, each glasses manufacturer has very specific technologies for each type of lens and frame," he explains, noting that it's nearly impossible for store associates to remember such a myriad of details, so in the past they'd inadvertently give customers incorrect or imprecise information. "With AdvanLook we have all this information inside the system, immediately available, and it makes everything much easier."

Now, Puig says, store associates can quickly explain to customers all the specifics about the technologies used in the glasses they're interested in. "Furthermore," he says, "we can show the customer the availability of different colors and sizes of the chosen model in an instant, without having to look through a catalog." If customers aren't ready to make a decision, he adds, the store associate can e-mail the information to them.

Holavisió also uses AdvanPay, an RFID reader, at the point of sale to speed payments. AdvanPay can detach hard tags and transmit data to the AdvanCloud software platform.

Since deploying the system in June 2016, Holavisió has seen sales increase by 25 percent, Puig says. "Customers remember our store because of AdvanLook," he says. "It is our main differentiator."

The implementation took only a matter of days, Puig says, because the retailer's website contained all the information and content, including product images and descriptions, that had to be fed into AdvanLook. "The only challenge was to work in the composition of a spreadsheet," he adds, to upload the data to the AdvanCloud platform.

In September, Holavisió is scheduled to begin using AdvanScan, a handheld reader for managing product inventories, in one store. The retailer intends to deploy AdvanLook in all its stores, Puig says.

In addition to eyewear, AdvanLook supports a variety of retail products, including apparel, cosmetics, footwear, jewelry and sporting goods, De Porrata-Doria says. Spanish footwear company Munich Sports, for example, has been using the solution at a children's store in La Roca Village, near Barcelona. The technology has been popular with customers, says Xavier Berneda, Munich Sports' general manager. The system has increased the speed of the shopping process, he reports, while also making workers more productive and boosting the store's image for innovation.

The solution's wall-mounted touch screen comes in a variety of sizes, from 10 inches to 46 inches, and the interactive AdvanLook display is available as a horizontal tray or a fitting-room mirror. The user interface, based on HTML5 templates, can be customized to a retailer's needs, De Porrata-Doria says. Apparel retailers, for example, can use AdvanLook to recommend complementary items that create a particular look.

AdvanLook can perform other functions, including displaying user ratings and reviews, and enabling customers to share items on social media. If a desired item isn't available in a store, a touch screen can display a map with

PRODUCT DEVELOPMENTS

Holavisió uses AdvanPay, an RFID reader, at the point of sale to speed payments. AdvanPay can also detach hard tags and transmit data to the AdvanCloud software platform.

PHOTO: KEONN TECHNOLOGIES

nearby stores that have the item in stock. Retailers can also use AdvanLook to let customers pay for products through PayPal on their smartphones, to avoid checkout lines.

AdvanLook reads all kinds of UHF Gen 2 RFID tags, including wet inlays, paper labels and hard tags, De Porrata-Doria says. Depending on the tag's sensitivity, the reader's power and sensitivity might have to be adjusted, he adds.

Data generated by an AdvanLook touch screen can be compared with data from the point of sale, so retailers can analyze customer behavior. They can know, for example, which products customers examined and which they bought. Retailers can also learn which product colors are most popular, the time of day and days of the week when purchases of specific products are made, and which items are shared on social media.

"Some retailers prefer to start using RFID for inventory management or for loss prevention, and later they adopt AdvanLook for enhancing the customer shopping experience and increasing sales," De Porrata-Doria says. "But some retailers that put a lot of importance in the customer experience start using RFID with AdvanLook [and] later they adopt RFID for inventory and other purposes. The decision depends on what is the main priority for the retailer: inventory accuracy or customer experience."

Preventing Eavesdropping and Tag Cloning

NXP's Ucode DNA chip provides cryptographic authentication of vehicles at long read ranges.

The Ucode DNA chip (pictured at right) does not transmit crypto keys over the RF waves—they're used only within the chip.

PHOTO: NXP

THERE ARE MANY GOOD REASONS to identify vehicles with RFID tags: The tags can be used to authenticate license plates, enable electronic toll collection, automate parking access, enforce traffic laws and search for stolen vehicles.

There's also one good reason not to: security concerns.

Typically, applications that require security, such as verifying banking cards, passports or transportation tickets, use passive high-frequency RFID tags, which have a short read distance, making it unlikely that someone could eavesdrop on or clone a tag. But the ability to identify HF tags only when they're placed directly in front of a reader made them impractical for vehicle identification.

Last year, global semiconductor company NXP introduced the Ucode DNA integrated circuit, a passive EPC Gen 2 ultrahigh-frequency RFID chip designed to prevent both eavesdropping and tag cloning. It provides cryptographic authentication at long read ranges (10 meters/30 feet or more), says Mahdi Mekic, NXP's marketing director for smart mobility solutions. The chip, which can be read via most standard UHF readers, transmits an encrypted message that changes with each read event and requires decryption of each message by utilizing a cryptographic key that is securely stored either in the reader device or on a back-end server. This prevents a tag from being read without authorization.

A tag that combines long-range contactless performance with cryptographic security for tag authentication was just what the Tönnjes Group, a global supplier of security license plates and vehicle registration and identification systems, required, says a spokesperson for

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the German company, which began using Ucode DNA in May 2015. "In order to prevent theft and misuse of license plates, we have to enable a reliable and tamperproof identification process," the company rep says.

Tönnjes uses the Ucode DNA chip in its license plate (IDePLATE) and windshield label (IDeSTIX) vehicle identification systems. The chips are integrated into both during the production process, and contain a unique and unchangeable identification number. "Using the Ucode DNA, this number can be transmitted encrypted," the spokesperson says. "Authorized reading devices enable a reliable identification and secure verification."

Tönnjes Group uses the Ucode DNA chip in its license plate (IDePLATE) and windshield label (IDeSTIX) vehicle identification systems.

The license plate technology becomes increasingly important as the number of applications using the plates rises, the spokesperson says. In addition to the original function of identifying cars for registration purposes, the license plates can now be used for a variety of applications, including traffic management, parking and access control.

The Ucode DNA chip "opens up new opportunities regarding applications based on our products," the spokesperson says. "We no longer have to choose between contactless performance and the need for secure verification. Additionally, it enables a privacy protection in full compliance with European Union regulations on data privacy."

"Many companies talk about secure RAIN UHF solutions and what they mean is a variety of low- to medium-level protection mechanisms such as passwords, proprietary protocols and encrypted user memory," Mekic says. What all these protection schemes have in common, he explains, is that they're based on static memory content that is sent over RF waves between tag and reader.

"As such, these systems are susceptible to cloning and emulating," Mekic says. "With cryptographic authentication, which is the key capability of Ucode DNA, security is based on a high-level cryptographic scheme that uses crypto keys." These keys are never transmitted over the RF waves—they're used only within the chip for cryptographic calculations.

Government and business customers in North America, Europe, Southeast Asia, Africa and South America are using the chip for automatic vehicle identification and other applications, Mekic says. The chip can be integrated into cards or wearables to provide the convenience of hands-free access control while maintaining a high level of security, which is important in restricted areas of hospitals or factories. People with disabilities can use an RFID card to access public transportation. The Ucode DNA chip is also being used for secure asset tracking in the automotive, health-care, and oil and gas industries.

PHOTOS: NXP

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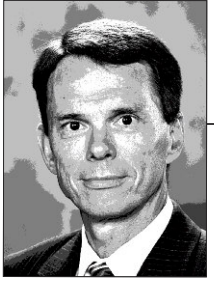


Awareness→Acceptance→Accelerated Adoption

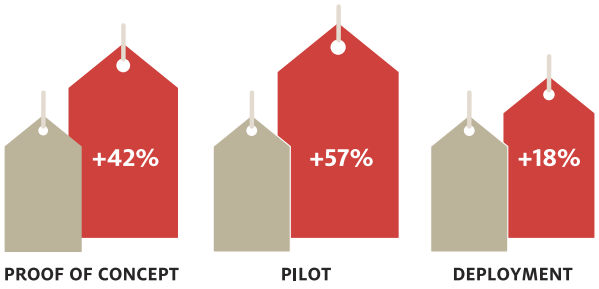
The RFID Lab's 2016 study shows that more U.S. retailers are using RFID to enable omnichannel shopping.

Last year, when the RFID Lab examined the state of RFID adoption in the U.S. retail sector, we saw a healthy rise in the adoption rate—from large department store chains to smaller specialty shops, though almost exclusively in the apparel sector. I attributed this to the growing awareness among retailers that RFID is necessary for omnichannel retailing, a service retailers must provide to remain competitive (see Try It—You'll Like It!).

I also predicted the following year's growth would exceed that of the current year. I am happy to report that the RFID Lab's 2016 study supports my prediction. Overall, the RFID adoption rate among U.S. retailers increased a whopping 32 percent from 2015 to 2016 (up from a 23 percent increase the previous year). I believe the accelerating adoption rate continues to be driven by the demand for retailers to offer omnichannel services. Store executives now understand that inventory accuracy is a requirement for omnichannel retailing, and they simply cannot efficiently achieve a high level of inventory accuracy without RFID.

As in past years, the RFID Lab's analysis is based on publicly available information and the lab's work with various retailers. While it's not a scientific study, it does provide a reliable snapshot of both new and existing adopters. For the study, we consider whether a retailer is conducting a proof of concept (PoC) to demonstrate RFID's effectiveness in its environment, a pilot to determine if the RFID application and the resulting benefit can scale, or a deployment, tagging additional categories in more stores.

Growth in RFID Adoption by U.S. Retailers, 2015-2016



The 2016 study reveals a pattern of movement expected in a healthy adoption environment. Many are new entrants—the study shows 42 percent growth in retailers conducting PoCs. And many of the retailers that conducted PoCs last year moved to pilots this year (57 percent growth).

The study revealed a relatively small percentage increase in phased deployment (18 percent). This was most likely due to extension of existing pilots or internal considerations regarding when to expand the use of RFID (these discussions often take months, and retailers tend to delay rollouts to coincide with the beginning of a new budget year). While we did see a doubling (100 percent increase) of those at full deployment, it represents just a small number of retailers and should be interpreted accordingly.

While the apparel sector continues to drive adoption, during the past year more retailers began RFID-tagging consumer electronics, sporting goods and other product categories. I expect this will be a growing trend. I also feel confident predicting that the number of new adopters will continue to increase in the coming year—and the move up the adoption curve will continue its current pattern. Given the number of retailers conducting PoCs and pilots, I will be particularly interested in following their progress into the pilot and deployment stages, respectively—and seeing what the lab's 2017 study shows.

Bill Hardgrave is dean of Auburn University's Harbert College of Business and founder of the RFID Lab. He will address other RFID adoption and business case issues in this column. Send your questions to hardgrave@auburn.edu. Follow him on twitter at @bhardgrave.

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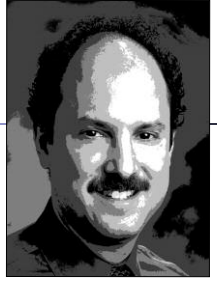

The Rules of Encoding

Here's how to ensure RFID tags and bar codes coexist happily.

Some applications identify an asset, product or other item with both an RFID tag and a bar code. For this to work, the same unique identifier must be encoded to both the tag and the bar code. But there are different rules for encoding data to tags and bar codes. Here's what you need to know to program your software to encode the same data to tags and bar codes.

Let's consider the common case of a product that carries a Global Trade Item Number (GTIN) and a unique serial number. The GTIN is a 14-digit number that looks like this: 00614141123452, and the serial number is a few digits, such as 5678.

A bar code holds a single string of characters. To encode a GTIN and a serial number, there has to be a way to separate the GTIN from the serial number—and to distinguish both from other data a bar code might contain. The industry-standard GS1 General Specifications explains it: The GTIN is preceded by the digits "01," indicating that the next 14 characters are a GTIN, and the serial number is preceded by "21." The GTIN-serial combination is preceded by the Function Code One (FNC1) symbol, which means the remainder of the bar code is encoded according to GS1 standards. Putting that all together, the contents of the bar code become <FNC1>0100614141123452215678.

An RFID tag does not hold any characters. Instead, it contains 96 bits of binary data. A common mistake is to program the bar-code data into the RFID tag, character by character, but that is not what applications reading an RFID tag expect to see. The correct way to program a tag is to use the binary-oriented GS1 EPC Tag Data Standard. Generally, this requires specialized software that knows the encoding rules or writing your own software following the rules in the Tag Data Standard. (My online tool lets you try out the encoding interactively.)

In our example, the GTIN and serial number would be encoded into the following 96 bits: 3034257BF40C0E400000162E (the hexadecimal representation of binary data in which each character corresponds to four binary bits). Keep in mind that, just as you can't program bar-code characters into the RFID tag, you can't put a hexadecimal string into a bar code (another common mistake).

If you're printing RFID labels that include a bar code, look for label-writing software that has built-in support for both the RFID and bar-code standards. In other instances, you will need to encode the tag and bar code separately.

A business application should work with the GTIN and serial number regardless of whether a bar code or RFID tag was read. But first, the bar-code string and the RFID binary data must be decoded. For more information about how to use RFID and bar codes for the same application, see the GS1 Bar Code/RFID Interoperability Guideline.

Ken Traub is the founder of Ken Traub Consulting, a Mass.-based firm providing services to companies that rely on advanced software technology to run their businesses.

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