Bar Coding and RFID: The Key to Traceability and Safety in the Foodservice Supply Chain

A ZEBRA **BLACK&WHITE** PAPER

Zebra

Executive Summary

An early Efficient Foodservice Response study identified $847 million in savings available to the foodservice supply chain through more extensive use of bar coding. Since then, improved product identification and traceability became a requirement because of the U.S. Bioterrorism Act, European Union Food Law and HACCP. Today, technologies, techniques and standards have been developed to help organizations throughout the food supply chain gain traceability for compliance and business improvement.

This white paper examines how the foodservice industry can take advantage of bar code and radio frequency identification (RFID) technologies to improve safety and security, reduce operating expenses, meet compliance requirements and improve efficiency. It covers:

- How bar code and RFID support compliance with regulations such as the Bioterrorism Act and EU Food Law;
- Traditional uses and advantages of bar code data collection;
- Emerging technologies and standards, including Reduced Space Symbology® (RSS) bar codes, Electronic Product Code™ (EPC) RFID technology, and the GS1 Global Traceability Standard.

Introduction

Automatic identification and data collection used to provide the required documentation can also improve business responsiveness and efficiency. For example, a Zebra customer in the baking industry reduced its inventory and distribution costs by $3 million in the first year after an automated pallet labeling and identification system was installed. The company, which operates six warehouses throughout the U.S. and previously was not able to measure and balance inventory throughout its operations, began printing and applying bar code labels to all its cases and pallets and then scanning the bar codes to capture quantity, location and product identification numbers, including lot codes.

The system enabled the company to gain an accurate, timely view of inventory and to increase the average number of pallets per shipment from 47 to 61, a 30 percent improvement. By increasing load yields, the company significantly reduced the need for expensive less-than-truckload (LTL) shipments to customers to fulfill orders, which contributed greatly to its cost savings.

Shortly after the system was implemented the company had to recall some products because it had received a bad batch of ingredients from one of its suppliers. Using the lot number information captured from bar code scanning, the company traced its shipments and conducted a highly targeted recall by contacting only those customers who had received the affected products. The recall was completed quickly, with minimized cost, and without having to pull unaffected products from store shelves.

The system described above is fairly typical and relies on standard, commonly used linear bar code formats for cases and pallets. Increased traceability and other applications are possible using more advanced, standardized identification technologies such as RSS bar codes and RFID. RSS was created for produce, loose items and other products that are difficult to identify. There are high–data-capacity versions of RSS that can be used to encode lot codes or other variable information.

The EPC RFID system creates a unique serial number for each item (in contrast to a U.P.C./EAN number that identifies the product type and manufacturer), which is very helpful for traceability applications. EPC can be implemented on rewritable RFID tags that have extra memory sufficient for lot codes and other information. RFID tags can be updated with time stamps and transaction records to create electronic pedigrees. EPC use is spreading in the pharmaceutical industry to improve traceability and security, and meet pedigree requirements. Tags can also be integrated with sensors to record temperatures and other data.

Improving Identification Helps Business

These technological capabilities provide efficient, accurate ways to comply with regulations such as the Bioterrorism Act and the EU Food Law, which require businesses to collect, process and store vast amounts of information. Automated data collection removes much of the time and expenses required for data processing, and builds a foundation for other efficient business processes. Data collection by bar code and RFID is exceptionally accurate (accuracy often tops 99 percent), which can help prevent errors in order picking and shipping that plague the foodservice industry. Product codes, lot numbers, invoice data, order numbers and other information can be recorded in less than a second with a bar code scan. Gathering this information manually is time consuming, because the information first must be recorded at the point of activity, then later transcribed and entered into the computer system. The redundant manual data recording procedures provide two opportunities to incorrectly record the information.

Errors occur in 36 percent of consumer packaged goods orders according to a study by the Grocery Manufacturers Association (GMA). Such errors lead to inventory inaccuracy and eventually to out-of-stocks, which are acknowledged as a multi-billion dollar problem. They also have more direct impact on operations and profitability for distributors, as the following example shows.

Consider the effect of a common shipping error in which an employee picks the wrong SKU to fulfill a customer order. The customer might discover the error while validating the shipment at receiving, and would engage the delivery driver to help resolve it. If the error was discovered later, it would result in a call to the supplier's sales or customer service department. In either case, the distributor incurs labor charges to research and correct the mistake.

Involving the driver at the time of delivery could create delays that would cause him to miss delivery windows with other customers, causing additional problems and possibly creating the need for an additional, rush shipment from the distribution center. The customer will hold up payment of the invoice until the error is resolved, slowing the cash cycle. These actions, which all trace back to a preventable warehouse picking error, can have a significant impact on productivity and profitability if they become an accepted part of doing business.

For example, a hypothetical company earning a 3 percent profit margin makes an average of only one shipping error per day (which is a very conservative estimate considering the GMA study found 36 percent of orders contain at least one error). If each error takes 20 minutes to resolve, the company spends 10 hours a month on error resolution. If the average labor cost for pre-sales and delivery personnel, customer service representatives and warehouse workers is $25 an hour (which does not include shipping expenses), the monthly labor cost for error resolution is $250. The per-error resolution cost is $8.33 (1/3 of an hour of labor worth $25/hour). At a 3 percent profit margin, the company must make $8,333 in new sales to offset the monthly cost of errors.

The table below shows a sampling of the revenue required to offset the errors based on different costs per error and different profit margins. Calculations were made based on one error per day and 30 days per month.

Figure 1: Monthly error costs and economic impact

		Revenue required to offset monthly error cost			
Daily error cost	**Monthly cost**	**1% margin**	**2% margin**	**3% margin**	**5% margin**
$5	$150	$15,000	$7,500	$5,000	$3,000
$10	$300	$30,000	$15,000	$10,000	$6,000
$15	$450	$45,000	$22,500	$15,000	$9,000
$20	$600	$60,000	$30,000	$20,000	$12,000
$25	$750	$75,000	$37,500	$25,000	$15,000

The table illustrates how common picking and shipping errors can have significant impact on profitability. It also underscores the value of using bar code and RFID technologies to accurately identify goods throughout the supply chain. High-profile business improvement initiatives like Global Data Synchronization (GDS), total supply chain visibility and electronic pedigrees all rely on accurate identification on the case and pallet level that RFID and bar code systems provide. The following sections describe common applications, their benefits, and how they relate to higher-level industry initiatives and regulations.

Standards and Tools for Traceability

By using automated data collection, systems and processes created to meet traceability requirements can also improve efficiency and reduce costs. The Bioterrorism Act and EU Food Law require traceability one step forward and one step back through the supply chain, which requires timely, accurate information exchange between trading partners. The Global Data Synchronization system provides a standardized framework for all supply chain parties to consistently identify products and communicate data. In 2005, only 303 company locations and 314,000 items were registered for GDS, but more than 9,800 locations and 588,000 items were registered in 2006.

GDS makes use of the Global Trade Item Number (GTIN) identification standard from GS1 (formerly UCC/EAN), which is widely used throughout the world. GTIN numbers are usually encoded in U.P.C./EAN bar codes at the item level, or other GS1-standard bar code formats (e.g. SSCC-18, UCC-128, SGTIN) at the case and pallet levels. Other encoding options are gaining adoption to support the food industry's needs for increased traceability. GTIN is the basis for EPC numbers (the EPC standard system is also administered under the GS1 umbrella) for unique item identification by RFID tags. GTINs can also be encoded in RSS bar codes, with additional capacity to encode lot codes and data useful for more precise identification and traceability. GS1 has established a "Sunrise Date" of January 1, 2010 for bar code scanning systems to be capable of processing RSS symbols. The date is a foundation step to prepare for RSS to replace U.P.C./EAN as the primary bar code format used to identify consumer goods.

GS1 has also created the Global Traceability Standard, which establishes processes for identifying any type of item globally, in any or multiple supply chains. The Grocery Manufacturers Association (GMA) and Canadian

Produce Marketing Association are among the organizations that have expressed support for the standard. More information about the standard is available at www.gs1.org.

The following sections explain how to use bar code and RFID to gain visibility and accuracy in internal operations, and to gain data to support supply chain initiatives and industry regulations.

Receiving

For traditional receiving applications, a bar code label on incoming shipments can be scanned to record the item's arrival. If shipments are labeled with RFID smart labels, an RFID encoder at the receiving dock can be used to automatically apply a time and date stamp and the Global Location Number (part of the GS1 standard system) to document receiving for traceability. For traditional bar code systems, the scan at receipt can trigger a software application to automatically update records with the same data. Putaway locations and other data can also be included with the record for even more traceability.

The absence of bar codes or other identification on cases, and poor quality symbols on cases that are labeled, presents a major obstacle to efficient warehouse operations in the foodservice industry. Only about 64 percent to 83 percent of cases delivered to foodservice distribution centers are bar coded, according to EFR. Many of the cases are marked with low-quality bar code symbols printed directly on the corrugated packaging material, which are often unreadable. Printing bar codes on separate labels that are applied to the packaging dramatically increases read rates and improves overall system performance.

Given the tremendous value of bar code-based warehouse management operations, and the relative ineffectiveness of supplier bar coding efforts, foodservice distributors would be well served by installing bar code labeling equipment to mark incoming materials at the receiving area. Bar code label printers are rugged enough to be used anywhere within the warehouse and can connect to host systems through a variety of interfaces, including wireless communication for use in areas not wired for computing or networking. Bar code label printing systems are inexpensive to operate; have the flexibility to connect to any legacy computer, network and software system; and can significantly improve the performance and return on investment of warehouse management, inventory control and shipping systems. If distributors are required to provide RFID-tagged shipments to customers, encoding and applying RFID smart labels at receiving rather than when cartons are shipped can lead to internal tracking benefits.

Traditionally, bar code labels are scanned at receiving to record receipt and update inventory records. Manual bar code scanning can be replaced with unattended RFID read portals to reduce the time and labor required. EPCglobal calculated savings of between $0.01 and $0.03 per case when receiving is done with RFID instead of bar coding. Primary benefits are labor savings and improved accuracy resulting from fewer miscounted or unidentified products. The data came from a seven-month study of EPC-enabled receiving operations at an actual distribution center. The study also found that receiving errors were the root cause of 58 percent of all shipment shortages and overages. These errors contributed to out-of-stocks, which was factored into the benefit calculation. A separate study by the GMA found that reducing out-of-stocks for direct store delivery items can improve sales by 2.9 percent. An analysis of early RFID adopters conducted by the University of Arkansas concluded RFID procedures reduce retail out-of-stocks by 14 percent.

Cross Docking

Cross docking does not work if materials can't be identified quickly and accurately, making bar code or RFID identification essential for the operation.

Mobile bar code label printers are especially valuable for cross docking. Shipping and receiving workers equipped with mobile computers, bar code scanners and label printers can receive inbound shipments, log them into the host warehouse or inventory control system with the mobile computer, then immediately generate a bar code shipping label with the required cross dock information using the mobile printer, which may be mounted to a forklift or worn on a belt or shoulder strap. Some mobile printers can also connect directly to wireless LANs to manage communication between the host system and the warehouse worker.

RFID can also facilitate efficient cross docking. Incoming pallets or cartons with smart labels can be automatically routed through conveyor systems to other dock doors because the fast-reading capabilities enable instant identification of the shipping container plus all of the individual items inside. For shipping, RFID readers can help packers quickly locate and aggregate all the items needed to complete the load.

Lot Control

Putting lot numbers and expiration dates in a bar code makes it easy to record the information accurately and automatically at any point in the supply chain. This capability improves data accuracy, while reducing the effort needed to record and transcribe the information. Production management, enterprise resource planning, environmental health and safety monitoring and other systems frequently provide or require lot-level traceability, which means the supply chain may be the only area where the information is not readily available. Lot-level supply chain traceability is extremely valuable for batch-oriented food recalls; for an example, see the "Recall Management" section later in this white paper.

Lot numbers may be encoded into bar codes or RFID tags and applied to pallet-, case-, inner pack- or item-level packaging. Expressing lot codes in a bar code or RFID tag in addition to human-readable text enables it to be scanned and processed by automated systems. Inventory management systems, for example, could use variable lot code or best-by information to reduce waste by ensuring first-in, first-out (FIFO) procedures are followed.

Encoding a lot number provides another level of identity that will help the industry meet traceability requirements. The globally standardized U.P.C./EAN bar codes used on products, and their associated case codes, are extremely limited in their ability to provide traceability information because they only identify the manufacturer, product type and packaging level, but do not uniquely identify each item. An additional identifier is needed, such as additional information encoded on the pallet label. Reduced Space Symbology and the EPC RFID system address this need. RSS originally was developed to allow variable data, such as lot codes or best-by dates, to be encoded on grocery items in addition to provide the information necessary for checkout operations, all within a compact bar code label. The EPC system creates a unique serial number for each item, making it possible to conveniently associate specific products with lot and other production information held in central databases. There are also database and information sharing components of the EPC system to support rapid data exchange among supply chain partners.

Warehouse Management

Improved warehouse management was rated the top advantage of using bar codes in an EFR survey of foodservice distributors. The advantages of bar code-based warehouse management systems are confirmed by the EFR research data, which found improved warehouse operations could provide more than $1 billion in savings to the

industry. Since the study, RFID has started to appear in distribution centers to assist shipping and receiving operations and further reduce labor requirements.

Bar coding and RFID are typically used with warehouse management system (WMS) software packages, which perform a variety of functions to improve labor productivity, documentation and efficiency. For example, a basic function of a WMS is to calculate the most efficient picking and putaway sequences, which will reduce required labor and handling. When supported with timely, accurate information, a WMS can manage inventory by expiration dates to reduce spoilage. Many WMS packages can also help generate required shipping labels, EDI transactions and other required documentation.

Shipping

A common bar code shipping application is to scan each case and pallet being loaded for transport to verify that all required items are included and to prevent items from being loaded onto the wrong truck. A wireless LAN connection communicates the bar code scans to the host computer, which compares the items being loaded to the actual customer order. Incorrect or missing items are immediately detected and shipping personnel are notified with a wireless message. Shipment accuracy often exceeds 99 percent when bar code data capture and real-time verification are used. Capturing outgoing shipment information automatically is an efficient way to build traceability records without requiring time-consuming manual data entry.

The foodservice industry could expand this application to enhance safety and traceability by automatically capturing lot codes and expiration dates from outgoing items. The lot and expiration information could be appended to the record of the customer order. In the event of a shipment discrepancy or recall, the distributor would have the documentation needed to trace specific lots to specific customers. The lot codes or other variable information about the cases in a shipment could all be encoded in a two-dimensional bar code applied to the pallet, which the logistics provider and receiving organization could read with a single scan to gather information about the entire contents of the pallet.

RFID provides similar functionality because every tagged case or package can be scanned simultaneously without requiring the pallet to be opened, a feature that is central to many of the cross docking and other logistics advantages RFID can provide. At the point of shipping, as for receiving aggregated loads, RFID provides the highly desirable function of automatically recording what's on a pallet (regardless of whether the goods are all of the same type or mixed), creating an electronic manifest of goods shipped or received. This is a unique and powerful core feature of modern RFID systems now being applied to retail supply chain operations.

Recall Management

Food recalls are a near daily occurrence and distributors need to have plans and processes in place to execute them quickly and efficiently. The degree of traceability suppliers and distributors have over their products is what determines the size, scope and expense of a recall.

The amount of information included on unit-of-use packaging can make the difference between a general, mass recall with notices going out in newspapers and TV news, and a highly targeted, limited recall where customers may receive notification by a phone call from their supplier. By including lot codes with shipping labels and other product identification, and marrying them with customer order and shipping records, businesses could communicate a recall like this: "We are recalling 8-ounce packages of Ourbrandpasta, lot number 0123456789, made on March 19, 2003, between 8 a.m. and 1 p.m. on production line 2 at our Anytown, N.J., facility. These products were shipped to Fictional Foodservice Distributor warehouses in Memphis, Tenn., and Columbus, Ohio. No other products are affected." The distributor could then execute its part of the rollout in a similar

fashion by tracing the affected products to specific customer locations. Using RFID and EPC item-level traceability provides a similar level of control.

Production control systems and auditing procedures enable manufacturers to isolate quality or compliance problems at the lot level. By making lot-level traceability available throughout the supply chain with a bar code scan, specific quantities and shipments can be recalled. This degree of traceability limits the logistics handling costs and administrative burden, so recalls can be resolved more quickly. The audit trail would also limit liability exposure and prevent lawsuits from unaffected individuals. When returned products are received, lot codes can be checked efficiently with a bar code scan, so unaffected products can be redistributed quickly.

Returns Management

Variable information unit-of-use printing could have similar effects on returns management, although the benefits should be greater and more immediate because returns are part of every producer's and distributor's everyday business. Returns may be subject to numerous local and national regulations regarding safe handling and transport, documentation and traceability. One of the best ways to collect the information and create the audit trail required to satisfy these regulations is to scan items with bar code readers, which can easily be programmed to attach a date-and-time record to every transaction. Scanning all movements and transfers and applying an automatic time-and-date stamp creates traceability and produces tremendous time and labor savings for data recording.

By setting shipping or database systems to record shipments to customers by specific lot number, manufacturers and distributors can verify that they are receiving authorized returns by quickly scanning an item label. This practice could also help detect unauthorized or counterfeit products. Scanning expiration dates will enable companies to determine if products are eligible for return and if returned products can be redistributed or require disposal or special handling.

Container Management

Using automatic identification systems to track pallets, milk cartons, trays and other returnable containers can provide a strong return on investment by lowering operating expenses. Many producers and distributors do not have accurate information about the quantity and location of their shipping containers because the assets often dwell at customer facilities and aren't returned promptly. As a result, businesses purchase more returnable containers to ensure they have an adequate supply, creating excess capacity and locking capital into fixed assets.

Identifying returnable containers and tracking them to customers provides the information businesses can use to improve returns and recoveries. The first step is to permanently identify each asset with a bar code label or RFID tag. Label material is available for permanent identification even when exposed to industrial cleaning, sterilization and cold storage conditions. The assets can be scanned as they are loaded onto trucks at the distribution center, or in the field upon delivery. The information could be recorded in a database field in the customer record or order management system, or in a separate database. Returned assets would be scanned to check them back into the distribution center, similar to a video rental return.

Managers could consult the system software to get a real-time view of container availability. Outstanding containers could be tracked by customer, with documentation provided to aid return and recovery. By actively monitoring and managing container usage, businesses can improve cycle times and inventory turns, and lower their fixed asset base.

The applications and benefits described above all rely on accurate product identification. Bar code and RFID provide accuracy, but only if the printers and label material provide the quality and durability needed for food storage and supply chain operations. The following sections present considerations for selecting bar code and RFID formats, printers and label materials for different marking needs.

Pallet Marking

The Serial Shipping Container Code (SSCC) is a GS1 standard for identifying pallets and cases. The SSCC is an 18-digit number expressed in an EAN.UCC-128 symbology bar code (it can also be encoded in an RFID smart label) that uniquely identifies the contents of the pallet or case. The SSCC number may be included in an EDI advance ship notice (ASN) to help the receiving organization automatically recognize the material when it arrives.

SSCC was developed to describe the contents of a pallet or case for a specific shipment and is not typically used for permanent identification of the physical pallet. Pallets and other returnable containers should be marked with a separate unique identifier for asset management applications. Companies are free to develop their own serial numbering system to identify each asset or may use the GS1 Global Returnable Asset Identifier (GRAI) standard. The standard provides a numbering system that identifies the asset and its owner, describes the asset type (keg, pallet, etc.) and allows users to add their own unique serial number. The information can be expressed in a bar code and/or RFID tag.

Case Marking

Cartons within a case or pallet should receive their own bar code labels to facilitate automated warehouse, shipping and receiving applications. The SSCC data structure and EAN.UCC-128 bar code symbology are suitable for case marking. Regardless of the numbering system or bar code symbology selected, cases should always be marked with a label to ensure readability.

Many case codes are produced by inkjet printing directly onto the packaging material, which often fails to produce the quality needed for the bar code to scan. An EFR study of 1,896 different suppliers found that 18 percent of all case codes were unreadable. The problem with inkjet printing is that it does not provide enough control over how the ink is absorbed by the packaging material. The printed image spreads as the ink soaks in to the cardboard, which often produces bars and spaces that are out of tolerance for successful bar code reading.

Thermal label printers are built specifically to meet the precise print tolerances that bar codes require. As with pallet marking, automated print-and-apply systems have the speed, bar code support, print quality and variable data processing capabilities required for successful case coding. Advanced thermal printers also have connectivity and other features that improve productivity and labeling accuracy.

A yogurt producer implemented an automated print-and-apply system to maintain high throughput and reduce packaging changeover time on its five production lines. The company supplies thousands of retail outlets and does private labeling for multiple customers, which requires frequent changes to the label format applied to finished products. When customers began requesting GS1-standard case codes on packaging, the manufacturer installed Zebra® print engines with a wireless interface and automated applicators to satisfy its marking requirements.

When the line needs to change to begin labeling for a different customer, an operator finds the customer name on a menu sheet and scans the corresponding bar code. The scan triggers a database lookup on the host computer, which retrieves the appropriate label format. The host computer communicates the new label format to the Zebra print engine over a wireless LAN connection. The print engine receives the wireless transmission and automatically begins producing the new labels. The first label is printed within 1.5 seconds of the operator scanning the customer code, resulting in extremely fast changeovers and high productivity.

Environmental Considerations

The physical label should not be overlooked when planning applications, data content and bar code formats. The temperature extremes and temperature changes that are common in foodservice operations pose several challenges to label performance. Ensuring that labels will remain affixed and the bar codes will remain readable requires planning for all the conditions the labels will be exposed to throughout the supply chain, including the environments they will face after they leave your own facility.

Moisture and temperature extremes can cause adhesive to fail, and moisture can also damage the surface of an unprotected label and make the bar code unreadable. Because cold and moisture are commonplace in refrigerated and frozen food warehouses, specialty label material is often required. The Zebra Trans Matte 3000 is freezer-grade label material that withstands exposure to temperatures as low as -65º F and has a coated face stock to permanently protect the bar code image. Other synthetic and paper materials are available that withstand heat, moisture, blood, cleaning materials and other potential hazards.

Conclusion

Tighter traceability does not have to burden business. Companies in the foodservice industry can take advantage of proven traceability tools and techniques to tighten their own operations by driving out excess inventory, storage and handling costs. All of the benefits described in this paper result from improved identification, which is accomplished most efficiently through the use of bar code, RFID and related systems.

Many foodservice companies rely on printers, label materials and connectivity solutions from Zebra to help meet their identification and labeling needs. Zebra has a complete range of thermal bar code and RFID printers, including high-speed, industrial, mobile and RFID models for all types of warehouse management, distribution and DSD operations.

Zebra Technologies Corporation (NASDAQ: ZBRA) delivers innovative and reliable on-demand printing s olutions for business improvement and security applications in 100 countries around the world. More than 90 percent of Fortune 500 companies use Zebra-brand printers. A broad range of applications benefit from Zebra-brand thermal bar code, “smart” label, receipt, and card printers, resulting in enhanced security, increased productivity, improved quality, lower costs, and better customer service. The company has sold more than 5 million printers, including RFID printer/encoders and wireless mobile solutions, as well as ZebraDesigner™ label formatting software, ZebraLink™ connectivity solutions, Genuine Zebra supplies and ZebraCare™ services and support. Information about Zebra bar code, card and RFID products can be found at www.zebra.com.

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