

Bar Codes in the Manufacturing Process



A ZEBRA BLACK&WHITE PAPER





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Manufacturers depend on a well-coordinated chain of events to make their operations work effectively. Today's business software packages, such as enterprise resource planning (ERP), materials management, production control and supply chain execution applications depend on real-time data collection systems to provide information crucial to the entire manufacturing operation. As more companies turn to enterprise-wide software for process improvement and cost reduction, there is a significant opportunity to enhance these systems by adding bar coding and radio frequency identification (RFID) applications throughout manufacturing facilities.

This document takes you further into a production facility and provides an overview of the many, growing applications for bar coding and RFID in manufacturing.

Compliance Labeling

Ever since the Wrigley Company put a Universal Product Code (UPC) label on a pack of gum, bar codes have been a key component of the industry. Manufacturers' shipping labels are often designed to meet the needs of their customers. Many organizations in all business sectors, including Wal-Mart, General Motors, Boeing, the U.S. Department of Defense and various regulatory and safety bodies require compliance labels on all incoming packaging. Many compliance programs have evolved beyond traditional bar coding and require two-dimensional (2D) bar code symbols or RFID tags. Other compliance programs require permanent identification for parts, components and finished products for traceability and product genealogy applications. These programs are most prevalent in the aerospace, automotive, defense and electronics industries, but the principles are widely used.



Compliance labels and tags can also be useful within a manufacturer's own facility for timely and accurate data collection. Bar code and RFID labels provide serial numbers and other important product information that various production, inventory and shipping systems can use to run effectively. Bar code and RFID readers and data collection terminals quickly, accurately and automatically capture this information and communicate with a computer host that processes the data.

Two Types of Manufacturing

There are two basic types of manufacturing: discrete and process. Discrete manufacturing (e.g., automobile manufacturing) relies on a bill of materials (BOM) to identify the large number of specific parts or subassemblies and their quantities. Process manufacturing (e.g., chemical processing) is formula-based. It relies on weights and measures (pounds or gallons) of raw ingredients. In both cases, bar coding and RFID are used to identify component parts or containers of ingredients, work-in-process, finished goods inventory and products packaged for shipping.

What follows is a step-by-step journey through a typical manufacturing facility. At each step, we'll explain how and why bar coding or RFID is used.



Step 1: Receiving

Raw materials or sub-assemblies arriving at a manufacturer's receiving dock have ID labels on their packaging to meet the company's requirements for materials management. Otherwise, the receiving department logs in the item and typically generates a 4-by-6-inch or smaller bar code label to identify the material before it is moved to an inventory location or inspection station. These labels are produced with either an industrial thermal printer at the receiving area, or perhaps a mobile printer mounted on a lift truck or worn on a shoulder strap. Remote printing at receiving and other areas throughout the facility helps productivity by saving workers from having to travel to central locations to pick up labels. Decentralized printers can be linked to manufacturing systems and other enterprise applications through a variety of networking techniques, including secure IEEE 802.11-standard wireless communication.



Step 2: Raw Material Inventory

A warehouse operator transfers the material to an inventory location. These sites often are identified with bar code location codes printed on reflective labels. The reflective material (such as Zebra's 8000T RetroScan labels) allows readability from scanners up to 30 feet away. Bar codes and RFID provide accuracy because the operator scans both the package and the new storage location to complete the transfer operation and automatically record it in the system.



Step 3: Picking

A work order from the factory floor signals the picking operation to retrieve raw materials or parts from inventory. The workers using fork trucks, carts or just walking the aisles are directed to the exact inventory location where the material is located and told how many of each part to pick. Bar codes are scanned again to complete the transfer operation. Reusable totes and containers used for picking and material handling operations can be identified with permanent bar code or RFID labels for automatic tracking. In some cases, inventory labels may need to be updated or corrected in the warehouse to replace damaged labels or to identify a change in quantity. Secure, wireless mobile printers mounted to lift trucks simplify this operation. Pickers who don't work from vehicles often use mobile or cart-mounted printers to produce labels on demand. RFID tags are read/write, so tag data can be updated without generating a new label. This feature is sometimes used to encode reusable totes with a tracking number that associates the tote with the specific order it is being used to fill.



Step 4: Work-in-Process (WIP)

The picked materials are checked to confirm the right parts and quantities were picked. Labels on each item are scanned for confirmation. As the parts are used in assembly, bar code or RFID labels enable part tracking throughout the process—showing that it was consumed in an assembly, or was set aside due to a defect or other issue. As parts become assemblies, additional bar code labels can be added to identify and track the assembly by its new part number, or the RFID label can be updated.

Bar codes and RFID labels produced on durable and specialized media enable materials to be automatically identified and tracked in challenging production environments. Thermal printers support media that withstands heat treatment and other temperature extremes, exposure to chemicals, cleaners and solvents, UV light, abrasion, humidity and condensation, and can meet stringent clean room and electrostatic discharge (ESD) requirements. RFID is commonly used in environments where optical identification of bar codes is impossible because of low light, no visibility, or other conditions.

In some process manufacturing, bar code and RFID labels are used to identify transitions between lots or batches. For example, in paper, film, or coatings manufacturing, splices can be required between batches used to complete a master roll of material. The splice point is identified with a bar code label that identifies the time and batch number of the new material.



Step 5: Product Identification

Thermal-transfer printing is widely used to print nameplate identification labels on-demand with serial number information and/or UL/CSA regulatory content. Synthetic label materials ensure the durability of the image and the label's longevity. Most products and components that require a UID two-dimensional bar code to comply with U.S. Department of Defense lifetime identification requirements can be successfully labeled using thermal-transfer printers and media. Thermal-transfer printing also meets many lifetime marking requirements in the aerospace, automotive, electronics and other industries.

For electrical products, labels with UL/CSA logos or content are unique because only specific label supplies tested by UL or CSA are approved. Zebra offers hundreds of tested, UL/CSA-approved label and ribbon combinations for this purpose. Pre-approved label and ribbon combinations from Zebra can save manufacturers extensive paperwork and product delays when they need a new type of label or one for a new application. Contact a Zebra supplies specialist when regulatory requirements exist for a label application.



Step 6: Finished Goods

At the completion of the packaged assembly in discrete manufacturing, or the packaging of the product in process manufacturing, bar codes are used to identify the package contents. If no sales order for this product exists, the fork truck operator collects the package and takes it to a finished goods warehouse location for inventory. Bar codes on the product and at the warehouse location are scanned to complete the transfer operation.

A customer's sales order signals the picking operation to retrieve the product from finished goods inventory. Thanks to the information retrieved from the label, the operator knows the precise inventory location and picks the inventory for shipping. Bar codes or RFID tags are read to confirm the correct item was picked and to record the transfer to the shipping department.



Step 7: Shipping

The bar code on the package is scanned in the shipping department to acknowledge receipt. New labels are printed with shipping information. These labels are typically 4-by-six-inch paper labels with customer- or carrier-specific compliance formats. Compliance formats may include 2D symbologies such as PDF417 found in the GM 1724 label standard series, or Maxicode symbology for UPS shipping labels. RFID compliance labels still have a bar code component.

If multiple labeled packages are combined on a pallet and shrink-wrapped, a larger, master label is often required for the pallet. Paper labels are commonly used for these applications, but synthetic master labels (such as Zebra's PolyPro 4000T) should be specified if the shrink-wrapping is recyclable. Other regulatory or environmental requirements may impact the label format, content or label materials.

The U.S. Department of Transportation (DOT) and National Fire Protection Association (NFPA) are among the organizations with mandatory regulations for labeling of chemical packaging and containers used in transportation. Although many of these labels contain static information, on-demand, thermal-transfer printing onto preprinted label materials can provide a substantial cost savings by reducing the storage of expensive label inventory and waste that occurs when adhesive backings degrade.



Labeling Relates to Manufacturing Trends

E-Commerce

The impact of e-commerce has reached far beyond consumers purchasing books and compact discs online. Business-to-business online purchasing now accounts for the bulk of e-commerce transactions, and it is steadily increasing. Today, instead of a small number of large, infrequent product shipments to a distributor, manufacturers often are asked to drop-ship individual packages directly to the end-users. As a result, the number of shipments (and shipping labels) required is dramatically higher, and so is the effectiveness of on-demand printing compared to batch.

JIT Operations

To reduce inventory levels and overall inventory carrying costs, resellers are pushing much of their earlier stocking levels of inventory back to the manufacturer and demanding faster response to their orders. Manufacturers are responding similarly with their parts suppliers. To avoid stock-outs or production downtime, manufacturers and other supply chain participants are investing heavily in methods that deliver inventory just in time (JIT) — the precise quantity of the specific product required, at precisely the time it is needed. With increased customization and make-to-order (MTO) requirements, many manufacturers also need to provide components just-in-sequence to support their customers' manufacturing processes. As a result, JIT systems rely on bar code and RFID reading and printing to track products accurately and in real time.

This improvement in tracking lowers economic order quantity (EOQ) requirements by notifying part suppliers earlier about inventory replenishment requirements (EOQ levels alert purchasing to reorder parts). The result is lower inventory carrying costs, higher inventory turnover rates, reduced misplaced inventory and more room to manufacture product cost-effectively.

ERP and WMS Systems

Major manufacturers have implemented or at least initiated an ERP, warehouse management systems (WMS), or related software applications to manage their enterprise. These systems allow JIT purchasing to work by tracking process components throughout the supply chain. By knowing what is required by when, and what is available from where, the ERP system optimizes the timing and efficiency of the purchasing, production, and fulfillment components of its business.

This system investment completely depends on the ability to track each component part, subassembly, and finished product from the raw material supplier to the end-user. Data collection for each transaction is critical in providing the ERP system with continuous status updates. Likewise, the necessary data collection steps are not possible unless identification is provided for each component part, subassembly, and finished product. Automated data collection is the keystone of the ERP system. The result: both the parts labeling volume and the number of locations that perform bar code printing within a manufacturing plant increase.

After the implementation of an ERP system it often takes between two and four years before companies have the budget available to implement label printing solutions. Only in a project's second phase will middleware vendors specify the data collection and label printing hardware for the selected ERP solution. Thermal printing solutions that can interface directly with SAP, Oracle and other enterprise software systems are often easier to integrate and maintain and more cost effective than systems that require middleware, print servers or custom programming. Companies should also consider bar code label printers that can be upgraded to support RFID tag encoding in the future if they currently are affected, or anticipate being affected by an RFID compliance mandate.



Wireless Communication and Network Administration

Wireless communication in manufacturing is growing rapidly because it allows real-time data collection in remote portions of the plant. With wireless technology, label printers can operate on location, eliminating the need for an employee to run back and forth between a centrally located printer and the point requiring a label. For example, mobile printers with wireless capabilities are mounted on forklifts to provide on-demand printing whenever and wherever a label is needed. The information is uploaded immediately to the ERP system instead of synchronizing at a shift change. This increases productivity and reduces errors.

The growing use of networked printers with enterprise systems, increases the importance of network administration. Managing the network by remotely configuring or monitoring printers, or updating label formats, is becoming increasingly valuable, especially as advancements in security evolve and network administrators look to update their networked devices. Printers that automatically communicate situations requiring attention, such as the completion of a roll of labels or an error condition, improve uptime and are critical to the efficient operation of the plant.

Global Supply Chains

With companies transacting business around the world, it's more important than ever to be able to identify parts, products and pallets of goods – plus their ports of call – in different languages on the same label. Organizations that need to print shipping labels in multiple languages have been faced with implementing costly custom output solutions, or to treat characters as graphics, which results in very slow label printing. Printer support for Unicode simplifies international character printing and eliminates many modification and support expenses. A Unicode-enabled printer can seamlessly output any language, with no need for an operator to select the language, font, codepage or otherwise configure or adjust the printer.

Thermal Printing Preferred for On-Demand Applications

Of all the methods available for printing bar codes, thermal technology is preferred for on-demand applications. Thermal, which includes direct thermal (ribbonless) and thermal transfer printing, consistently generates crisp, clear lines and spaces for the highest read rates with today's scanning technologies. Unlike laser or dot matrix printing, which wears over time, thermal labels are long-lasting, especially thermal-transfer printing on specialized media.

Thermal printing also is the best choice for immediate, on-demand printing. It is fast (up to 12 ips), inexpensive, and offers the greatest flexibility for placing bar codes on different kinds of labels, or on products and packages of different sizes and shapes.



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