



A Zebra Technologies White Paper

How Mobile Printing Benefits Warehouse Operations



Executive Summary

To maintain accuracy and efficiency in warehouses and distribution centers, bar coding and radio frequency identification (RFID) systems are indispensable. Businesses can enhance these benefits by using mobile printers to produce and attach bar code and RFID labels at the point of application. Supplementing stationary bar code and RFID printing operations with mobile printers can reduce operator errors, streamline operations associated with labeling in inconvenient locations, and eliminate costs associated with correcting errors.

Using mobile printers to eliminate the distance that workers travel to pick up labels can boost productivity, often providing a full return on investment (ROI) in less than a year when used in warehouse, distribution center, and other industrial environments. The ROI is especially strong for facilities with existing wireless LANs, because a relatively small incremental investment in mobile printers creates new ways to increase efficiency, reduce operator errors, and leverage the wireless infrastructure investment.

RFID is an automatic identification technology that relies on radio frequency (RF) waves to read encoded digital data. RFID is similar to bar code technology in concept. Unlike a bar code, RFID does not require a visible tag or label to read its stored data.

This white paper shows where it makes sense to supplement bar code and RFID labeling operations with wireless and/or mobile printers by:

- Identifying common operating procedures in warehouses and distribution centers that mobile/wireless printing can improve.
- Illustrating how businesses can prevent common operator labeling errors by printing at the point of activity.
- Providing real-world examples of how mobile printing systems have improved operations.
- Presenting formulas and guidance for creating an ROI calculation.
- Describing how mobile printers can be integrated with wireless LANs and batch operating systems.
- Presenting an overview of mobile printing technology and capabilities.

Switching to Mobile Printers Delivers Real Results

The case for using mobile printers becomes stronger with every step users must take to pick up labels. Zebra Technologies conducted a time-motion study of receiving operations, in which the warehouse worker only had to take nine steps to travel from the pallet with items for labeling to the workstation where labels were printed. Pallets were labeled in 42 percent less time (28.11 seconds compared to 49.74) when belt-worn mobile printers were used to eliminate the short walk to the central printing station. Based on the volume of materials processed at that particular distribution center, managers quickly determined that a mobile printing system could provide significant productivity gains and a rapid ROI.

The Zebra study used the following table as the worksheet for measuring and comparing the labor costs required for labeling with stationary and mobile printers. Businesses can add their own numbers to calculate the potential savings mobile printing could provide operations.

Mobile Printer Cost-Benefit Analysis

Example Data	Fixed Printers	Mobile Printers	Annual Savings
Number of shifts per week	10	10	
Number of hours per shift	8	8	
Number of weeks worked per year	48	48	
Number of hours worked per year	3840	3840	
Average number of items labeled per hour	15	15	
Average time spent getting labels (minutes)	2	0.5	
Number of hours getting labels per year	1920	480	1440
Average labor cost per hour (Euros)	12	12	
Cost of getting labels per year (Euros)	23040	5760	17280

Eliminating wasteful trips also eliminates a potential source of distractions that can lead to labeling errors. A worker's concentration shifts each time they leave their task. Walking through the aisles creates many opportunities for distractions with other work-related tasks or chatting with co-workers. Each delay increases the likelihood that the worker will pick up the wrong batch of labels from the printing station, or make a data entry error if the worker is printing the labels, resulting in the wrong—or incorrect—label being applied to the item.

The above example shows simple mistakes that managers may regard as “business as usual.” Scanning a bar code—which produces greater than 99.9 percent data accuracy—is a far superior method of entering data into a host system than key entry, or, worse yet, manual record keeping with pencils and forms. Driving inventory accuracy or warehousing efficiency to this level provides dramatic improvements over prior procedures.

However, there is still tremendous value in developing new procedures featuring mobile printers to improve accuracy rates even further. Today, most companies have inventory control systems that efficiently manage inventory. However, these systems can only be as accurate as the data entered into them. Inventory accuracy is critical to having the proper inventory at the right time. Increasing safety stock to make up for poor accuracy leads to lower inventory turns and negatively impacts return on assets (ROA). Mobile technology provide a mechanism for warehouse personnel to perform cycle counts while they are in the aisles, improving real-time inventory accuracy.

Other forms of accuracy problems, such as shipping the wrong item or quantity, or shipping cartons to the wrong customer, also create hidden expenses that undermine profitability. For example, the industry considers 2.5 percent as a typical error rate for warehousing operations, and various studies have determined that shipping errors cost a company between \$60 and \$250. The cost of errors varies by the expense of shipping replacement orders, warehouse labor, and handling expenses, sales and customer service time spent on error resolution, and other factors. At the standard error rate of 2.5 percent and an error cost of \$60, a company loses \$150 for every 100 orders processed. If errors cost \$250 to resolve, the error cost per 100 orders jumps to \$625.

Consider a company that ships 100 orders a day, has an error rate of 2.5 percent, and spends an average of \$100 to resolve each error. Errors cost the company \$250 per day. If the company has a five-day workweek

and operates 52 weeks a year, the errors cost \$65,000 annually. A one percent improvement in the error rate, from 2.5 percent to 1.5 percent, would save \$26,000 error-related expenses annually. If the company has a profit margin of 5 percent, it needs to bring in \$1.3 million in revenue just to offset the cost of errors if the error rate is 2.5 percent ($\$65,000 \text{ annual error cost} \div .05 \text{ profit} = \1.3 million).

The following section describes how mobile and wireless printers can support common warehouse processes to reduce these types of problems.

Common Mobile Printer Applications

Businesses can apply the time savings and labeling accuracy benefits that mobile printers provide to many common warehouse processes, including receiving, quality assurance, cross docking, putaway, picking, packaging, and shipping. Mobile or cart based printers can go wherever workers go. Work areas that require the farthest travel to get labels, or operations that could benefit from improved accuracy, are the best candidates to support with mobile printing. The sections that follow detail ways mobile printing technology can support typical warehouse operations.

Improve Receiving Dock Productivity

It is common practice for organizations to print batches of labels for incoming goods at a central IT office after receiving an advance ship notice (ASN) from a supplier. The labels are stored in the office and retrieved by a receiving worker when the shipment arrives. This process requires the receiving worker to make a time-consuming round trip between the dock and the office, and creates the possibility that a worker might apply wrong labels to the shipment.

Eliminating this process is a major way mobile printers can produce productivity gains and accuracy improvements. Workers can use forklift-mounted mobile printers to apply bar code labels on incoming materials immediately as they are unloaded. This procedure ensures items are prepared for scanning and other automated processing systems in place at the facility. Labeling items at the receiving area also ensures that 100 percent of incoming materials receive bar codes, so that bar code-based check-in, putaway, conveyor, and other automated applications remain fully leveraged and provide maximum benefits.

In the receiving yard or other outdoor locations, workers can label large, bulky items and cargo containers because mobile printers are available for indoor and outdoor use. The Surface Deployment Distribution Command (SDDC), a branch of the U.S. Department of Defense responsible for managing port operations, uses mobile printers to help process tanks, trucks, and other military cargo loaded and unloaded from ships. Mobile printers create documentation, generate tracking labels for unmarked items, and print replacements for damaged or incorrect labels on the cargo. The SDDC previously printed all labels in a central office at each port, so the switch to mobile printers has produced tremendous time savings because workers no longer have to leave the dock and make the long trip to the office.

Advance Quality Assurance Tasks

At the QA station, inspectors can take advantage of mobile printers to create clear, legible labels to identify samples taken for quality assurance. Workers can pull items from incoming shipments or from inventory and apply a tracking label tag. Then, as the sample routes through testing, the label serves as a work order indicating the required tests the lab must perform. Quality assurance workers could also use mobile printers to clearly identify samples with "pass," "rework," or "reject" labels. Using a mobile printer can virtually eliminate the chance of misidentified items—thereby avoiding quality problems.

Streamline Cross Docking

Warehousing operations use cross docking to save time in receiving and redistribution. Mobile printing presents the optimal solution for this environment because it saves steps for receiving personnel. Shipping and receiving workers equipped with mobile computers, bar code/RFID scanners, and label printers can receive inbound shipments and log them into the host warehouse or inventory control system with the mobile computer. Once logged, they can then use the mobile printer to quickly generate a bar code or RFID shipping label with the required cross-dock information. Point-of-activity labeling provides the accuracy needed to process fast-moving items, without adding delays.

Simplify Putaway Tasks

The company that Zebra conducted the time-motion study for receiving operations described earlier also uses a process where workers label items in the warehouse aisles prior to placing them into storage. Items labeled at putaway were processed 62 percent faster when mobile printers supported the operations as compared to when workers picked up labels from a stationary printer located one aisle away from the putaway location.

The company put the data points into a cost justification worksheet and concluded that they would receive full ROI in less than a year by using mobile printers to supplement putaway and receiving operations. Workers now initiate label requests by entering information into a handheld computer. The data transmits instantly to the company's enterprise resource planning (ERP) system over an 802.11b-standard wireless LAN that covers the facility. The ERP system receives the transmission, updates inventory records, and returns the information required to produce the bar code label. The system saves an average of 30 minutes per day per user.

Businesses can also use mobile printers with wireless-directed putaway operations. By receiving real-time updates of forklift locations and transaction activity, warehouse management system (WMS) software can balance workloads, calculate the most efficient putaway route for each forklift driver, and communicate instructions in real-time to a vehicle-mounted mobile computer. Route efficiency receives even more of a boost when drivers use mobile printers, thus eliminating frequent stops to stationary print locations.

Simplify Picking Tasks

Picking works like putaway in reverse, and holds the same time-saving potential. Wireless LAN and on-board printing are especially valuable because they enable operators to pick multiple orders simultaneously within a small zone, which reduces empty travel time and raises productivity. Mobile printers are used to generate bar code labels for each item that can be scanned in the staging or packaging areas to expedite the sorting of items for specific shipments.

To provide an example of the efficiencies generated through a bar code-based system, consider a Midwestern distribution center that was previously losing valuable time in its picking operations. To fill an order, the forklift driver received a printed pick list from the shipping office, and then drove through the distribution center to pick up the listed pallets. After completing the task, the driver returned to the shipping office to pick up the required shipping labels based on the number of cartons on each pallet.

Solving the above challenge prompted the distribution center to implement bar coding that helped automate the pick list creation, ensure picking accuracy, and prepare items for shipping. Forklift-mounted Zebra mobile printers enable the forklift driver to print on-demand shipping labels—saving the trip back to the shipping office.

Each forklift is now equipped with a small LCD screen that displays the pick list items in an order that optimizes the path to order fulfillment. The screen updates continuously from the company's enterprise-wide wireless network. For each item, the driver scans the product and the shelf label, communicating the selection to the network. If it is the correct item, the network automatically sends a confirmation that appears on the LCD screen and sends the shipping label information to the Zebra printer, thus ensuring that the label is the right match for the picked item.

The introduction of bar coding cut picking time in half, and helped achieve nearly 100 percent picking accuracy. The application improved efficiency to the extent that it even saves mileage on the forklifts, enabling the company to extend the life of its costly vehicles. As workers pick and place items into a carton, workers scan the product identification bar code to report their removal from inventory and record the transfer to the order fulfillment/packing department.

Complete Packing and Finished Goods Faster

Mobile printing is useful in warehouses and distribution centers where kitting or light assembly takes place, or where workers place items into packaging. When assembly or packaging is complete, the worker can immediately generate a label to identify the finished goods. The label can have a serial number or two-dimensional bar code that has the specific configuration information for the item. This application is important for maintaining accuracy, because many unique items may look alike and contain mislabeled tags if the worker had to leave the work area to pick up a batch of labels. Scanning the bar code label prior to placing the item into finished goods inventory ensures the storage location is recorded accurately, thus preventing picking errors for look-alike items.

Campbell Hausfeld, a leading manufacturer of home improvement and automotive tools, improved distribution speed and accuracy using Zebra's RFID printers and supplies. The company had difficulty tracking production of finished goods, and tracking the shipment of those products from their distribution facilities—resulting in inventory inaccuracy and discrepancies between production and distribution. This inefficient process forced employees to scan each pallet manually that came off the line for accurate reporting of production rates.

Once deployed, the RFID system benefited Campbell with significant time savings. All products receive an RFID label created from a Zebra printer. When workers place products on a conveyor, an RFID reader tracks each item. In 10 seconds, employees can perform the same task that previously took up to four minutes. In addition, operations can print long plays (LPs) in bulk, instead of printing the same label 15 or 20 times, thus saving more time. In addition to numerous operational benefits, Campbell realized significant labor cost savings, as well as an 80 percent decrease in error rates.

Fulfill and Track Ship to Order Operations

Businesses can leverage a similar application to manage ship-to-order operations. Rather than identifying and labeling final assemblies, workers use bar code labeling and scanning to verify the picking and packing of all items required to complete the order.

Shipping departments can label items with an order code during picking, or at a packing area to associate them with specific orders. Prior to shipping, a worker in the packaging or shipping department scans the bar code label on each item and system software alerts the operator if any items are missing or duplicated. After final order assembly or completion, the worker can use a mobile printer to generate a shipping label. This application ensures packing of the correct items into an order and that the order includes identification with the proper shipping label.

Bringing Wireless to Larger, Stationary Printers

Mobile printers are not the only way to achieve wireless in the warehouse. Departments can enable stationary printers with ZebraNet® Wireless Print Servers. These 802.11b print servers present lower-cost connectivity options that replace clumsy wireless bridges and power supplies by removing network tethers and providing location-independent printer operation. Adding a wireless option to these stationary printers can add flexibility to a warehouse by eliminating the need to implement costly hardwiring that needs to be reconfigured every time the warehouse layout changes.

Transportability as a Mobility Alternative

Bringing wireless to stationary printers is one way of eliminating the cost and frustration of hardwiring. With the ZebraNet PS4000™, however, businesses can bring both wireless and a level of mobility to large stationary printers. This wireless print server allows connection of up to four USB 2.0 printers, giving the printers cart mobility so that workers can push the printers through the warehouse. This allows users to gain the benefits of printing at the point-of-application, in real-time via their network, while improving ergonomics by removing the need to wear handhelds and printers.

With multiple printers, the user can print on multiple different formats as well, such as labels, tags, or receipts in different colors, sizes, or shapes. This saves the time and effort of swapping out media rolls on mobile printers. This is also a great alternative for higher-volume printing applications, because workers can use larger rolls in stationary printers. Additionally, if users opt to use Zebra's Desktop series printers with their cart solution, they can also choose an LA-24 battery pack, which powers the PS4000 and up to four printers on a simple non-powered cart.

Understanding Mobile Printer Technology

Mobile printing is adaptable to numerous applications because Zebra specifically designs mobile printers to integrate into industrial business processes and information systems. In most operations, workers use mobile printers with mobile computers, and have the communications interfaces and mounting options necessary to ensure convenient, efficient operation. The sections that follow describe the various printer connectivity, printer design, and media options that warehouse and distribution operations can leverage to maximize productivity and achieve the highest mobile printer ROI.

How to Leverage Networking

Mobile printers can use a wireless network connection to receive print jobs, label formats, variable data, and other information from host systems. The printer contains an IP address and appears like any other device on the network, which lets users take advantage of third-party software products available for network management and security. Wireless network printing is possible even if the mobile computer used with the printer does not have a wireless network connection.

Warehouse management systems and other enterprise applications can take advantage of existing wireless networks to direct mobile printing operations. Organizations that already have wireless LANs for warehouse management systems or other enterprise applications can integrate wireless printers without having to develop special interfaces. The wide variety of radio technologies and designs makes it easy to add wireless printing to most information systems. Wireless connectivity provides many safety, convenience, and productivity advantages.

Cable Replacement Considerations

Wireless communication between the mobile computer and printer also includes infrared (IR) light or radio frequency (RF). A wireless configuration frees an interface port on the mobile computer for use by other peripherals. Mobile computers with two radios can do wireless networking and wireless printer communications without interference. A wireless printer interface improves worker safety and convenience because there are no cables to tangle. Cable-less mobility means fewer connections to repair or replace—thus providing a significant cost benefit over the life of the system.

Under most normal usage conditions, cables will need repair or replacement long before the printer reaches its end of life. Connectors are especially prone to weakening and failure. Solution providers often specify custom cables designed for the specific models of mobile printer and computer to minimize strain on the connectors. The additional cost for custom cables plus normal repair and replacement expenses can easily exceed the cost of a wireless interface, which will last the lifetime of the printer.

Workers try to adjust and fix aging cables before turning them in for repair or replacement, which causes distractions and lost productivity. A retailer that uses mobile printers for in-store operations studied its employees and found that each mobile worker spent an average of two minutes a day on cable-related tasks. When matched to warehouse operations, a warehouse with eight mobile workers would lose 16 minutes a day, or 1.33 hours per week, in productivity due to cable-related issues. A wireless interface eliminates this drain on productivity, which is another example of the incremental benefits that wireless mobile printing systems provide.

Infrared was the first technology used for wireless printer communications and was very popular, but Bluetooth® Technology now stands as the dominant short-range choice. Bluetooth is the leading wireless technology to replace cables. Bluetooth is a standardized, short-range wireless technology that enables up to eight computers, printers, and other devices to communicate with each other. Bluetooth communication has a range of up to 30 feet (9 m), and does not require routing through a centralized hub or server. Bluetooth provides fast and reliable printing. Because Bluetooth operates via radio frequency, it does not require line of sight, and is immune to physical or light sources of interference.

Zebra Wireless Options for Seamless Operation

Zebra Technologies supports all the wireless technologies described above. For maximum flexibility, it is important that the user also address the issue of security. Many authentication and encryption options are available to protect the wirelessly transmitted data. Some of the more robust and popular security options used today include VPN, 802.11i, WPA, EAP-TLS, and more.

The Importance of Printer Design

Warehouse workers typically wear mobile printers on a belt or shoulder strap, or mount them on a forklift or cart. Size and weight are the most obvious and easily understood design characteristics but may not be the most important, especially if workers mount the printer on a vehicle or carry it on a strap. Features like the size and location of displays, position, and style of controls, and accessibility to media can have much more impact on productivity than size or weight. Mobile printing should provide convenience, and the benefits to implementing a mobile printing system fall short if the printers are awkward to use.

Application testing by the user can reveal which design features are the most important, and the suitability of specific printer models for the operation. Testing and evaluation shows how cables flex, and if they get in the user's way during normal activity. If warehouse workers wear gloves, be sure to determine if users wearing gloves can operate printers easily. In cold storage warehouses or other facilities where equipment is subject

to extreme temperature changes, test to ensure that condensation does not reduce display screen readability, and that temperature conditions do not affect print quality and label media performance.

Match Media to Printer Usage

Businesses must consider resistance to moisture and temperature ranges, in addition to many other factors, when identifying a warehouse's media specifications. Media must match to the specific model of printer and the usage environment to ensure optimal performance for the label material itself and for the printer. Media optimized for the printer requires less battery power for printing, and extends the life of the thermal printhead. Additionally, appropriate levels of adhesive ensure that the label will adhere for the length of time desired, and that excess adhesive does not clog the printhead.

Most mobile printers use direct-thermal media, a technique also used by most stationary printers in warehouses to create picking and putaway labels. Mobile printers used in warehouses accept a variety of label, tag, and ticket stock to produce shipping labels and other types of bar code identification that retain quality and readability through all storage, handling, and supply chain operations.

Longer Battery Life Means Higher Shift Availability

How the printer manages its power requirements impacts overall battery life and application effectiveness. Battery life varies widely based printer usage. Print volume, label size, the amount of wireless activity, and other factors all affect how long batteries last before recharge or replacement. It is critically important in warehouse and distribution applications to have enough battery life to power computers and printers for the entire shift, or workers cannot complete their daily tasks. Mobile printers specify a variety of battery chargers, and various models include adapters for drawing power from vehicle batteries.

Users must test their applications to ensure that the batteries they use consistently perform as needed and will not contribute hidden expenses to the total cost of ownership. For example, nickel metal-hydride (NiMH) batteries have a higher initial cost than nickel cadmium (NiCAD) products, but have less performance degradation over time, are more efficient at holding their charge, and have a longer life span. Lithium-ion (Li-Ion) cells offer the highest power-to-volume and power-to-weight ratio of the three. For example, in a typical printer application, a lithium-ion battery pack producing 7.2 volts has 30 percent more power than a nickel metal-hydride pack, with half the volume and half the weight.

High Printer Performance Enables Productivity

Mobile and wireless printing offer options to make select warehouse labeling operations more convenient, improve productivity, and reduce labeling errors. Supplementing enterprise printing operations with mobile printers can produce time savings that eliminate bottlenecks, or boost accuracy that results in better overall performance of warehouse management, shipping, and other operations. The examples presented in this white paper show how saving a few steps, or improving upon already accurate identification and labeling procedures, can produce measurable cost savings and productivity gains. Enterprises can maximize these improvements by selecting the products and features that best meet operational requirements.

Zebra Technologies Corporation (NASDAQ: ZBRA) provides the broadest range of innovative technology solutions to identify, track, manage, and optimize the deployment of critical assets for improved business efficiency. Zebra's core technologies include reliable on-demand printer and state-of-the-art software and hardware solutions. By enabling improvements in sourcing, visibility, security and accuracy, Zebra helps its customers to put the right asset in the right place at the right time. Zebra operates in over 100 countries and serves more than 90 percent of Fortune 500 companies worldwide. For more information about Zebra's solutions visit www.zebra.com.

**CORPORATE HEADQUARTERS**

Zebra Technologies Corporation
475 Half Day Road,
Suite 500
Lincolnshire, IL 60069 USA
T: +1 847 634 6700
+1 800 268 1736
F: +1 847 913 8766

www.zebra.com

USA

Zebra Technologies Corporation
333 Corporate Woods Parkway
Vernon Hills, IL 60061-3109
U.S.A.
T: +1 847 793 2600 or
+1 800 423 0442
F: +1 847 913 8766

LATIN AMERICA

Zebra Technologies International, LLC
9800 NW 41st Street,
Suite 200
Doral, FL 33178 USA
T: +1 305 558 8470
F: +1 305 558 8485

EMEA

Zebra Technologies Europe Limited
Dukes Meadow
Millboard Road
Bourne End
Buckinghamshire SL8 5XF, UK
T: +44 (0)1628 556000
F: +44 (0)1628 556001

ASIA-PACIFIC

Zebra Technologies Asia Pacific, LLC
120 Robinson Road
#06-01 Parakou Building
Singapore 068913
T: +65 6858 0722
F: +65 6885 0838

OTHER LOCATIONS

USA
California, Georgia, Rhode Island,
Texas, Wisconsin

EUROPE
France, Germany, Italy,
Netherlands, Poland, Spain, Sweden

ASIA-PACIFIC

Australia, China, India, Japan,
South Korea

LATIN AMERICA

Argentina, Brazil, Florida (USA),
Mexico

AFRICA/MIDDLE EAST

Russia, South Africa, United Arab
Emirates