



# Efficiency NEW

## In 50 Words Or Less

- A variety of auto-ID systems are available to combat the pains of supply chain management.
- Barcode currently leads in terms of use, but RFID is starting to make up ground.
- The technologies can be used in tandem to counter the challenges found in retail, warehouse and manufacturing environments.

Barcode  
and RFID  
in the  
supply  
chain

by Dennis Lin and  
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# GETS A IDENTITY

**AUTOMATED DATA COLLECTION** systems (auto-ID) consist of many technologies, including barcode, voice systems, radio frequency identification (RFID), pick to light and laser scanners.<sup>1</sup> These systems allow for noncontact reading and are effective in a wide range of applications.

The most commonly used auto-ID technique is barcode, but RFID is catching up, primarily because it has been adopted by many of the world's largest retailers, including Wal-Mart, Target and Tesco. This article demonstrates the impact RFID will have on existing supply chain processes and the improvements RFID implementation will bring by comparing the benefits of RFID with those of barcode for various supply chain entities.

## RFID for automated data collection

RFID is a generic term for technologies that use radio waves to automatically identify people or objects by tagging and tracking individual items, cases and pallets as they move through the supply chain and into the hands of the consumer.<sup>2</sup>

As the objects move through the supply chain, RFID readers collect information about the object and match the tag number in a central database to access the complete record for that object. Because of those abilities, RFID technology can provide unprecedented speed and accuracy in a supply chain.

In a recent study, efficiency and productivity were cited as the two main areas that would benefit most when implementing RFID. The other main drivers of RFID implementation include reducing out-of-stock incidents and warehouse operating costs, increasing supply chain visibility, reducing theft and improving order fill rates.<sup>3</sup>

The structure of a typical supply chain consists of a supplier, manufacturer, warehouse and retailer, although the actual details can vary for different supply chains. Each of these supply chain entities encounter situations on a daily basis in which barcode and RFID could be used to solve any problems that might arise. Some of the processes that will be impacted by implementing an auto-ID system are shown in Figure 1.

For organizations with a global supply chain and a vast distribution and retail network, the benefits of auto-ID are numerous. The increases in data capture

capability, data integrity and supply chain visibility will considerably reduce costs and increase the supply chain's efficiency.

Although barcode and RFID are different technologies, they can work well in tandem to help drive down supply chain costs.

## Auto-ID in retail

The aim of every retail store is to satisfy a high percentage of customer demand from available stock while reducing operating costs and inventory levels. There are a number of pain points in a retail environment: receiving and moving the product to the store from the back room, out-of-stock incidents, check-out wait time and product pricing.

Most of the problems in a retail store can be attributed to three main sources:

1. Product did not get to the store.
2. Product got to the store but not to the shelf.
3. Product got to the shelf but was not recognized as being for sale.<sup>4</sup>

To avoid these pain points, many retailers have invested in technology solutions like enterprise resource planning or inventory management systems. But investment in these technology solutions alone is not enough. These systems are data intensive and need reliable and abundant data to function smoothly.

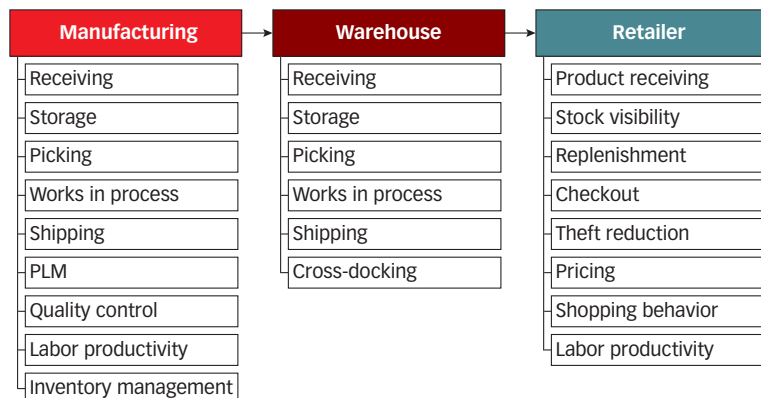
Auto-ID techniques can help many organizations garner the required data effortlessly, which can be used in several places in a retail setting. Table 1 summarizes how barcode and RFID can solve the retail pain points.

RFID can provide several other advantages that cannot be achieved easily using a barcode system: faster product check out, theft reduction, dynamic pricing of products and tracking employees for labor efficiency.<sup>5</sup> In the same retail environment, barcode systems suffer since each barcode needs to be scanned individually, and barcode requires line of sight for scanning, which makes using barcode a labor intensive process.

In addition, the speed of barcode systems is a hindrance to the process of obtaining real time information. On top of that, barcode systems are unsuitable for receiving product when there are multiple products on a single crate.

RFID can help eliminate some of these issues that accompany barcode. But those advantages come at a

## Processes affected by auto-ID implementation / FIGURE 1



## Benefits of barcode and RFID in retail / TABLE 1

Issue	Problem	Barcode solution	RFID solution
Receiving the product.	Trade-off between counting the entire product and receiving the product as is.	Barcode placed on the product can be scanned to record the arrival.	RFID readers placed at the door would automatically scan the product and match quantity against the purchase order. RFID increases the speed of scanning and reduces the labor usage.
Stock visibility of perishables.	Perishables, if not sold by a due date, have to be scrapped. The problem is maintaining the product visibility.	Barcode can only alleviate the problem of what product is available since the inventory count might not accurately tell where the product is.	RFID can enable item-level identification, providing complete visibility. RFID implementation can enable product removal from the back room to the sales floor in FIFO (first in first out) manner.
Replenishment of product from the back room to the sales floor.	Most retailers don't realize when an item is close to being out of stock.	With barcode, it is virtually impossible to detect the available quantity of product.	RFID readers located in the store can continuously monitor the shelf. When the available quantity reaches a threshold, a restocking order can be issued.

price. RFID tags cost more than barcodes and make a more profound impact on the bottom line when putting tags on low value items. Unless RFID is standardized and the cost of tags falls to around 1 cent, barcodes cannot be totally eliminated. As a result, barcode and RFID will co-exist in retail for many years to come.

### Auto-ID in the warehouse

The warehouse is an important supply chain entity because it acts as a buffer to minimize the effects of variability in the supply chain and serve customers in a timely fashion during peaks in demand. The major warehouse functions that will benefit from implementing an auto-ID system are receiving, storing, picking and shipping, as shown in Table 2.

Cross-docking, another critical activity in the warehouse, can be improved significantly using RFID's ability to instantly identify individual items. By placing RFID

readers near dock doors, RFID tags on pallets and cartons are automatically read and routed for cross-docking.

There are many other processes that would benefit from RFID implementation, including inventory management, theft control and labor efficiency. But, like in a retail environment, the cost of implementing RFID could be a hindrance.

It is estimated that an RFID-enabled warehouse would cost in excess of \$2 million. Every organization has to weigh the increased cost against savings before embarking on an RFID journey.

### Auto-ID in manufacturing

In most supply chains, manufacturing is an important function that is initiated either by customer demand or in anticipation of customer demand. The pain points in a manufacturing environment are: resource allocation, operation scheduling, execution, data capture, quality

## Benefits of barcode and RFID in the warehouse / TABLE 2

Issue	Problem	Barcode solution	RFID solution
Receiving the product.	Receipt of all product into warehouse, matching received quantity against purchase order, and distribution of product.	The process of receipt can be sped up using barcodes, but the process is still labor intensive and has room for improvement.	RFID can eliminate the verification step, as all incoming shipments are checked automatically. The speed and accuracy of RFID is much higher than barcode.
Storing the product.	Storing is labor intensive and time consuming, especially for mixed-pallet shipments.	Using a portable barcode reader, the operator first scans the item that is to be stored and then scans the barcode fixed to that location.	RFID eliminates the need to scan the barcode on the pallet and at the storage location, and improves temporary storage at the warehouse.
Order picking.	About 50% of warehouse staff and 50% of operating cost are expended on order picking.	A barcode label on product and location uniquely identifies product. A portable reader is then used to retrieve the order.	Use of RFID reduces the efforts needed to locate product, which reduces labor costs.
Shipping the product.	Shipping the correct order at the correct time to the correct customer.	Preprinting the barcode labels on the shipment improves the shipping process. Barcodes used to establish a shipping log are helpful for item-level coded items.	RFID product information can be gathered effortlessly, and the exact product location is known with certainty. Products shipped can be matched against purchase orders.

management and product life cycle management.

Auto-ID techniques work in almost all areas of a shop floor, from raw material to final product to production control. The advantages of implementing RFID for a manufacturer are similar to those of the warehouse—for example, order picking, order sorting and order shipping. But RFID can provide many other distinct advantages on the shop floor:

- **Product life cycle management.** The RFID tag is attached to an assembly or part. This tag contains all relevant information about the product, including date produced, manufacturer and customer. This information remains imbedded as long as desired. RFID readers can extract this information at any time. Product life cycle management enables returns and eases the processes of recall management and warranty claims.
- **Quality control.** RFID tags on inbound and outbound works in process ensure that the right product goes to the right place, thus enabling strict process control. Such a system is also beneficial in process manufacturing, which relies on weights and measures instead of parts and components. To achieve quality control, RFID tags are placed on the containers containing the mixture, and RFID readers are placed on the dumping mechanism. If an incorrect mixture is about to be set into motion, a warning is generated and the process is stopped.
- **Inventory management.** One of the biggest selling points of RFID is efficient management of inventory.<sup>6</sup> If retailers, distribution centers and manufacturers could collaborate to collect and share information, they could provide complete visibility for every item in the supply chain. Because RFID tags can be read without line of sight in challenging environments where barcodes would fail (heat, dirt, contamination) and information can be rewritten onto the tags, RFID is ideal for managing inventory.

Raw materials, work in process and finished goods can be tracked using the highly accurate, real time and unattended monitoring capabilities of RFID. As a result, manufacturers can improve visibility and lower the overall inventory levels, labor costs and safety stocks.

Readers covering warehouse racks, shelves and other storage locations could automatically record the removal of items and update inventory records. Misplaced or lost items could be located easily. Workers could scan the inventory for a specific electronic product code (EPC) number, and the item will be found if it's available in the inventory.<sup>7</sup>

## Still work to be done

Although RFID can provide most of the barcode functions, in addition to a few of its own, it's still far from being the dominant auto-ID technology. Cost and standardization remain the biggest hindrances to implementing an RFID system. As a result, RFID and barcode will continue to be used side by side for many more years because the two technologies can complement each other very well and be used effectively in many applications.

RFID technologies, while generating an unprecedented amount of data, are only as valuable as the resulting information, knowledge and wisdom that can be gleaned. The data alone are of little to no value since most of the IT systems in place are not prepared to handle a vast amount of data. Our next step in the research on RFID is to develop data mining techniques to extract useful information from the amount of data produced by RFID.<sup>8</sup>

## REFERENCES

1. J.M. Hill, "Automated Data Collection Perspective," white paper, ESYNC, 2003.
2. Olin Thompson, "Supply chain payoffs with RFID," *Food Engineering*, Vol. 76, No. 4, 2004, p. 119.
3. William Atkinson, "Tagged: The risks and rewards of RFID technology," *Risk Management*, Vol. 51, No. 7, 2004, pp. 12-18.
4. Keith Alexander, Garry Birkhofer, Kathryn Gramling, Herb Kleinberger, Stephen Leng, Dhaval Moogimane and Maurice Woods, "Focus on Retail: Applying Auto-ID to Improve Product Availability at the Retail Shelf," white paper, Auto-ID Center, MIT, 2003.
5. NCR Corporation, "50 Ideas for Revolutionizing the Store Through RFID," white paper, 2003.
6. Gavin Chappell, Lyle Ginsburg, Paul Schmidt, Jeff Smith and Joseph Tobolski, "Auto-ID on the Line: The Value of Auto-ID Technology in Manufacturing," white paper, Auto-ID Center, MIT, 2003.
7. Ibid.
8. Dennis Lin, Russell Barton, et al, "Challenges in RFID Enabled Supply Chain Management," *Quality Progress*, Vol. 39, No. 11, 2006, pp. 23-28.



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## IDENTIFY YOURSELF

Barcode, RFID or both? Weigh in on the best method for keeping everything in the supply chain linked on the discussion board at [www.qualityprogress.com](http://www.qualityprogress.com) or e-mail [editor@asq.org](mailto:editor@asq.org).