

RFID

Wireless Innovations in Inventory Monitoring and Accounting

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A soldier falls injured behind enemy lines and can't be located, his life hanging in the balance. A newborn is abducted from a hospital—her parents, law enforcement, and medical personnel are searching frantically for her. A traveler's suitcase, containing family heirlooms, goes missing at an international airport. Can it be recovered, or is it lost forever? A relatively untapped technology—radio-frequency identification (RFID)—can provide a good outcome in each of these scenarios, as well as in many others.

RFID systems are rapidly replacing many UPC (Universal Product Code) and manual systems to monitor and account for inventories. The primary motivating factor for this change is the potential for greater efficiency and lower costs. For many companies, RFID promises highly automated, paperless inventory systems with significant

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benefits, profoundly affecting the way business is conducted. RFID isn't without its disadvantages, however, and actually increases some risks.

This article will examine the pros and cons of radio-frequency identification and will offer suggestions for companies that are considering reengineering their legacy inventory systems.

Managing Inventories: A Brief History

Methods of managing and accounting for inventories have changed dramatically over the ages. Around 2,000 years ago, shepherds accounted for their flocks of sheep using simple approaches such as tying knots in strips of leather. During those early centuries, inventory systems developed very slowly. Eventually, advances in manufacturing techniques and the Industrial Revolution impelled the development of more-sophisticated methods of costing and accounting for inventories.

As time passed, better information technology, maturation of markets, and increases in global competition demanded even greater accuracy in product costing and timelier accountability. With increasing worldwide competition, automating manual processes and adopting more-efficient systems became increasingly more important to the survival of companies with relatively high labor costs. Automation helped.

Although the key idea to electronically tabulate data may have arisen from John Shaw Billings (creator of the

National Library of Medicine and the first director of the New York Public Library), Herman Hollerith developed the first mechanism in the late 1880s. Officials used his famous Hollerith cards to count the 1890 census in a single year compared to the eight years it took to tabulate the results of the 1880 census.

Following Hollerith's lead, several inventors developed and patented coding schemes, as well as mechanical and electrical equipment, to exploit the potential associated with automating inventory and point-of-sale systems. The evolution of these coding schemes led to the UPC systems that are now immensely popular and have broad commercial use. Yet the first retail application of a UPC didn't occur until 1974—a 10-pack of Wrigley's Juicy Fruit gum sold in a supermarket in Troy, Ohio.

Radio-frequency identification's exact birth date isn't clear, nor can a single party receive sole credit for its invention. In fact, RFID is really just a more advanced, wireless application of the earlier electronic tabulation systems. Some attribute its roots to an espionage tool, developed for the Soviet Union in 1946, that retransmitted radio waves with audio information. Others assert that RFID emerged from research in the United Kingdom to develop transponders for distinguishing friendly from hostile aircraft during World War II. In any event, it wasn't until 1973 that the first passive radio transponder containing memory was patented in the United States by Mario Cardullo.

RFID vs. UPC Systems

RFID uses radio-frequency tags to enable the physical tracing of goods through the receiving process, raw material stores, production, finished goods inventory, and shipping. It does so without the "line-of-sight" proximity that systems using legacy UPC technology require. The RFID tags—which consist of an antenna and a tiny, implantable silicon chip—allow each stage of a product's history to be recorded automatically, including the revenue each item generates.

RFID systems consist of three fundamental components: an electronic tag to identify each item, a tag reader, and a computer system. The tags, which can be as small as the head of a pin, contain attribute and identification data that can be read using radio-frequency devices. Such data is typically coded using an Electronic Product Code (EPC) that follows globally adopted standards. Tag readers, in turn, serve as input devices for the computer systems that automate transactions and manage, monitor,

Examples of RFID Implementations

- 1.** Because of the potential benefits, Walmart implemented an initiative a few years ago that required its top 100 suppliers to start using RFID by January 2005. At that time, Beaver Street Fisheries, a seafood dealer, wasn't among the top 100 suppliers but recognized the potential savings and eagerly started implementing the technology. The program was so successful that Walmart now cites the company as a top supplier. Howard Stockdale, CIO of Beaver Street Fisheries, stated, "In a few short years, we have gone from managing shipping with a clipboard to employing cutting-edge RFID technology. Given this, we believe its potential for improving our business is virtually limitless."
- 2.** LXE, a mobile computing company, reports that the convergence of RFID and voice technology may prove to be synergistic in their operations. The company is in the process of implementing a new system based on this combination. (The existing system requires scanning a bar code and manual data entry, and errors have been very expensive.) LXE believes that its RFID-based system will catch errors earlier and automate data entry—saving save both time and money.
- 3.** In the airlines industry, existing UPC systems for tracking baggage are accurate only 80% to 90% of the time. Tags with bar codes often get bent or damaged to the point of being unreadable; the baggage then requires manual sorting. These factors contribute to misplaced luggage and added cost to the airlines. Seeking a solution for this problem, airlines and airports have started adopting RFID systems to improve their baggage-handling procedures. Estimates indicate that the airlines can save \$760 million per year by adopting radio-frequency technology.
- 4.** The pharmaceutical industry is another active adopter of RFID technology. In November 2004, the U.S. Food and Drug Administration announced an initiative for implementing RFID to improve the safety and security of the country's drug supply. RFID helps control counterfeit drugs by providing a fast and efficient means to evaluate the authenticity of drugs. Also, the technology shortens the timetable for drug recalls.
 - 5.** One particularly interesting development is chip-less RFID ink that can be used to tattoo and track both animals and humans. Reports indicate that the U.S. Department of Agriculture is pushing for the tagging of farm animals to monitor food safety. Another potential application is the use of tattoos by the military to track and rescue stranded soldiers, potentially saving lives.

and account for inventories.

Potentially, RFID systems have two major advantages when compared to legacy UPC systems: (1) the range at which data can be read or transmitted and (2) the volume of information that can be stored and conveyed. UPC systems require that bar codes be physically scanned using a reading device, and their codes can convey only limited data. RFID tags, on the other hand, can be read from a distance of 100 feet or more, and the EPC stores significantly more information about the tagged item.

The major drawback of RFID systems is that they're pricey. By comparison, the cost of printing a UPC bar code on an item is usually only a fraction of a cent. Although they can cost thousands of dollars, some bar code readers are available for less than \$100, and most cost less than \$300. On the other hand, RFID tags and equipment can be considerably more expensive. Of the two types of RFID tags, passive and active, passive tags are more economical but generally store less data. They have no self-contained power source but instead rely on

the energy from the tag reader (specifically, the incoming radio-frequency signal) to operate. Although prices are dropping, passive tags generally cost about 20 cents each. Active tags contain their own power source, such as a small battery, and continuously transmit data. They typically cost between \$10 and \$50 but can be even more expensive. The reason for their higher cost is that active tags can be read from a greater distance than passive tags, and they don't need a continuous radio signal to keep them functioning properly, which makes them more reliable. Most tag readers cost between \$500 and \$3,000. As technology improves, however, and more and more users adopt RFID systems, costs should decline to near the level of UPC systems.

RFID's Radio Signals

A number of factors affect radio-frequency signals and the quality of data transmission. As we explained earlier, passive tags generally require close proximity to the reader, but active tags can usually transmit their information over greater distances. In addition, the radio frequency, the size of the antenna, and the quality of the reading device all affect the range. RFID systems may use low-frequency (LF), high-frequency (HF), or ultra-high-frequency (UHF) bandwidth. Older systems tended to use HF technology, and newer systems favor UHF. Also, environmental factors and certain materials that surround the tags can affect the quality and range of data transmission. For example, metal shelving can reflect radio-frequency signals, and, although the shelving may distort or interfere with them, it can actually enhance performance in some instances. Water-based products or items composed of mostly water, such as the human body, tend to absorb radio-frequency signals, degrading RFID performance. Nevertheless, RFID systems work effectively for tagging patients in medical applications—for instance, to help track patients and to note important facts such as allergies or other medical conditions, medication history, diagnoses, etc.

The selection of the best radio frequency and RFID equipment is a technical decision that merits the expert advice of consultants. Management accountants and other finance professionals interested in implementing this technology are well advised to require vendors to provide in-house demonstrations of their equipment. The process is complicated not only by the complexity of the technology but also by the number of vendors and the large assortment of tags and equipment available. For example, in the cattle industry alone, *Beef* magazine and Kansas

State University teamed up to compile and publish a list of 36 providers of RFID technology.

Adoption of RFID Systems

Even with the evolution of RFID technology over the last 35 years, UPC systems have historically dominated in business applications. Yet with technological advances, prices are moderating, and RFID is growing rapidly. The general consensus in the business world is that RFID systems now have great potential to enhance the efficiency of supply chain management (SCM), customer relationship management (CRM), and general business processes in many operational settings. Accordingly, the growth of RFID is indisputable, and many companies report enormous benefits from its adoption.

RFID is a global phenomenon with leading applications in the airlines and transportation industry, the government, and the financial and smart-card industries. (A few of the more innovative approaches are summarized in “Examples of RFID Implementations” on p. 37.) One source estimates the value of the RFID market in 2009 at \$5.56 billion compared to \$5.25 billion in 2008. These estimates include the sale of 2.35 billion tags in 2009 compared to 1.97 billion in 2008. The U.S. government, in particular, plans to invest heavily to support the commercial deployment of RFID in both the public and private sectors.

The Managerial and Accounting Impact

In the business world, the benefits of radio-frequency identification include:

- ◆ Streamlining inventory management by automating data capture,
- ◆ Increasing the quantity and quality of data,
- ◆ Eliminating manual counting of inventories,
- ◆ Improving the monitoring of inventory,
- ◆ Facilitating the selection of items from warehouses, and
- ◆ Helping to eliminate costly mistakes.

We've already mentioned many of these potential benefits, but the managerial and accounting implications are noteworthy.

RFID promises many improvements in accounting processes and may have a direct impact on Generally Accepted Accounting Principles (GAAP). Using EPC with radio-frequency devices makes the specific identification method of costing inventory practical and cost effective, and it reduces the need for using cost-flow assumptions,

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such as First-In, First-Out (FIFO) or Last-In, First-Out (LIFO).

Management may not warm to RFID, however, as it may affect the ability to manipulate earnings. For example, during business upswings, managers could choose to sell higher-cost items at lower profit margins to create a “cookie jar reserve” by saving items with larger profit margins for leaner periods. Likewise, managers could enhance short-term profits to the detriment of long-term profitability by selectively selling those items that have lower costs and greater profit margins. Of course, such manipulation isn’t possible during periods of stable prices or when inventory items *aren’t* interchangeable and management has no control over which individual items are sold.

Another significant implication for accounting is the enhancement of EDI (electronic data interchange), which would be possible through the automation of processes using RFID. If all of a company’s vendors used compatible tags, the firm could automate the physical counting of goods received and the preparation of receiving reports. This would enable receiving-department personnel to concentrate on accepting only authorized shipments, inspecting the quality of goods received, and safeguarding

those items until they’re warehoused. Strengthening these areas could lead to faster identification of damaged units, more speed and accuracy in preparing debit memoranda, and quicker resolution of disputes regarding damaged or nonconforming goods.

Documentation of changes in fiduciary responsibility for inventory items could also be automated as goods are transferred from one location to another. For instance, as items travel from the receiving department to stores, perpetual inventory records could be updated in real-time. Location information would also be readily available. With proper monitoring, this sort of system should serve as an effective deterrent against employee theft.

Customer relationship management is a hot topic today as many companies strive to build brand loyalty, enhance the firm’s reputation, and increase repeat business. To this end, RFID benefits both front-office and back-office CRM systems. RFID supports front-office systems by feeding information to support salesforce automation (SFA) systems and by providing more-accurate and more-detailed information about inventory stock and replenishment times. This information can improve marketing efforts, provide better responses to order inquiries, and facilitate order taking. With regard to back-office systems, RFID provides better information to address customer inquiries. It also streamlines the fulfillment process and keeps customers happy when returns are necessary.

RFID in Manufacturing Concerns

In manufacturing concerns, the use of RFID can have an innovative impact on cost accounting. Goods placed into production would automatically trigger material requisition forms without human intervention. Likewise, direct labor would be allocated to inventories as it is incurred. With properly designed systems and internal controls, fewer recording errors should occur. As goods move

through production processes, the location of each individual part would be monitored and assimilated into identifiable work-in-progress (WIP) inventory units. This tracking information could—and should—be coupled with detailed bills that better identify and document the points where materials, labor, and machine work are applied. Instead of using highly subjective stage-of-completion estimates to calculate equivalent units of production, a properly designed RFID system could more accurately calculate the stage of completion of each partially processed unit and its prime costs. This, in turn, would enable a more reliable allocation of overhead. Individual costs of the unfinished units could be aggregated to provide a precise valuation of WIP inventory.

Closer monitoring of WIP items should facilitate the timely identification of damaged goods, spoiled items, and rework requirements. This in turn should improve cost decisions concerning which damaged items to repair and reenter into the production process and which to scrap.

As goods are sold, each unit's individually determined cost would be transferred automatically from finished products to the cost-of-goods-sold account. Material requisitions, shipping documents, and invoices would be prepared automatically, may exist only in electronic form, and may be transmitted to customers as part of an EDI system.

RFID and Privacy Issues

Privacy issues represent RFID's greatest threat. The ability to read tags without line-of-sight proximity, a major advantage of using this technology, also creates the privacy problem. Tiny tags could easily be included in products without the public's knowledge. Moreover, many tags contain detailed personal information that isn't encrypted or protected by other security measures. Without proper security, anyone could read these tags with an RFID scanner *after* the sale. The privacy of sensitive health information is just one example of data that should remain private but could become public knowledge. Although tags can be permanently disabled, they're often left active to convey information about the product after the sale, such as whether the buyer is meeting warranty conditions.

The large number of RFID tags that are already in circulation accentuates privacy concerns. Tens of millions of tagged credit cards, ATM cards, enhanced driver's licenses, passports, and ID cards (such as employee ID cards or China's national ID cards) are already in use. But even when little or no personal information is stored on the tags, privacy may be jeopardized, and identity theft could

occur. When someone uses an RFID-tagged device, a link is created between the tag and that individual's identity. Since the tag can then serve as a proxy for the individual, it's capable of divulging sensitive information.

In addition to the ability to disable tags, RFID technology companies are starting to implement strict security controls into newer versions of the tags. Also, interested parties and regulatory agencies are developing new standards. For example, the U.S. Department of Commerce's National Institute of Standards and Technology (NIST) has issued a list of recommended practices for ensuring the security and privacy of RFID systems. (For the complete guidelines, including an RFID systems security checklist, see NIST Special Publication 800-98, available at http://csrc.nist.gov/publications/nistpubs/800-98/SP800-98_RFID-2007.pdf.)

The Future

Wireless technology is pervasive and affects every aspect of our lives—sometimes without our even knowing it. Used properly, RFID delivers significant increases in productivity, reduces labor costs, and enhances information for decision making. Radio-frequency technology streamlines processes by automating many mundane, manual tasks that are often error prone, such as assigning accountability for custody over inventories and tracking the transfer of goods from one area or process to another. In addition, the reengineering of business systems to integrate RFID with transaction processing promises more-accurate and timely costing of inventories as well as more-efficient logistics, storage, and retrieval procedures. Tagging of individual items supports the specific identification of unit costs and, in many instances, may render traditional cost-flow assumptions unnecessary.

While it streamlines many work processes and makes our lives more comfortable, RFID also creates genuine security and privacy issues that must be resolved. One of the prime questions to answer is, "How much privacy are we willing to surrender to enhance the flow of information and increase productivity?" Striking the proper balance will be the key to RFID's success or failure. **SF**

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