



# The **NUTS** and **BOLTS** of **BAR CODE PRINTING**

How Bar Coding Can Make Your Company

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More Productive And Efficient

## **Introduction**

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Bar coding is not just for groceries anymore. The familiar stripes are popping up in new and unusual places such as doctors' offices, law firms, the post office and rental cars. Bar coding has been used in manufacturing companies for shipping and receiving operations for more than 30 years. But even in these more traditional settings, bar code applications have spread throughout the enterprise to include warehousing, accounting and customer service functions, as well as the assembly line operation itself.

In all of these applications, the motivation to begin bar coding is the same: the increased use of computers in commercial and industrial companies is fueling a need for improved data management and accessibility. Companies now expect immediate and accurate reporting as a standard business practice. To meet this need during the 1970s and 1980s, companies hired armies of data entry professionals tasked with entering repetitive information into network terminals. Today, many data entry tasks can be replaced by bar coding—a technology that can introduce data capture into new operations where speed or logistical considerations make manual data entry impossible.

## **Benefits of Bar Coding**

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### **Improved Data Accuracy**

Improved data accuracy is the single most common motivation for implementing a bar code system. Often the backbone of operations, data entry enables a company to produce accurate reports and predictions about future needs and actions. With data entry playing such a critical role in a company's operations, it is important to identify the extent to which data entry errors are tolerated. During the 1970s, it was not uncommon for large corporations to allow for data entry errors in 85 percent of transactions. By 1985, these same companies were striving to reach tolerances of 90 percent.

Bar coding enables these companies to reach goals that were unthinkable 10 years ago. Today, companies with integrated bar coding systems that enable users to scan bar codes rather than type numbers are commonly achieving 99 percent data accuracy.

For companies in which data errors are a mere nuisance, the difference between 85 percent and 99 percent may not seem that extreme. But for organizations in which data entry errors are catastrophic, such as hospitals, crime labs and manufacturing companies, the goal is 100 percent accuracy. Bar coding is the best tool that these organizations have to ensure data credibility and thereby greatly reduce the impact of human error.

### **Efficiency Benefits**

Besides providing near-perfect accuracy, bar coding also enables users to work faster, without sacrificing accuracy. Also called automatic identification or auto ID, bar coding gives enterprise computer systems the capability to "see" exactly what is happening within an organization, enabling companies to instantly convert physical actions into digital transactions. When factoring in the time it takes to correct simple data entry errors, it is easy to see the improved efficiency that comes with bar coding.

While the time saved in data entry operations is easily recognized, the true efficiency improvements emerge when bar coding capabilities are extended to other areas of the organization, resulting in functional automation.

### **Consistency**

Bar coding, particularly in fast-paced industrial environments, enables consistent and predictable operations by combining data management functions and by preventing bottlenecks at data entry stations. Auto ID systems usually operate at a defined pace, either self-determined by the printer's maximum speed or triggered by the action of another device. For instance, in an assembly line, operations that were previously slowed by congestion at the point of data entry can now progress smoothly through a system of automated print-and-apply labeling machines and fixed scanners.

### **Improved Inventory and Asset Management**

Bar coding can help any company get a handle on resources. Companies are routinely bar coding assets such as manufacturing equipment, computer hardware, office furniture and tools in order to record the number of each item, as well as the condition, color, features and the designated user. Libraries around the world are starting to place bar codes on books to track borrowing history. Likewise, automotive fleet owners, public transportation agencies

and rental car companies have begun utilizing bar codes to track detailed maintenance records for each vehicle.

Manufacturing companies have similar applications in place to track both resource and finished product inventories.

Many companies complete the manufacturing process by affixing a label to the finished product, container or pallet. This label often contains very specific information about the product in both bar-coded data and human-readable text. The human-readable portion of the label is likely to describe the product characteristics, the packaged quantity and the names of both the manufacturer and the customer, if known. The bar code contains internal information such as production line number, date of completion, materials used, serial numbers and miscellaneous quality control information. By scanning the label in the shipping department, the company can identify the exact inventory, in real time, as well as the precise date and time that any product leaves the warehouse.

## **Cost/Benefit Analysis**

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Besides the cost of the equipment, including the printer, scanner and media, the cost justification of an auto ID system can be a tricky computation. It is widely thought that most auto ID systems pay for themselves in less than two years, but this figure is dependent on a company's commitment to widespread implementation and acceptance of the bar coding technology. The "two year" argument alone is often not enough to gain approval of a proposed bar coding system and, similarly, is not even a sound consideration when planning an executive-mandated automation project.

Bar coding only generates a profit when supported by improved processes. When considering an implementation, every possible process improvement should be considered. There are some obvious improvements that can be achieved by implementing bar coding systems, such as placing bar codes on retail goods to spare employees from manually entering each product's price or serial number. Conversely, there are several new capabilities and controls that will appear from the improved data management that comes with a bar coding system.

The initial cost savings companies discover after implementing an auto ID system include labor cost reduction, improved customer service and supplier response times, capital and inventory management, space management and equipment costs.

In addition to the apparent savings, each of these areas also produces several hidden savings that must be considered during the cost analysis, though the answers may not surface until the implementation is complete. Once the data entry on the production line is automated, can production be sped up? If we create unique bar codes for each product, can the company fulfill customized solutions? Once inventory is monitored in real time, can we trim warehousing costs? These are just a few examples of the hidden gains resulting from bar coding. Several other opportunities will emerge as the use of auto ID gains synthesis with operations.

## **Bar Code Printing Technologies**

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The variety of technologies available for bar code printing can be overwhelming. Further complicating the decision is whether it is better to invest in a bar coding system or to purchase pre-printed bar code labels.

### **On Demand vs. Pre-printed Labels**

Thousands of companies have reaped significant benefits from ordering pre-printed bar code labels from service bureaus rather than investing in a bar coding system. Pre-printed labels are useful in operations that require only a low volume of identical or serialized labels, often with extensive use of colors or graphics.

However, companies that start with pre-printed labels quickly discover the limitations of this solution. Besides restricted flexibility, the use of pre-printed labels prevents companies from including customized human-readable text or bar-coded information.

As a result, most companies find the financial commitment of printing on-demand bar codes worth the initial investment because of the added value from printing customized information on each label. For many applications requiring high-volume, mission-critical labels, the added cost of pre-printed labels quickly exceeds the cost of the entire system.

To the surprise of many bar coding novices, most of the companies that order pre-printed labels also have bar coding systems. The pre-printed labels are ordered with the necessary color, graphics or standardized text (such as return addresses on shipping labels) and are then fed through a bar code printer to receive customized information.

Whether a user elects to use pre-printed or plain labels, media selection is critical to the success of any bar code integration. The variety of ribbons, paper and synthetic labels and tags is too great for discussion in this document, but the bar code application, the intended life span of the label, and the environment to which the label will be exposed, all have a direct impact on media selection.

## **Printing Technologies**

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Bar coding novices often assume that laser printers, dot matrix printers or ink jet printers already connected to the network are suitable for bar code labeling. While these printers can be used for some very simple applications, they have serious limitations that make them inadequate for professional labeling. The common limitations among these traditional office technologies include print speed and flexibility, as well as the inability to print labels that are durable enough, or have the longevity or clarity required for all but the most basic bar coding applications.

### **Ink Jet Printing**

Ink jet printers spray ink onto the label surface in either a continuous stream, covering the entire print width with one spray, or one drop at a time. Though it is the least expensive printing technology, ink jet printing is not acceptable for most applications. The most prohibitive factors concerning ink jet printing are ink-media compatibility, print speed and resolution. Most inks used with this technology are water-based and, therefore, streak, run or blur when they come in contact with water. Non-water-soluble inks are available, but these inks often produce a shine that reflects light back to the scanner, thereby rendering the bar code unscannable. Additionally, these printers are often too slow and are unable to reproduce bar codes with acceptable accuracy.

## **Dot Matrix Printing**

Dot matrix technology uses a hammer or pin to transfer pigment from a ribbon onto the substrate. Due to the inaccuracy of dot placement and low resolution of the printing technology, these printers are nearly unusable for bar coding.

## **Laser Printing**

Laser printers can be used for bar coding, but they too have several drawbacks for bar code labeling. Laser printers typically print only entire sheets of labels. Printing individual, unique labels requires several print cycles or printing the labels in batches. Laser printing is also susceptible to toner flaking and smudging, making the technology unsuitable for long-term bar coding.

## **Thermal Transfer Technology**

The most widely used technologies for dedicated bar coding systems are direct thermal and thermal transfer printing. Both technologies use a heated print head to create the image on the label.

Labels printed with thermal transfer printing are easily identified by the crisp, often glossy, printed surface. The clarity is achieved by using a thin ribbon roll that, when heated by the print head, melts onto the label to form the image. When matched with suitable media, thermal transfer technology is not only impervious to heat and moisture, but the image can not be rubbed off, making the printed labels the most durable available. An additional benefit of this technology is the continuity of the printed image. Because the color and density of the printed image is determined by the ribbon and the resolution of the printer, thermal transfer printing produces consistent, reliable printing on every label.

## **Direct Thermal Technology**

Direct thermal printing utilizes heat-sensitive media that blackens as it passes under the print head. Because they print without a ribbon, direct thermal printers are noted for their simplicity. Typically, direct thermal printed labels have a considerable shelf life. But labels that may come in contact with heat, face exposure to extended periods of direct sunlight, or get scratched or rubbed, are more suitable to the thermal transfer technology.

## **Bar Coding in Use**

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### **Receiving and Shipping Operations**

Outside of retail operations, receiving and shipping applications are the most widely used and recognized implementations of bar coding technology. International shipping companies depend on bar coding to enter packages into their route systems and, after quickly passing through transit hubs to transport the packages to the appropriate destinations, record the eventual delivery. Providing customers with a tool to track the progress of the package is a side benefit. Without bar coding, delivery companies such as UPS would be unable to process the immense number of packages that flows through their systems each night.

Bar coding does not have to begin, or end, once a package arrives or leaves a company's shipping department. Many companies, particularly large industrial ones, are using bar code label printers on receiving docks to place internal information on the incoming product. These labels may include supplier and product information, inventory location or other pertinent information. Companies may also print a small label to affix to the packing slip or bill of sale to track the item at a later date.

Shipping operations can also be a critical component in any bar coding system. Besides creating a label that complies with the specifications of the shipping company (if applicable), shipping operations may scan the existing bar code to remove the product from inventory or to acknowledge the shipping transaction. Again, a smaller label can also be printed to follow the shipping receipts through the accounting system. For additional information about integrating bar coding with enterprise-wide computer systems, see page 10 of this document.

### **Manufacturing Operations**

Manufacturing functions are just beginning to recognize and reap the benefits of bar coding. Many modern factories feature bar coding at several points in the production cycle. The most common application of automatic ID in manufacturing is for "job tickets"—tags or labels that utilize a combination of one or more bar codes and human-readable text to track the product's progress and provide assembly and warehousing instructions.

In some applications such as computer assembly, the job ticket can also serve as the product's permanent identification, enabling end users and tech support personnel to immediately identify the production characteristics of the item, much like a vehicle identification number on an automobile. By tracking these job tickets after the sale, companies are improving customer service response times and quality control. In addition, the information contained on the label, which serves as a guarantee of the product's original features and maintenance history, may improve product resale, thereby boosting the initial value of the item.

Depending on the environment and the volume of labels used in a manufacturing application, the bar code systems integrator should consider the durability of the printers. Traditionally, only metal-framed and encased printers are appropriate for industrial applications that rely on bar coding in mission-critical operations. Many people erroneously view plastic and metal/plastic printers as less expensive alternatives to the desirable metal printers. Non-metal printers are suited for medium- to light-volume printing and, with few exceptions, should not be used in industrial environments where the printers are subject to vibration, adverse operating conditions or 24-hour duty cycles.

### **Asset Management**

Large and small companies across all industries work hard to manage resource and product inventories, as well as an inventory of capital assets such as computers, office furniture, machinery and tools. Tracking inventory may be a security management task or may be required by governments to manage taxation related to the depreciation of assets. Whichever the case, bar code labeling provides exceptional control over all company assets, without extensive systems integration or expense.

For example, many small businesses place permanent labels on their computers and office furniture to denote ownership and to assist with annual inventory recording. In some companies, inventory is recorded using serialized labels to identify each item. Companies are just beginning to see the benefits that bar coding can bring to this process. When tasked with taking inventory of office computers, for example, users could scan the bar code on each computer and learn about the maintenance record of the unit, the physical migration of the computer from office to office and even a list of installed software. While this detailed information would be excessive and cumbersome without bar coding, it is easy to see the gains that any size company can achieve with this newfound data access.

## **Warehousing**

With space at a premium and rises in warehousing costs, companies have been searching for every possible way to trim inventory and the costs associated with managing the supply of raw materials and finished goods. At the same time, companies are looking for additional reporting about what is in inventory at any given moment. By now, it should be clear how bar coding can address all of these needs.

Bar coding simplifies the reporting process by avoiding the painstaking process of manually entering data into computer terminals. Many manufacturing and shipping operations feature automated picking stations that monitor and report about each item that enters and leaves inventory. Even companies that have not reached this level of automation can realize the benefits of auto ID by manually labeling and scanning each product to change its status in inventory. When connected to an enterprise-wide computer system, warehouse management systems can produce real-time reports detailing every product in inventory, giving warehouse managers the confidence to improve inventory efficiency.

In addition to individual packages, bar coding has been used effectively on other warehousing components. Pallet and shelf labeling has grown in acceptance as a method of recording the placement location of finished cartons. Even forklifts are being labeled to track and improve the paths of the lift around the warehouse floor.

## **Office and Customer Service Applications**

Another operation in which bar coding has gained new acceptance is in the office and in all customer service functions. It is becoming commonplace for law firms, hospitals and service organizations to use bar coding on files to identify clients and sort client records. Networking professionals and electricians routinely use bar codes to label cable and data ports. To meet the growing demand for office-friendly bar coding equipment, a growing selection of printers with small footprints has emerged with the same choice of technologies as the industrial-strength printers.

## Selecting the Right Printer

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Selecting the right printer is not as intimidating as it first appears. By describing the bar coding functions in specific terms and answering a few simple questions, users can narrow their printer choices considerably. The primary questions to ask yourself are:

- What are the intended uses of the bar code labels?
- Where will the printers be located?
- In what kind of environment will the printers operate? (temperature fluctuation, vibration, high humidity, exposure to chemicals, etc.)
- What are the anticipated duty cycles for the printers?
- Are there any minimum speed requirements?
- What are the dimensions of the labels to be used?
- How frequently do label specifications change?
- What kind of environments will the labels be exposed to? (temperature fluctuation, abrasion, high humidity, exposure to chemicals, etc.)
- Will the printers be connected to a network or connected to stand-alone terminals?
- What is the budget for the project?

## Integrated Bar Code Systems

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Though the advance of bar coding has created new data management opportunities, much of the potential of bar codes remains untapped. Most bar code printers are connected to stand-alone personal computers (PCs) that control the bar code label design and function as a print server. While these stand-alone systems, dubbed "island systems," can still take advantage of bar code scanning to provide data automation, human users must direct the printer to print and manually enter nearly every piece of information.

The recent explosion of enterprise resource planning (ERP) software has given bar coding an enhanced role in corporate information systems. In island systems, the bar code printer has no direct interaction with the corporate enterprise. When connected to an ERP system, the printer can take direction from other processes and print and encode data automatically when the server directs it to do so.

ERP systems, when used alone or partnered with warehouse management software or supply chain management applications, are capable of producing detailed reports based on the information they gather from the system operations. This reporting capability can be used with bar code integration software to print labels containing this same information.

## **Planning for Future Bar Code Requirements**

When planning a bar coding system, it is essential to plan for upcoming developments in the automatic ID industry. Besides staying abreast of the developing auto ID technologies, it is essential to make the system adaptable and scalable.

### **Compliance Labeling**

Compliance labeling, a common practice among large retailers in North America, is a growing challenge to bar coding systems. Several companies are mandating that their suppliers place bar code labels on their packages to speed processing. These labels must contain a specific list of information, and every label must be scannable using the receiving company's equipment.

For the suppliers, compliance labeling is a very serious undertaking. They risk fines, called "chargebacks," for labels that fail to meet specifications. This presents an even greater challenge to suppliers that sell to multiple customers that specify compliance labeling.

The ideal solution varies from industry to industry, but as compliance labeling expands outside of retail, and additional customers demand in-spec product labels, a greater number of suppliers will be forced to comply.

## **Growth of Automation, E-Commerce and Computerized Control**

The growth of electronic commerce and computerized transactions has led to new uses and new possibilities for bar code systems. Several companies have created automated picking systems that use Internet-based instruction to initiate transactions and pull products out of inventory.

It is unknown what additional new technologies will have an impact on bar coding systems. Radio frequency identification and wireless networking are already on the technology horizon. While it is impossible to plan for every technology development, it's clear that bar code systems will continue to reduce costs and improve efficiency throughout the entire enterprise.