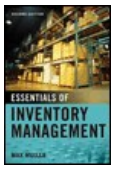


Essentials of Inventory Management, Second Edition

by Max Muller

Chapter 4: Automatic Identification

Errors and time increase dramatically the more often a human being is involved in identifying an object, inputting that information into a database, and then modifying the knowledge to keep track of changes in location, pack size, quantity, and so on.

The less you rely on human intervention to identify items, input information, and track data, the more timely and accurate your records will be.

Automatic Identification (*Auto ID*) refers to a broad range of technologies that are used to help machines identify objects without the need for a human being to key in the information. Auto ID is often coupled with automatic data capture. These technologies include bar codes, smart cards, voice recognition, some biometric technologies (retinal scans, for instance), optical character recognition, and radio-frequency identification (RFID). One-dimensional, linear bar coding is the most common method of automated inventory identification. In recent years, stacked symbologies, often called “2D symbologies” consisting of a given linear symbology repeated vertically in multiple and presented in various shapes, have evolved. Given the large number of 2D symbologies and their rapidly changing properties, this chapter will only deal with one-dimensional, linear bar coding—and with RFID.

The Basics of Bar Coding

Bar coding, an optical method of achieving automatic identification, is a major tool in capturing critical data quickly and accurately. It relies on visible or invisible light being reflected off of a printed pattern. The dark bars or dark areas within the pattern absorb light, and the intervening spaces or areas reflect light. The contrasting absorption and reflection is sensed by a device that “reads” this reflected pattern and decodes the information.

The time and dollar savings that would be realized if your organization could eliminate the time and errors noted above will often pay for a bar coding system. The speed of information capture and the accuracy of bar coding are often sufficient reasons to cost-justify installing bar coding within your operation.

Bar coding is not the only automated method of identifying inventory. For example, there is also optical character reading, machine vision, magnetic stripe, surface acoustic wave, and radio-frequency tags. See Exhibit 4–1.

Exhibit 4-1: Various Automated Methods of Identifying Inventory

Technology	How It Works	For Your Information
Optical Character Reading (OCR)	Numbers, letters, and characters are printed in a predetermined, standard character style or font. Like a bar code, the image is illuminated and the reflection is sensed and decoded.	▪ Allows for both human and machine readability ▪ 10 characters per inch data density ▪ Slower read rate than bar codes ▪ Higher error rate than bar codes ▪ Very sensitive to print quality
Machine Vision	Cameras take pictures of objects, encode, and send them to a computer for interpretation.	▪ Very accurate under the right light conditions ▪ Reads at moderate speed ▪ Expensive
Magnetic Stripe	A magnetic stripe, like those on credit cards, is encoded with information.	▪ Proven technology ▪ Readable through grease and dirt

		▪ Relatively high density of information—25 to 70 characters per inch ▪ Information can be changed ▪ Must use a contact reader, making high-speed reading of many items impractical ▪ Not human readable
Surface Acoustic Wave (SAW)	Data is encoded on a chip that is encased in a tag. In response to a radar pulse from a reader with a special antenna, the tag converts the pulse to an ultrasonic acoustic wave. Each tag is uniquely programmed so that the resulting acoustic wave has an amplitude matching the chip's code. The wave is converted back to an electromagnetic signal sent back to the reader.	▪ Can be used in highly hazardous environments such as high heat and acid baths ▪ Can be read up to 6 feet away ▪ No line of sight required ▪ Physically durable
Radio-Frequency Tag	Data is encoded on a chip that is encased in a tag. In response to a radar pulse from a reader with a special antenna, a transponder in the tag sends a signal to the reader.	▪ Tags can be programmable or permanently coded ▪ Can be read up to 30 feet away ▪ No line of sight required ▪ Physically durable—life in excess of 10 years

Bar code systems generally consist of three components: the code itself, the reading device(s), and the printer(s). The objective of this chapter is to provide you with a working knowledge of (1) elements of a bar code symbol; (2) the fundamentals of the more commonly used linear bar code languages/symbologies in the inventory control world; (3) printing and scanning (reading) basics; and (4) some practical bar code applications.

Elements of a Bar Code Symbol

Why can you easily read the sentence, "Inventory control is fun?" You can read that sentence because you recognize the alphabet and understand the rules of grammar and sentence construction. A bar code "symbology" or language is very similar because it has a fixed alphabet made up of various patterns of dark bars and intervening light spaces coupled with rules for how it is presented.

There are many types of bar codes, not all of which consist of the linear symbols most commonly found in the inventory control world. For example:

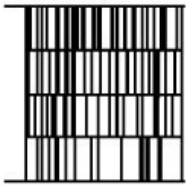
Appearance of common one-dimensional, linear types of bar code patterns:

Appearance of common two-dimensional, matrix and stacked bar code patterns:

Presently, linear bar codes are the most commonly used for general inventory control purposes.

Structure of a Generic Bar Code Symbol

The entire pattern is called the “symbol.” Each bar or space is called an “element.”



Quiet Zone

Symbols can be read from left to right or right to left. A bar code scanner (reader) must make a number of measurements to decode the symbol accurately. The quiet zones on each side of the symbol gives the scanner a starting point from which to start its measurement.

Start and Stop Characters

For codes to be read from either direction or top to bottom or bottom to top in a vertically oriented symbol, start and stop characters tell the scanner where the message begins. It is customary for the character on the left or at the top of the symbol to be the start character, and the one on the right or bottom to be the stop character.

Data Characters

The data characters are the actual message within the code. These can be letters of the alphabet, numbers, symbols (+, −, /, =), or a combination of all three.

“X” Dimension

The narrowest bar or space in a bar code is called the “X” dimension. This width can run from 5 mils to 50 mils. A mil is one-thousandth of an inch.

This width is very important because it determines how wide each narrow and wide bar or space will be. The narrow bars/spaces are a single “X” in width, while the wide bars/spaces can be two, three, or four “Xs” wide. Therefore, an element (a bar or space) can be a single “X” or several “Xs.”

The larger the “X” dimension of a symbol, the easier it is to read.

Symbologies: Bar Coding Structural Rules

Just as there are rules for how an English sentence is structured, for the relationship of upper-case to lower-case letters, and for punctuation, similar rules govern bar codes. These rules are set out in a “symbology.” A symbology controls how information will be encoded in a bar code symbol.

Just as there are different languages, such as French, English, Spanish, Italian, Russian, Japanese, and Chinese, there are different symbologies. Common symbologies found in the inventory world are Code 39, Code 128, Interleaved 2 of 5, and UPC.

Symbologies are like typefaces with different character sets and separate printing characteristics. Some symbologies only present numbers. Some have numbers, upper-case alphabetics (A–Z), and limited special characters. Others have both upper- and lower-case alphabetics (A–Z, a–z), numbers, and a wide range of special characters. Some symbologies only allow for a set number of characters in a pattern, while others allow for variable-length messages.

Discrete and Continuous Symbologies

Bar codes can either be discrete or continuous. Characters in a discrete code start with a bar and end with a bar, and they have a space between each character. Characters in a continuous code start with a bar, end with a space, and have no gap between one character and another. The primary significance of the difference is that a discrete code is easier to print and read, but you can get more characters per inch with a continuous code.

Which of the following is easier to read?

Symbologies Symbologies Symbologies Symbologies

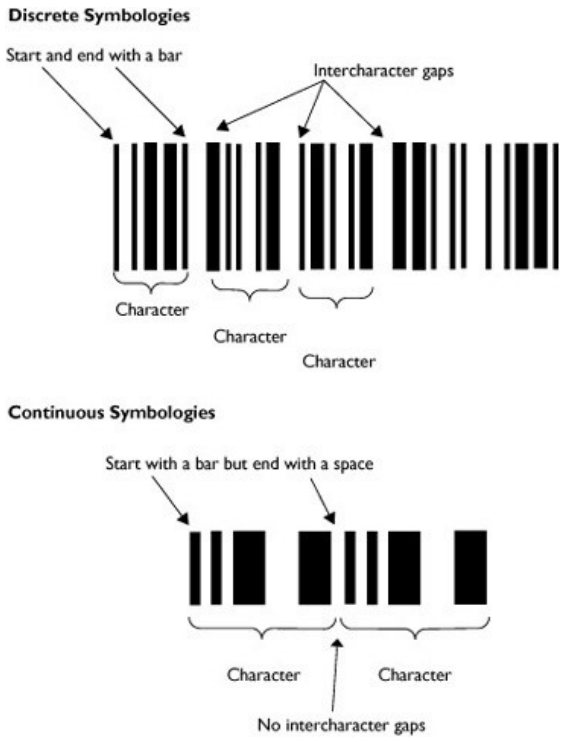
The word on the far left is the most difficult to read but has the greatest amount of information in the smallest amount of space, which is a good thing on a bar code label with limited space available. The word on the far right is the easiest to read, would allows for a more forgiving print job (for example, if the ink spread on the label surface between each letter, we would still be able to read it), but it takes up more space. Discrete symbologies are easier to print and read, but they take up more space.

Symbology Summary

The rules of a particular symbology control are:

- Character set—which alphabetics, numbers, and special characters are in the symbology?
- Symbology type—discrete or continuous? See Exhibit 4–2.
- Number of element widths—how many different “Xs” are there in the wide bars/spaces?
- Fixed or variable lengths of characters in a pattern?
- Density—how many characters can appear per inch?

Exhibit 4-2: Structural Differences—Discrete versus Continuous Bar Code Symbologies



Popular Symbologies Found in the Inventory World

Dozens of bar code symbologies exist. Many have failed in the marketplace because a large number of printer and scanner suppliers will not support them. Others are owned by individual companies that control and limit their use. Others have

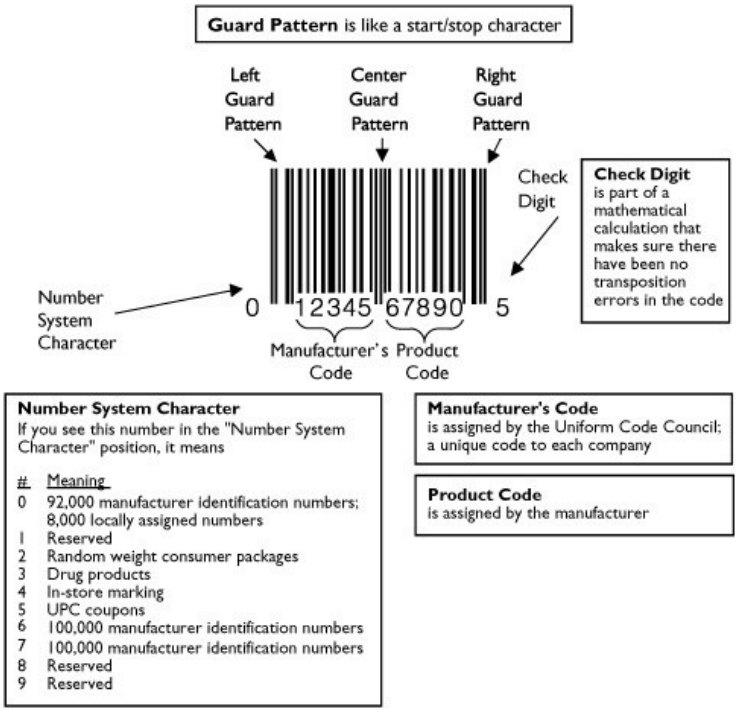
specialized uses, such as Postnet, which is used by the U.S. Postal Service. Some are widely supported and accepted in the inventory control world.

Universal Product Code/European Article Numbering System

Without question, when dealing with point-of-sale identification of product (as in a grocery or other retail store), the bar code used is the Universal Product Code (UPC). A very similar code, which will eventually be interchangeable with UPC, is the European Article Numbering System (EAN).

The UPC symbology is highly structured and controlled, and it is only used in general merchandise retailing. It is an all numeric, fixed-length (11 characters) symbology. The UPC symbol is physically arranged into two halves. The left half has six numbers that identify the manufacturer or packager. The right half identifies the product. See Exhibit 4–3. You have to license the right to use the UPC from the Uniform Code Council (UCC), an organization created by the grocery industry.

Exhibit 4-3: Structure of the Universal Product Code Symbol



The UPC is not suitable for inventory control use within a warehousing or manufacturing facility where there is a need for variable-length messages, alpha-numeric coding, flexible identification patterns, and so on.

Code 39

This symbology is the most widely used bar code in nonretail applications. It was first introduced in 1975.

Most stockkeepers will be able to find a Code 39 software to interface with their existing application software systems. In other words, you should be able to find a Code 39 bar code package that will allow you to continue to use your existing in-house software, numbering systems, and internal procedures.

Code 39 is sometimes referred to as “3 of 9 Code” because three of the nine elements (bars or spaces) making up a Code 39 character are wide and the other six are narrow.

Code 39 was the first alpha-numeric symbology developed. Among its most important features are:

- Entire alphabet in upper-case letters
- All numerics (e.g., 0 through 9)
- Seven special characters: −, ., *, $, /, +, %, and a character representing a blank space

- Discrete symbology
- Allows variable-length symbols
- Allows two messages to be decoded and transmitted as one (“concatenation”)
- Can be printed in a wide variety of technologies
- Although there are only 43 data characters in the basic Code 39 set, by using certain characters as internal codes, it is possible to encode all 128 ASCII (American Code of Information Interchange) characters used by computers. This feature is cumbersome and is not widely used.
- Self checking, which means a single printing defect cannot cause an error where one character is mistaken for another.

Code 128

This code, introduced in 1981, has many desirable features, such as:

- It uses three start codes to allow the encoding of all 128 ASCII characters without cumbersome procedures. Therefore, you can use the entire alphabet in both upper-and lower-case, all 10 numerics, and all special characters. Each printed character can have one of three meanings.
- There is high data density and continuous symbology that uses the least amount of label space for messages of six or more characters.
- Tests have shown this to be a highly readable code with high message integrity.
- Code 128 has become one of the two standard bar code symbologies used to identify the contents of corrugated boxes. (The other standard for corrugated shipping boxes is Interleaved 2 of 5 symbology.)
- Code 128 allows for concatenation.

Which Symbology Is Right for Your Organization?

Each symbology has its strengths and weaknesses. There is no one “right” bar code language that will fit every organization’s needs.

A starting point in reviewing appropriate symbologies actually begins with your own industry. Has your industry selected a particular type of symbology? For example, the automotive industry has been using Code 39 since 1980. You can obtain guidance from trade associations in your industry segment.

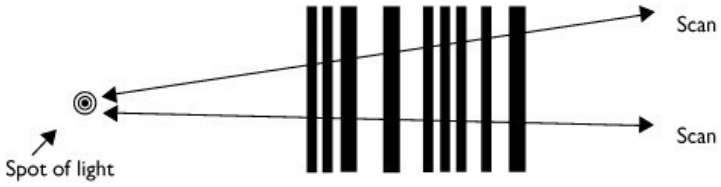
The reason to start with a symbology accepted by your industry is that direct application software and hardware will have been written or created for the specific requirements of your business. It is the old question, “Why recreate the wheel?”

If no symbology dominates your industry, then the real questions become, What do you want the system to do for you? and How large is your budget?

Scanning Basics

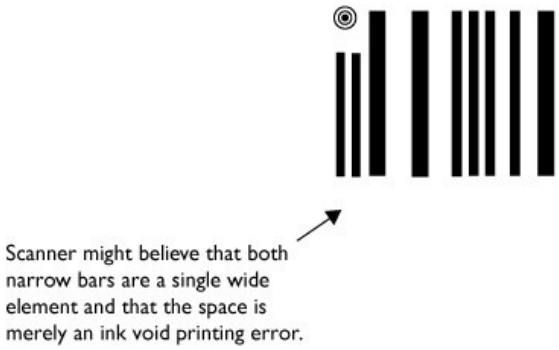
Something has to read a bar code. That something is a scanner. These electrooptical devices include a means of illuminating the symbol and measuring reflected light.

A scanner projects a tiny spot of light that crosses the bar code symbol and then measures the exact width of the bars and spaces. The measurement is determined by the amount of reflectance off of the dark and light bars and spaces. Software in either the scanner or in a separate plug-in device then translates the visual (analog) signal into a digital one that a computer can understand and then decodes what symbology (language) it is reading and the message contained in the pattern.



Light reflected is converted from an analog voltage (visual) format to a digital waveform for decoding.

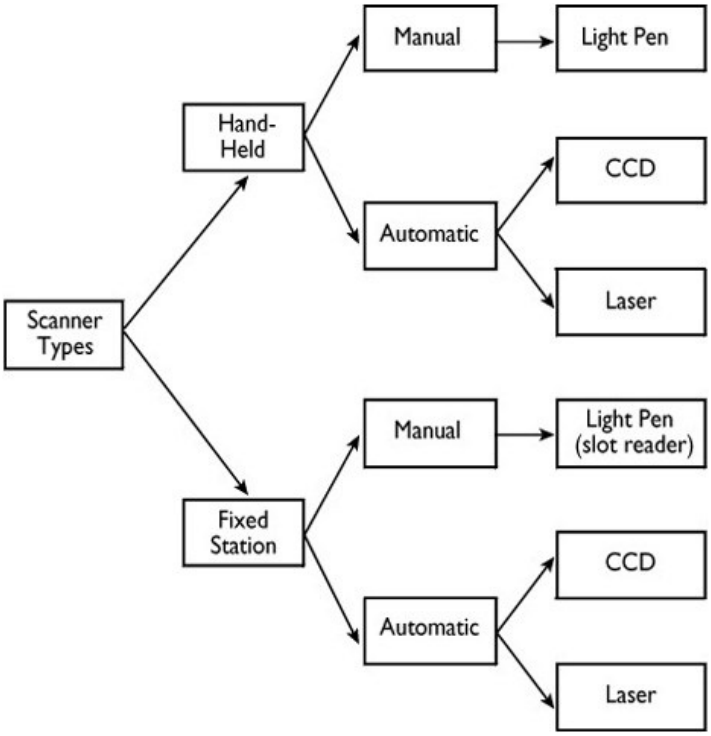
The spot of light must not be larger than the "X" dimension being used for that label or you will get misreads.



Scanners must be purchased so that they match the "X" dimension that will be used for printing labels or for printing directly onto a surface.

Scanners can either be manual (where the user supplies the scanning motion) or automatic (where the device provides the scanning motion). See Exhibit 4–4.

Exhibit 4-4: Scanner Types



- Light pen (wand scanner)

  —Makes contact with the label or surface on which pattern is printed

  —Inexpensive

  —Durable

  —Can be tied into various decoder types of equipment

- Charge Coupled Device (CCD)

  —Has a depth of field of several inches so you do not have to make contact with the label or other surface. Therefore,

you can read through shrink wrap, which is common in warehousing operations.

—Floods symbol with light and reflectance illuminates photodetectors in the CCD scanner. Can read very high bar code densities

—Moderate cost

- Lasers

—Project a beam of energy off of a rotating prism or oscillating mirror

—Depth of field of several feet

—Expensive but versatile

Printing Basics

Bar code printing can be done by the user on-site or by an off-site third-party vendor.

On-site printing generally occurs close to where product is either being received or shipped—its point-of-use.

Five basic on-site bar code print technologies are available: direct thermal, thermal transfer, dot matrix impact, ink jet, and laser (Xerographic). See Exhibit 4–5.

Exhibit 4-5: Common Bar Code Print Technologies

- **Direct Thermal** —Overlapping dots are formed on a heat-sensitive substrate (label or other foundation) by selectively heating elements in a printhead.
- **Thermal Transfer** —Same concept as direct thermal except the image is transferred to the substrate from a ribbon that is heated by the elements in the printhead.
- **Dot Matrix Impact** —A moving printhead with rows of hammers that creates images through multiple passes over a ribbon.
- **Ink Jet** —A fixed printhead sprays tiny droplets of ink onto a substrate.
- **Laser (Xerographic)** —A controlled laser beam creates an image on an electrostatically charged, photoconductive drum. The charged areas attract toner particles that are transferred and fused onto the substrate.

Off-site, commercial printers use a wide variety of printing techniques.

See Chapter 3, Exhibit 3–13, for a discussion of methods to affix bar code labels.

Bar Code Applications

It is far more important that you understand what you want to accomplish with bar codes than for you to understand all of the technical aspects of them.

Think of all of the bits and pieces of information you need to know to control inventory in a distribution environment. For example:

- Manufacturer
- Supplier
- SKU number
- Description
- Pack size
- Ship to address

- Bill to address
- Credit terms
- Identification of receiving clerk, stock replenishment worker, order filler, shipping clerk
- Shipper
- Carrier
- Quantity
- Throughput rates (e.g., pieces per hour)
- Time, date
- Location
- Purchase order identification

Think of all the information you need to control material in a manufacturing environment. For example:

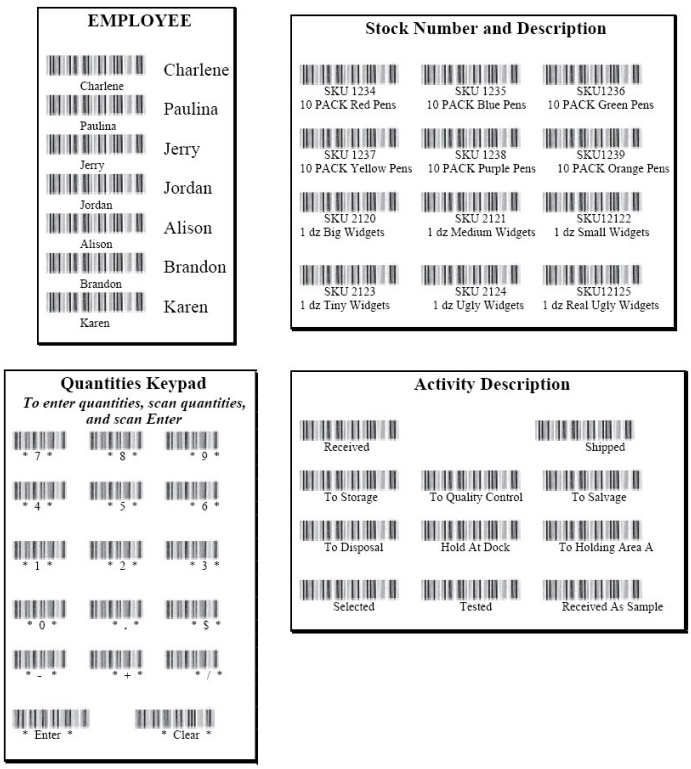
- Particular bill of materials
- SKU number
- Quantity
- Work in process (WIP)
- Individual tasks
- Throughput rates
- Scrap
- Time, date
- Which machine
- Which process
- Location
- Machine instructions
- Job number

All of the above can be given a bar code identifier.

Bar code labels and markings can be printed directly on forms, boxes, the product itself, or on labels that are then affixed to forms, boxes, items themselves, individual parts of items, and so on.

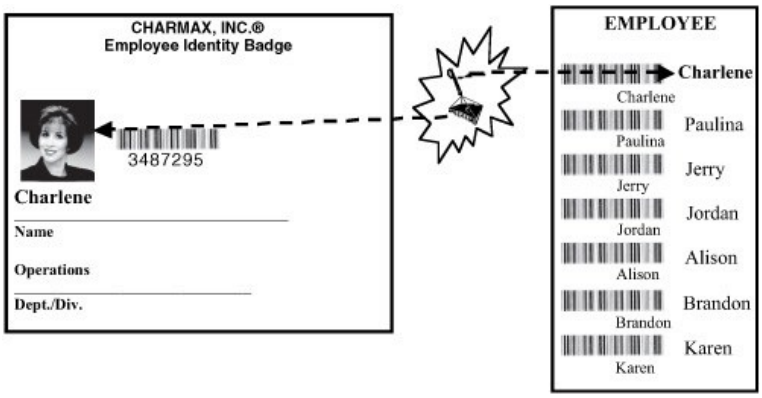
A quick and easy way to begin using bar codes is through the use of scan boards or menu cards. A scan board or menu card is merely a sheet of paper or heavier card stock that contains on it information in both machine readable (bar code) and human readable (plain alpha-numeric text) formats. See Exhibit 4–6 for examples of common scan boards/menu cards.

Exhibit 4-6: Common Types of Bar Code Scan Boards/Menu Cards

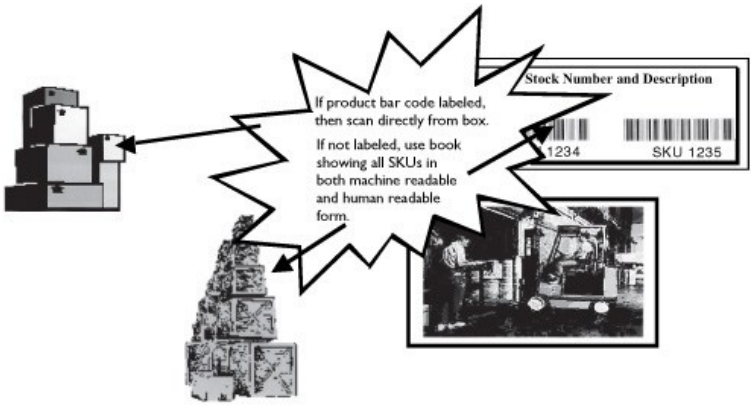


Examples of using bar codes include:

- Receiving—Shipping
  1. Employee scans in their own identity off of scan board or identification badge.

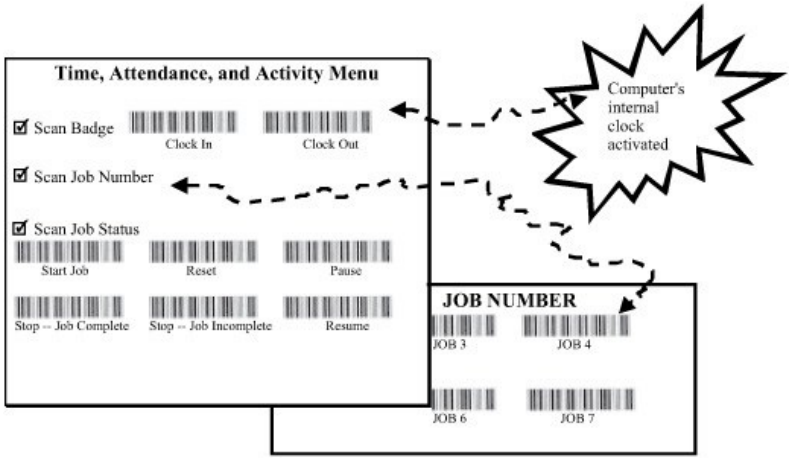


  2. Employee scans product code from either items themselves or from scan board.



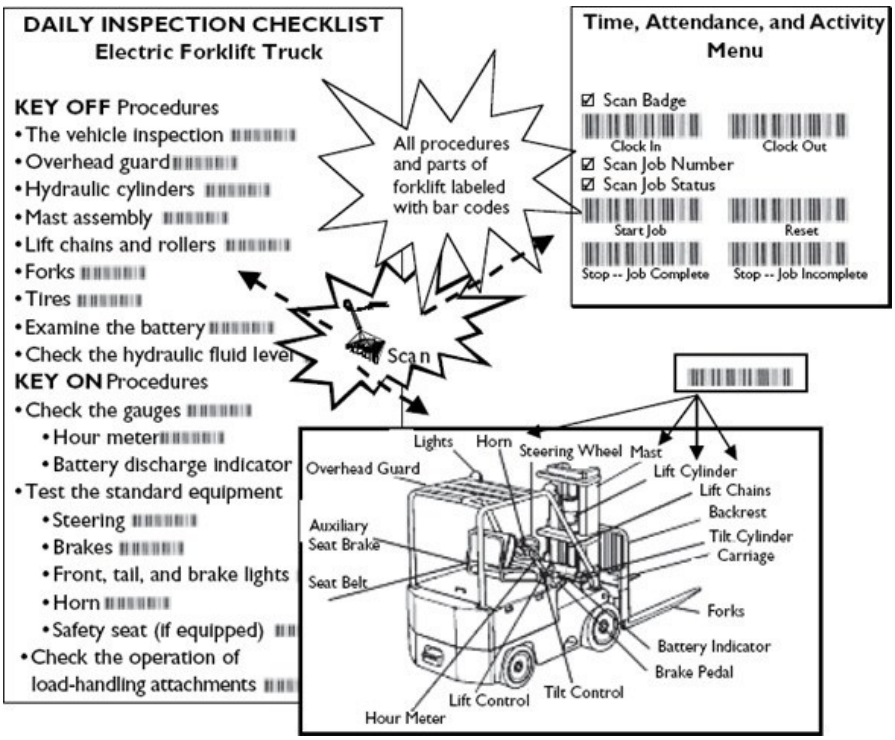
3. Employee scans in quantity.
4. Employee scans in activity (received, shipped, etc.).

- Tracking Multiple Activities at the Same Time in a Manufacturing Setting



1. Employee scans in his or her identity.
2. Employee scans in either “Clock In” or “Clock Out.” This starting/stopping time can be noted by the computer’s internal clock. In addition, the computer’s internal calendar notes the date.
    a. This information could be automatically routed to accounting for payroll purposes.
    b. This information will be captured for the particular job in question. That information can then be used as a part of various variance reports such as projected starting time versus actual starting time, projected ending time versus actual ending time, and so on. See Chapter 6, page 00–00 for a discussion of variance reports.
3. Employee scans in Job Number.
4. Employee scans in Job Status.
5. When employee scans in “Stop—Job Complete,” system could begin, for example, a backflush of all raw materials used as part of the job just completed. See Exhibit 6–1 for more information on backflushing.

- Using Bar Coding as Part of a Maintenance Program
    1. Bar codes are assigned to each part of the maintenance procedure and to various parts (engines, for example) of the piece of equipment in question.
    2. Employee then uses a Time, Attendance, and Activity Menu to track the maintenance tasks.



- Bar Coding and Physical Inventory and Cycle Counting

The Basics of Radio-Frequency Identification

Radio-frequency identification (RFID) is a generic term for technologies that use radio waves to automatically identify objects (or people). It is a still emerging overall set of technologies with no, as yet, universally accepted set of standards for label or tag layout, software or hardware design.

Although several methods of identification are available, the most common is to store a serial number that identifies an object and other information on a microchip. The microchip is attached to an antenna (the chip and the antenna together are called an RFID transponder, or an RFID tag). The antenna enables the chip to transmit the identification information to a reader. The reader converts the radio waves reflected back or sent from the RFID tag into digital information that can then be passed on to computers that can make use of it. See Exhibit 4–7.

Exhibit 4-7: RFID Components

- Bar coding is seeing; RFID is hearing.

RFID TAG TYPES AND CLASSES

There are two basic types and five basic classes of RFID tags.

The basic types are:

- ***Passive Tags*** —operate without an internal battery source. Electromagnetic waves sent from the reader starts a current in the tag's antenna, and the tag uses that energy to respond to the reader.
- ***Active Tags*** —powered by an internal battery and are typically read/write devices.

The tag classes include:

- ***CLASS 0 (Read-Only Tags)*** —Very basic tag with a minimum of data. Data is usually a simple Tag ID stored only once into the tag during manufacture.

1. Bar code markings in both machine-readable and human-readable form are placed on both the storage locations (shelves, racks, drawers, bins) and on the product itself.
2. A counter equipped with a portable scanner:

a. Scans in the identity of the SKU.

b. Enters the quantity through a keypad on the scanner. The record count and shelf count can be compared in a variety of ways:

1. The shelf count as captured by the scanner and counter can be transmitted into the system by way of radio frequency at the time of information capture, or it can be uploaded from the scanner at a later time. The computer system would then generate an exception report of those items where the record and shelf counts did not match.

2. Scanners are small computers. Because of that they can contain software allowing them to have the record count stored within them. As the scanner reads the bar code and the counter enters the quantity information, the scanner could immediately compare the record count and shelf count. If there was a discrepancy, the scanner could alert the counter either through audible tones, flashing lights, or LED displays. The counter could then immediately initiate a recount.

- ***CLASS 1 (Write Once Read Only [WORM])*** —These types of tags can be programmed by either the tag manufacturer or by the user only once.
- ***CLASS 2 (Read Write)*** —With these tags data can be read as well as written into the tag's memory.
- ***CLASS 3 (Read Write with on-board sensors)*** —These are active tags that contain sensors for recording parameters like temperature, pressure, etc., and can record the readings in tag memory.
- ***CLASS 4 (Read Write with integrated transmitters)*** —This class of tag can communicate with each other without any help from a reader.

The type of tag you use is dependent on how and why you're using RFID and the environment you're going to be operating it in. See Exhibit 4–8.

Exhibit 4-8: Tag Selection Considerations

- Data requirements—memory requirements, programmability, etc., will be dependent on use (e.g., item, box, case, pallet, returns).

- Type of reader—readers available to support the tag in question.
- Read speed—read speed will impact how long the tag has to be within range of the reader.
- Read redundancy—the number of times a tag must be read while in the reading area.
- Harsh environments—survivability and durability become factors in environments with high moisture (steam), corrosive chemicals, and high heat or extreme cold.
- Recordation—use may require tags to contain sensors that measure and record temperature, etc.
- Security—use may require tags to be capable of encryption.

Bar Code versus RFID

Neither of these two technologies is necessarily better or worse than the other. They have different applications, which sometimes overlap. You must look at your application and your financial and technological resources when deciding which technology will work best for you—and, which you can afford both short and long term.

Only your imagination limits what you can use RFID for. Common uses include, but aren't limited to:

- ***Asset tracking*** —tracking of assets in offices, labs, warehouses, pallets and containers in the supply chain, books in libraries
- ***Manufacturing*** —tracking of parts during manufacture, tracking of assembled items
- ***Medical*** —Linking patients to their specific drugs, personnel giving the drugs, biometric measurements
- ***People tracking*** —security tracking for entrance management or security, baby tags in hospitals to manage access to postnatal wards
- ***Retail*** —tracking grocery carts in supermarkets
- ***Animal tracking*** —implanted RFID tags in animals for tracking and linking the animal to food, location
- ***Time tracking*** —sports event timing to track athletes as they start a race and pass the finish line, pickup and delivery start and stop times

RFID Item Identification

One of the characteristics of RFID is that specific items in the supply chain can be individually identified. This is accomplished through a unique serial number. The dominant RFID code is the *Electronic Product Code™ (EPC).* The unique serial number allows inquiries to be made about an item wherever it is within the supply chain. The most prevailing version of the EPC contains information about the manufacturer, the type of object, and a specific serial number that relates to the specific object being monitored.

The EPC and all protocols and standards relating to it are overseen by EPCglobal, a not-for-profit joint venture set up by the Uniform Code Council, which licensed the EPC technologies developed by the Auto-ID Center, and EAN International, the bar code standards body in Europe.

The Advantages of RFID

There are a number of advantages to RFID. See Exhibit 4–9.

Exhibit 4-9: RFID Advantages

BAR CODES	RFID
▪ Require a direct line of sight to the printed barcode	Do not require a direct line of sight to the printed barcode. Can be read through most objects.
▪ Reading range generally up to 15 feet (depending on equipment)	Reading range up to approximately 300 feet (depending on equipment)

▪ Approximately a half second or more to successfully complete a read	Read rates up to 40 or more tags per second
▪ Bar code labels are more vulnerable. If a label is dirty, torn, falls off, etc., it can't be read.	RFID tags are more rugged because they are in a plastic cover and can even be embedded in a product (further protecting it from external forces)
▪ Barcodes have no read/write capability. Once printed no new information can be added.	RFID tags can be read/write devices. A RFID reader can communicate with the tag and alter as much of the information as the tag design will allow.
▪ Standard bar codes identify only the manufacturer and product, not the unique item (e.g., each widget is identified the same as every other identical widget — not that specific widget).	RFID tags identify the specific object.

Basically, bar codes are line-of-sight technology. A scanner has to "see" the bar code to read it. With RFID, tags can be read as long as they are within range of a reader. Bar codes can't see through objects or other barriers between the scanner and the reader. Radio waves, however, do travel through most barriers and are therefore far more versatile. (*Caution*: Radio waves bounce off metal and are absorbed by water at ultrahigh frequencies. Therefore, it's harder to RFID track metal objects or those with high water content. RFID designers and manufacturers continue to work on overcoming these issues.)

The Problems Associated with RFID

Although RFID providers continue to improve RFID delivery mechanisms, configurations, and hardware and software, there are a number of challenges associated with RFI.

Lack of Rfid Standards

Because global standards are still being developed, different manufacturers have implemented RFID in a variety of ways, Many of these installations are "closed-loop" systems. In a nutshell, this means that a company has implemented a system to track items that never leave its own control using a certain proprietary technology. Therefore, a different organization that has implanted RFID using a different RFID technology can't read the tags that were placed by the first company, and vice versa.

Many of the supply chain benefits of RFID are derived from being able to track items as they move from one organization to the next or, even, internationally. The lack of standardization frustrates those benefits.

Money, Money, Money

Cost continues to be a major consideration.

RFID readers typically cost hundreds of dollars. You must calculate how many readers you would need to cover all of your locations. Some companies would need hundreds, if not thousands, of readers to cover all their factories, warehouses, and stores.

RFID tags can also become expensive to the point of being cost prohibitive. Even if a tag only cost 10 to 20 cents, imagine the expense of placing hundreds of thousands of them on an item that only costs a few dollars.

System Disruption Vulnerability

Because RFID systems use the electromagnetic spectrum, they are relatively easy to jam using energy at the right frequency.

In addition, active RFID tags that use a battery to increase the range of the system can be repeatedly interrogated to wear the battery down, resulting in system disruption.

Rfid Reader Collision

When the signals from two or more readers overlap, reader collision occurs. The tag is unable to respond to simultaneous

queries.

Many systems use an *anticollision protocol* (also called a *singulation protocol*) that enable tags to take turns in transmitting to a reader.

Rfid Tag Collision

Tag collision occurs when many tags are present in a small area and are trying to send information simultaneously to the reader.

RFID providers are developing systems that ensure that tags respond one at a time.

Security, Privacy, and Ethics Problems With Rfid

- The contents of an RFID tag can be read in a pocket or purse. Since RFID tags cannot tell the difference between one reader and another and scanners are portable, RFID tags in your pocket or purse can be read from a distance, from a few inches to a few yards.
- RFID tags are difficult to remove. RFID tags are difficult to for consumers to remove, irritating them.
- RFID tags with unique serial numbers could be linked to an individual credit card number

The Universal Product Code (UPC) implemented with bar codes only allows each product type sold in a store to have a unique number that identifies that product. However, all of that product would have the same number—not a unique number for each individual item. In an RFID system *each individual item* can have its own number. With that type of a system in place, if an item is scanned for purchase and is paid for, the RFID tag number for a particular item could be associated with a credit card number.

Recap

The objective of this chapter was to provide you with an overview of automated identification approaches including bar coding, various popular symbologies, basic bar code applications, and radio-frequency identification.

The set of rules for how the bars and spaces of a bar code language, its symbology, are arranged dictates how much and what type of data can be displayed within a particular symbol. The language that is most appropriate to your industry will be determined by how much data and in what form that information must be displayed on your goods, inventory, or other materials.

RFID is a technology that has a wide array of potential uses. Although there are real challenges in implementing an RFID system, with proper implementation, RFID is a technology that can improve your supply chain process—and your bottom line.

In applying automated identification to your system, you are only limited by your imagination—and your wallet. Applications can be simple ones involving bar code scan boards or can be complex, utilizing laser scanners, radio frequency, and sophisticated sharing of information throughout the system at the time of information capture.

Review Questions

1. True or False ?

The Universal Product Code allows for the identification of each individual item sold in a retail environment.

a. True

b. False

2. True or False ?

There are only five types of bar code languages.

a. True

b. False

3. True or False ?

The most widely used bar code symbology for nonretail applications is Code 39.

a. True

b. False

4. True or False ?

When the signals from two or more readers overlap, tag collision occurs.

a. True

b. False

5. Which symbology is the most widely used for retail point-of-sale transactions? ?

a. Universal Product Code

b. Code 39

c. Code 128

d. Codabar

Answers

1. (b)

2. (b)

3. (a)

4. (b)

5. (a)