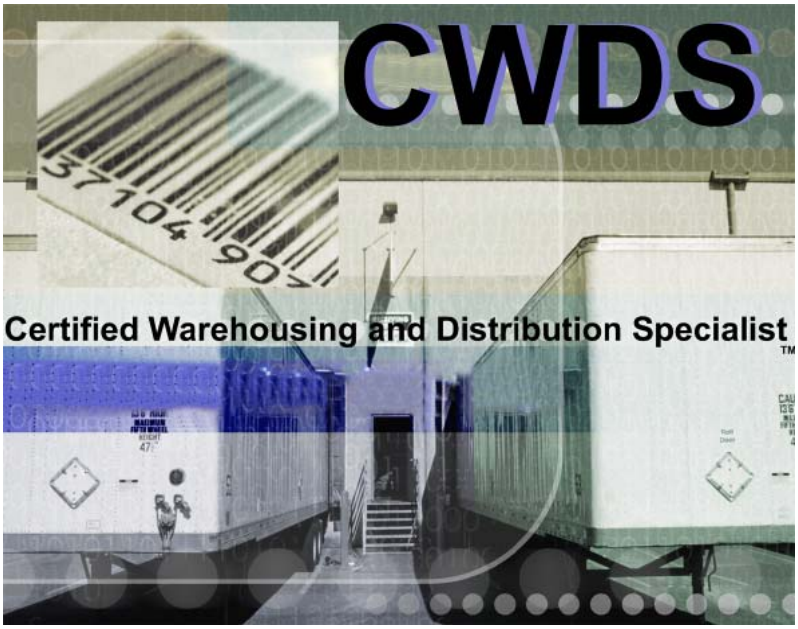

Warehousing Data Applications

QUICKSTART®
TECHNICAL COLLEGE SYSTEM OF GEORGIA

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Introduction

Overview

To successfully meet your customer's requirements the warehouse must be able to make efficient use of warehouse resources through the proper balance of labor, equipment, space and systems. To successfully balance warehouse resources the system inventory must accurately reflect the physical inventory. Accuracy can be attained through continuously checking the inventory or through confidence in the system inventory.

In a manual warehouse system inventory confidence can be assured by constantly checking stock through the use of personnel. In an automated system, confidence is placed in the accuracy of a computer-controlled system. In either case inventory accuracy requires an expenditure of either people time or computer time.

Automated Warehouse Management Systems are designed to serve warehousing needs that seem to be beyond the capabilities of manual systems. A Warehouse Management System (WMS) reflects the choice of computer time over people time. While Warehouse Management Systems can be very accurate, manual warehouses systems can also achieve very high inventory accuracy and very low outbound errors by adding order checkers, pickers, and proper paperwork to account for warehouse activity.

All WMS systems use some form of data entry automation to minimize errors. With complete confidence in the warehousing system, people no longer question the validity of the inventory. "Stock chasers" are no longer needed to check if the inventory accurately reflects product in the warehouse ready to ship. "Just-in-case" inventory is eliminated from the warehouse since the planning group is confident that the system inventory and the physical inventory match. The benefits associated with high confidence in accurate inventories are:

- Fewer customer complaints
- Eliminating physical inventories
- Stopping excessive returns
- Eliminating stocking errors
- Eliminating picking errors
- Stopping poor space utilization
- Stopping inventory accuracy errors
- Stopping excessive seek and search times
- Eliminating poor productivity
- Stopping excessive expediting

Warehouse Management Systems incorporate communication technologies, Inventory Identification Systems, Electronic Data Interchange (EDI), and Manufacturing Resource Planning (MRP II) to maintain an accurate and efficient inventory system. This unit will discuss some of these technologies that are commonly used in warehouse management.

Objectives

The information, activities and practice provided in this unit will enable you to:

1. List the four basic warehouse functions.
2. Describe different types of Warehousing Systems.
3. List the types of Inventory Identification Systems.
4. Describe the advantages of radio frequency communications.
5. List the fundamental units of a radio frequency communication system.
6. Describe a typical RF Warehouse Transaction.
7. Explain the advantages of RF data input over manual data input.
8. Describe the advantages of Electronic Data Interchange.
9. Explain how EDI helps the warehouse attain its goals.
10. Describe the MRP II communication process.
11. Explain how MRP II affects the manufacturing process.

Notes:

Warehouse Systems

All warehouses generally perform four basic functions.

1. Receiving
    a. Purchased items
    b. Subcontractor supplied goods
    c Customer returns

2. Warehousing
    a. Quality inspection
    b. Putaway
    c. Location and warehouse control

3. Picking product
    a. Raw material picking
    b. Work-in-progress picking
    c. Finished goods picking

4. Shipping
    a. Internal customer shipments
    b. External shipments

The Warehouse Management System (WMS) is in place to help the company attain its customer service goals through control of resources.
In the final analysis, the warehouse challenge is the proper use of its labor, equipment, space and systems to perform its basic functions. While these factors constantly change to meet the needs of customers, the controlling system should have sufficient flexibility to adapt to the changes. An appropriately employed Warehouse Management System will offer organizations a competitive advantage.

Manual Warehouse Systems

All warehouses have inventory locator systems of various sophistications in place. The lowest manual system level is called the "Hey Gus" system; i.e. "Hey Gus, where did you put those widgets last week?" This type of system can easily fail if Gus is out sick or has been fired for forgetting where the stock has been placed.

Usually, the Manual Warehouse System tracks inventory using paper documents and logbooks called Bin Card Locator systems. Bin Card Locator Systems have cards or sheets of paper containing product ID and storage information that are maintained manually and stored on the warehouse floor.

More sophisticated systems update and feed this information to the host computer when the information is manually entered at a terminal. These batch-type updates occur on a shift or daily basis causing information lags of from eight to 24 hours long.

Inventory locator systems used in Manual Warehouses are error prone at nearly every level:

- Manual errors at the card level when a worker accidentally writes down the wrong product ID or location.
- Bin Cards are misfiled or lost at the consolidation point.
- Batch entry input errors occur approximately once every 300 keystrokes.
- Frantic searches for lost or misplaced inventory.
- Struggling to meet orders due to old or bad information.
- Uncertain order status.
- Unsure turnaround and response time.

PC or Host-Based Warehouse Systems

The PC or Host-based locator system generates paper lists for picks, putaway, and other activities. Host-based systems share purchasing, sales, and inventory information with other business systems on the site but those entities cannot affect the inventory system. While Host-based systems are more sophisticated than manual systems they still have problems.

- Usually do not support critical activities like crossdocking, routing, or staging.
- No interaction with the system at pick and putaway points deters cycle counting strategies.
- Host-based systems still require periodic physical inventories.
- Picks and putaways can't be verified immediately on the computer.
- Detailed audit trails do not exist.
- Inventory information has time lags of from 2 to 24 hours.
- Batch entry information input errors occur approximately once every 300 keystrokes.

Very few Host-based Locator Systems support Electronic Data Interchange (EDI) or have Automatic Inventory and Data Capture (AIDC) systems in place. Most data entry is conducted by keystroke. Truly efficient Warehouse Systems cease to rely on manual data input and have employed AIDC and EDI for information interchange.

Progress Check #1

1. List the four basic warehouse functions.

2. Warehouses are charged with efficient use of

3. How often is warehouse data from Bin-card locator and Host-based systems entered into the system computers?

4. Lost or missing bin cards, batch entry input errors, unsure turnaround or response time, and uncertain order status are all symptoms of what type of warehouse system?

5. Even though Host–based inventory systems are more sophisticated than manual systems, they both encounter data error through

6. In Warehouse Management Systems AIDC and EDI technologies eliminate

Inventory Identification Systems

Inventory accuracy requires that the tools used to capture and record data be accurate and consistent. Inventory identification tools are grouped under the industry heading of Automatic Identification and Data Capture (AIDC). The many technologies representing AIDC are:

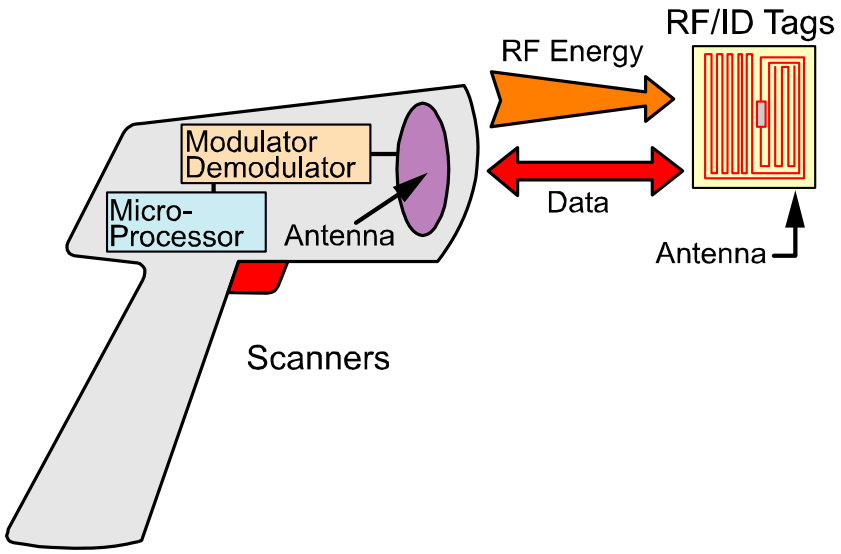
- Radio Frequency Identification (RF/ID)
- Magnetic Strip (Mag Strip)
- Optical Character Recognition (OCR)
- Voice Recognition
- Bar Coding

In order to choose the most effective tool for any application the environment must be taken into consideration. Consider the following points to help narrow the field of possible tools.

- Contact vs. Non-contact. Do you need to be able to touch the product or label?
- Line-of-Sight. Do you need to see the product or label to capture data?
- Environment. Is the environment hostile because of climate or chemicals?
- Data Density. How much data do you need to capture and how big is the area to read the data?
- Cost. What is the desired cost for the tool?
- First–read rates. How critical is it that every first read is good?
- Inventory tools

RF/ID Technology

RF/ID is an inventory control technology that transmits its identifying presence when inserted into an electromagnetic field. One very common application is a clothing tag that triggers an alarm when passing through an electromagnetic field at the store exit. RF/ID tags can also store data and are configured as either read only or read/write tags. RF/ID tags can be either active or passive. Passive tags are only on when in the presence of an electromagnetic field while active tags transmit data all the time.



RF/ID Technology

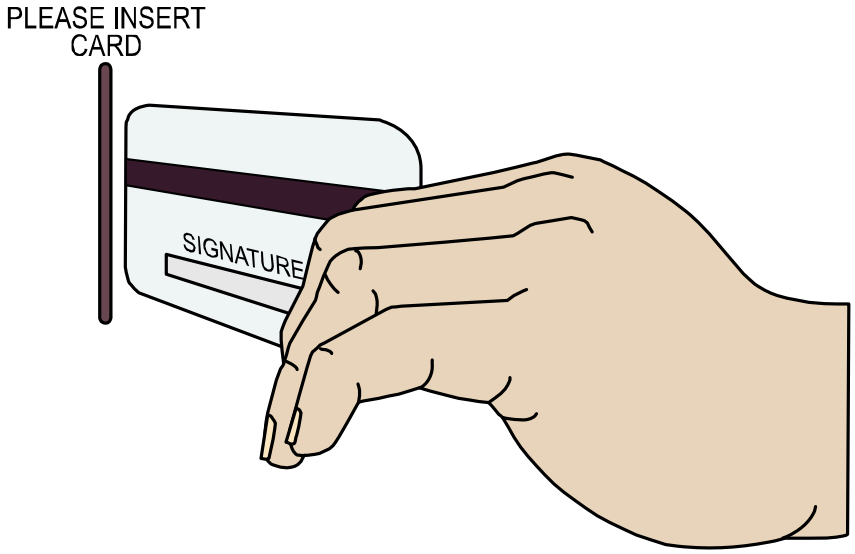
One great advantage of the RF/ID tag is that it transmits data in all directions so that the tag can be read from any direction. The receiver can read the tag data as long as it is in range of the tag. This device does not require line-of-sight to be effective. Another advantage is that the RF/ID tag can endure harsh environments. RF/ID warehouse systems have good range and can even be triangulated to provide location information.

RF/ID tags are used in Electronic Article Surveillance (EAS) as used in apparel stores. RF/ID is used to track transportation fleets to determine vehicle location and maintenance records. RF/ID tags travel with the product and can store the product's history and location. RF/ID tags can access customer accounts for quicker transactions.

The disadvantages of RF/ID systems are related to the limitations of radio frequency communications. RF/ID tags have a limited range of about one meter. To prevent confusion, only one RF/ID tag and only one transponder should be in the "read zone" at a time. Transponder cost is quite high and difficult to justify.

Magnetic Strip Identification Technology

Plastic cards with magnetic strips hold data and reduce human transcription error. Magnetic strip (Mag Strip) identification technology is used on the back of most credit cards and ATM cards. The magnetic strip carries an encoded ID number that can be read so that the system can retrieve the proper account information. Mag Strip is usually attached to a card, badge or ticket. The "media" can be made of any nonmagnetic material to which the Mag Strip can be made to adhere. The strip must be on the surface so that nothing can interfere with contact by the reader.



Mag Strip

Mag Strip requires contact and line-of-sight to read the data. Mag Strip is sensitive to the environment because rubbing the card against another card or passing it through a strong magnetic field can erase the magnetic data. Data density and costs are medium among identification technologies and first–read rates are high.

Mag Strip is usually applied for labor tracking and plant security. The data gained from employee entrance and departure can be channeled to the performance measurement and the payroll system through EDI.

Optical Character Recognition

Optical Character Recognition (OCR) is the only identification technology that tries to read regular handwriting and type. OCR software applies pattern–matching methods to character shapes that have been read into the computer. By careful comparison the software determines what the character that has been read into the computer represents. The United States Post Office uses this type of system extensively to read the zip code on envelopes. After the OCR system has read the zip code it is converted and printed on the envelope in bar code for future processing. OCR software available at present is usually divided into three levels of relative accuracy.

Conventional OCR software uses one OCR engine and is able to achieve about 76% first–read accuracy in recognizing typical data in documents. On a typical 2000 character document conventional OCR will generate 480 errors.

Level 3 OCR improves accuracy through the use of multiple OCR schemes. The data is passed through each of three different OCR technologies, called voting technologies, and the typical 2000 character document could contain about 17 errors or 99.15% accuracy.

Level 5 OCR technology increases accuracy to 99.6% or about 8 errors in 2000 by using 5 voting technologies. This level is rather expensive and time consuming but may be worth the expense in some applications.

OCR reading errors can be attributed to character variations such as:

- Image skew or rotation
- Color or print density
- Faults due to low quality documents

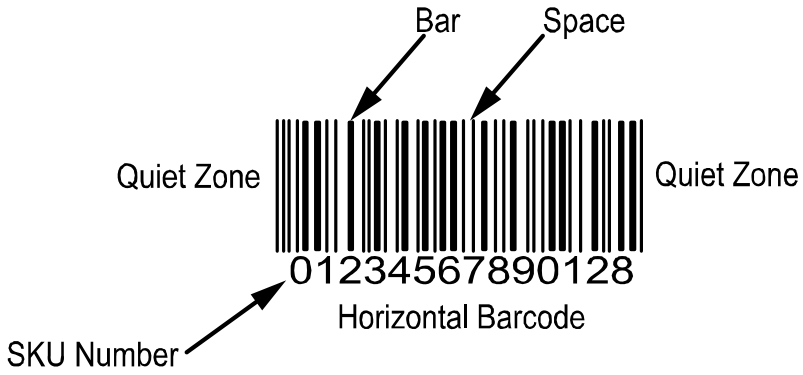
Voice Recognition

Voice recognition is the ability of a machine or program to receive and interpret dictation, or to understand and carry out spoken commands. Voice Recognition systems recognize words based on a fixed vocabulary. Using this system the operator can have both hands free without having to read instructions from a screen or instruction sheet. Tone and pronunciation can affect accuracy and this system is considered to be generally slower than conventional data collection systems. The size of a voice-recognition program's effective vocabulary is directly related to the memory capacity of the computer on which it is installed. With more RAM memory the program can search for matches faster than if the vocabulary is stored on hard disk. Processing speed is also critical to enable the program to search faster.

Voice recognition systems are subject to errors caused by background noises, echoes, and loud external conversations that can provide confusing input to the system. Homonyms can also cause confusion. This problem can be resolved by using stored contextual information that would also require more RAM memory.

Bar Coding

Bar codes are the most common identification technology used in distribution today and the future seems to point to increased popularity of bar codes. Currently about 225 bar code symbologies exist but only a few are widely used. The bar code uses parallel dark bars and spaces to represent alphabetic and numeric characters. Since light is reflected by light surfaces and absorbed by dark surfaces the dark bars absorb light. The bar code reader is a photo detector that can determine the relative difference between dark bars and light spaces. The bar code reader can generate an electronic signal that is then decoded by the system. An example of a typical bar code in illustrated in the figure below.



Bar Code

Bar code systems don't require contact but they do require line–of–sight. The paper medium used for the bar–coded information is usually sensitive to harsh environments. Data density of one-dimensional bar codes is limited but two-dimensional bar codes allow for much greater data density. The features and functionality of many popular bar code systems can be seen in Appendix.

Advantages presented by bar code systems:

- Clerical errors are detectable and may be automatically corrected.
- Processing errors can be reduced.
- Scanner can serve as an inquiry terminal.
- Inventory/disbursement data is collected when an item is scanned.
- Sale information is automatically collected.
- Eliminating many manual procedures reduces the number of personnel needed.

AIDC Technology	Contact	Line of Sight	Sensitivity to Environment	Data Density	Cost First Read Rates
RF/ID	No	No	Very Low	Low/ High	High 96%
Mag Strip	Yes	Yes	Medium	Med	Medium 95%
OCR	Yes	Yes	Low/Med	Low	Low 76%
Voice	No	Yes	Medium	Low	High 80%
Bar Code	No	Yes	Low/Med	Low/ Med	Low 98%

Summary of Inventory Identification Systems

Progress Check #2

1. Which AIDC technology does not require line-of-sight?

2. Which type of AIDC is used on credit cards?

3. What are the disadvantages of voice recognition?

4. Explain how each of the following AIDC Technologies works.

   a. Radio Frequency Identification (RF/ID)

   b. Magnetic Strip (Mag Strip)

   c. Optical Character Recognition (OCR)

d. Voice Recognition (Voice)

e. Bar Code

Warehouse Data Communications

In order for the WMS to be effective, an accurate data communication system must be installed within the warehouse network. In the past, terminals were hard-wired in place and data information was carried via written document from the point-of-use to the terminal to be manually entered into the system. This type of system could allow many different types of errors to exist in the inventory record. Since a major factor used to compare different warehouse systems is data input lag time, communication speed and accuracy is key to the system's ability to fulfill its potential.

One of the greatest challenges for businesses today is to provide the entire organization with more timely information. Recently much of industry's response to the challenge is to use computers to streamline job functions. One example is the widespread use of bar codes to identify products, warehouse locations, and manufacturing information. Usually technology is upgraded like this as a reactive response rather than a plan of growth for long-term strategy. To determine whether the current data communication system is appropriate, evaluate the following questions.

- Does the existing system collect process information such as picks, putaways, counts, etc., at the source?
- Does the existing system collect information when and where transactions occur?
- Is critical inventory and manufacturing data on a true real-time basis?
- Does the system know where all product is at any given time?
- Does the system know where product or material needs to go?
- Does the system know when the product or material needs to get there?

A negative answer to any of these questions reveals the need for a newer data communication technology to be installed. With this in mind, we shall investigate the advantages of Radio Frequency (RF) communications and the Local Area Network (LAN).

Radio Frequency (RF) Data Communications

RF data communication is the interactive exchange of data between a remote operator and a computer using radio waves as a communication medium. RF can be considered to be a wireless extension of an existing network. One important aspect of RF communication systems is that they extend the computer information systems to the physical points of need and use. Since radio waves can penetrate walls and floors, the network can be extended beyond the point where traditional cabling. An example might be a storage lot adjacent to the warehouse where terminals and power and data cabling are impractical.

When an RF system is implemented with appropriate technology, such as warehouse management software and bar coding you can expect the specific operational improvements listed below.

Reliable Information: The point-of-use capabilities of RF systems provide an organization with reliable information on process such as receiving, storing, picking, material handling, shipping, inventory control, quality control, distribution, and Just-in-time manufacturing processes.

A sharper competitive edge: Applying the information that RF data communication systems provide buys the organization formidable tools resulting in:

- An increase in inventory accuracy to between 99.5% and 100%.
- Labor management will increase throughput and productivity.
- Departments will be able to engage in interactive information exchange
- Paperless systems
- More flexible work force

Extending the reach of existing computer systems with RF-based network segments and point-of-use applications positions your organization for the information needs of the 21st century. Data flows attributed to specific users and locations facilitates better task management and provides detailed audit paths for operational analysis and efficiency. RF communication is the intuitive link to the powerful trend of bar coding and AIDC that customers and suppliers are expecting. Bar coding with RF is a key to more precise management of inventories. Cost-conscious businesses can no longer support vague, inaccurate inventories and "just-in-case" safety stocks. RF systems help improve customer service through enhanced responsiveness and increased order accuracy. As such, RF can have an important role in Total Quality Management (TQM) and ISO certification.

Advantages of RF-Based Warehousing Systems

As you have seen, the advantages of RF over traditional computer systems provide great potential to modernize any warehouse operation. The main advantages of RF Warehousing Systems are:

- Provides information at the point-of-application source.
- Instantaneously inputs information into the host without batch delays.
- Verifies all incoming data transactions instantaneously.
- Enables use of powerful warehouse management systems that increase inventory accuracy, increase labor productivity via task management, and can eliminate physical inventories through cycle counting strategies.
- Completes entire transactions in less time than it takes to pull and initial a bin card.

RF Data Terminals

There are many different types of RF terminals. The three most common are hand-held, hands-free, and truck-mount RF terminals.

Hand-Held

Hand-held terminals are designed to roam free with on-foot users. Hand-held terminals go to the point-of-use so that there is no need to bring the work or materials to the terminal. The best applications for hand-held terminals are when lift or pallet trucks are not required. Hand-held units are a good for most receiving, putaway, picking, merge, and shipping applications because they are kept on a tether or in a holster until needed. RF terminal manufacturers make special units for harsh environments such as ignitable vapor and materials, dust, moisture, and temperature extremes. Since most hand-held RF terminals will be carried all day, they come in a wide variety of sizes, shapes, and weights (the weight of hand-held terminals is largely determined by the battery). Weights range from 1 1/2 to 4 pounds. Shapes are generally determined by ergonomics of the application and the holder for the terminal. The size of hand-held units varies according to the features on the terminal unit, such as display size, scanner, or transponder type. Displays vary, with either LED (light emitting diode) displays or backlit LCD (liquid crystal display) screens for dim environments. Screen sizes vary from 2 rows x 16 columns to 16 rows x 26 columns, depending on the amount of information needed at the user's level during transactions.

Hands Free

Hands-free RF terminals are used in much the same way as hand-held terminals, except that the smaller, more compact unit is secured to the wrist or arm. Often the scanner and display screen are located on the "wrist-pack" and a cord runs to the terminal and transceiver worn on a belt. Due to their size, hands-free units have very small and display units. Hands-free terminals are used in applications where both hands are needed, such as picks with many small parts.

Truck Mount

Truck mount RF terminals are designed for mounting on pallet, lift and man-on-board trucks. These terminals are usually about the size of a notebook computer, with keyboards that allow a more extensive data display and operation while wearing gloves. Display sizes range from 2 rows x 40 columns to a full-sized 24 rows x 80 columns. Truck mount RF terminals may use battery packs but often will be wired to the electrical system of the truck. Truck mount terminals are designed to withstand the vibration and jostling associated with lift and pallet truck operation. The large display screens are better for workflow direction (where the host directs the operator what to do next) and work management through a continuous link to the host. Truck mount terminals usually have scanners on a tether or cord with a holster mounted on the vehicle.

Typical RF Transaction

RF transactions and processes usually direct the flow of work in the warehouse. The steps in a typical RF transaction, listed below, will help clarify the RF communication process.

1. A customer calls in an order. Sales takes the information, checks product inventory on the host and knows the information reflects what is available now, not eight to twelve hours ago. The sales department gives the customer a shipping date and enters the order into the host.
2. The host generates the appropriate information from the order and places the order pick list in the warehouse queue.
3. The order number is given to a warehouse worker either from a paper list generated at the warehouse or by electronic workflow direction on the screen of his or her RF terminal.
4. The warehouse worker enters the order number and queries the host.
5. The host returns the location of the first pick.
6. The worker goes to the location and scans the location bar code.
7. The host verifies the location and returns the directed pick quantity.
8. The worker completes the pick and enters the quantity into the RF terminal.
9. The host verifies the quantity and then returns to the next pick location, or directs the worker to take the order to the manufacturing, staging, or shipping area as is appropriate.

Transactions such as these reduce errors and improve inventory and order accuracy. In addition, a detailed audit path is left listing who picked what, how long it took, and so on. It's easy to see how this information can be turned into productivity measures and goals.

Progress Check #3

1. Usually when a warehouse takes steps to upgrade technology it is:

   a. A reactive response to an urgent need.

   b. A carefully considered plan for long-term growth.

2. Explain how RF communications systems would impact the following company departments:

   a. Warehouse:

   b. Sales:

   c. Purchasing:

   d. Personnel:

Electronic Data Interchange (EDI)

Over 70 percent of the data entering business computers comes from other computers. Electronic Data Interchange (EDI) enables computers to transmit data to each other eliminating the costly step of manual data entry. While the savings promised by reduced data entry costs are sufficient to encourage implementing EDI, the additional system efficiency and responsiveness can improve the entire supply chain.

In the same way that WMS has been used to improve the internal efficiency of an operation, EDI can achieve similar results both inside and outside the warehouse. Through the use of WMS and EDI efficiency results from effective workload planning, accuracy, and efficiency in the warehouse. EDI can improve the customer service provided by your warehouse by generating savings and service throughout the supply chain.

Definition of EDI

Electronic Data Interchange (EDI) is the electronic transmission of standardized structured documents between computer applications in two organizations or remote sites of the same organization.

As mentioned earlier, Warehouse Management Systems are judged by the speed with which they communicate information throughout the company. Electronic data transmission is necessary to accelerate the exchange of information to ensure that it is current, relevant and accurate. In order to ensure that both the sender and the receiver understand the data in the same way, standard structured documents are used.

Data must be transferred accurately between computer applications; otherwise, it is useless. Information must be transferred between business applications, such as from an ordering system to a purchase order management system, or from a freight management system to a WMS. Unless there is a geographic or functional separation of the organizations, other methods may be more suitable, such as sharing resources on a local or wide-area network.

EDI represents an exceptionally fast, accurate and automated technique for transferring information between companies and their suppliers and customers. It is the speed with which accurate data becomes available that is the most significant benefit of EDI. With EDI there is a significant reduction in the "lag time" normally associated with paperwork transactions while the documents are waiting in the queue for entry into the computer system.

How EDI Affects Business

The impact of EDI on a business is far from simple, which makes its financial effects difficult to quantify. Most commercial organizations rely on three things in order to function effectively. These three things are:

- The flow of products or services from themselves to customers (and also from their suppliers to themselves)
- The flow of cash into and out of the organization
- The flow of information

While the need for products and cash flow are immediately obvious, the necessity of the flow of information is not difficult to see. In the modern company, information is the glue that holds the organization together. The availability, distribution and use of timely, accurate and appropriate information are the critical factors for running efficient organizations. The WMS is the mechanism for capturing and using a substantial amount of important information in the area of physical distribution. EDI is an effective transport mechanism for that information.

Many operational and planning systems also rely on accurate and timely data from each other, which may also be attributable indirectly to EDI transactions. An example is the Manufacturing Resource Planning (MRPII) system, which requires an accurate inventory status being available from the WMS. If inventory is kept at remote sites or the organization manages inventory at its customers' sites, this inventory status information may be collected using EDI. In order to determine what must be manufactured, the MRPII system requires information about customer orders and their delivery dates. This information might come from an order processing system that accepts purchase orders using EDI.

An on-line Order Processing System will accept EDI purchase orders to reduce the order lead-time and ensure order entry accuracy. The Order Processing System will also rely on accurate inventory data from the WMS.

The Advance Ship Notice (ASN) or Ship Notice/Manifest / EDI transaction allows the WMS to identify inventory that is expected, as well as current inventory allowing order commitment against product which may not be currently in-stock but is expected soon.

Many organizations can receive significant advantages from EDI by enhancing their competitive advantage through reduced costs and improved customer service. The process of improving customer service while reducing operational costs will be familiar to those who have studied Total Quality Management. The systems enable the organization to make and distribute the right products at the right time by doing effective planning based on information acquired by accurate on-line measurement and control. If the organization is producing the right products at the right time, waste is eliminated, and costs are reduced.

How EDI Can Affect Warehouse Operations

Distributors receive EDI-transmitted ASNs from manufacturers and send EDI–transmitted ASNs to customers. If these customers are retailers with other customers, the ASN chain can go one level further. Another link might be EDI transmissions to and from the common carriers used by manufacturers and distributors. Within organizations both manufacturers and distributors may communicate between their locations through EDI–transmitted ASNs.

More specifically, the manufacturer's host computer sends an ASN to the distributor's host computer that passes the inbound ASN data to the warehouse system. In that process the manufacturer notifies the distributor about essential shipment details including the number of cartons, the quantities and items in them, the weight and the number of pallets, the truck delivering the shipment, and the date and time of arrival. Of particular interest to the distributor are lot and serial numbers and expiration dates which are very labor-intensive for the distributor to gather.

The warehouse prepares a customer shipment and then the warehouse sends similar data to the distributor's host computer. In the meantime, the distributor may send an EDI transmission to the common carrier that will transport the shipment to the customer telling the carrier what size truck to send and providing information so the carrier can schedule trucks and routing. Later the carrier reports to the distributor with an ASN reporting status and delivery information.

The ASN concept is based on a trusting relationship among the business partners. Each recipient assumes the shipment related to the ASN will correspond exactly with the ASN. As a result, when merchandise arrives the receiving process is greatly streamlined. The recipient can simply scan the product and put it away noting only the discrepancies. This process facilitates combining the receiving function with putaway for some operations.

Numerous other benefits result from using EDI to send ASNs among distribution business partners. They include the ability to:

- Manage docks for receipts of many trailers with shipments
- Anticipate personnel and equipment required to unload trucks
- Quickly find incoming items that are critically needed for resale or backorders by the recipient
- Foresee warehouse space requirements and reserve that space
- Plan putaways (RF transmissions or printed pick lists)
- Anticipate personnel and equipment required for putaways

The ASN supplies data for inbound workload planning. Once the distributor knows the size and complexity of the pending delivery and how to manage it then the distributor can plan to turn the merchandise around, after sending a similarly detailed ASN to the customer, because the distributor knows ahead of time when inventory will be available. Every advantage that the distributor receives from the manufacturer equally applies to the advantage that the customer receives from the distributor.

The customer may be a giant retailer with a distribution center that needs to service other customers. The distributor's outbound ASN gives the retailer all the detailed information necessary to pass on to the stores through the warehouse's outbound ASN. The process is like a snowball passing from manufacturer to distributor to retailer to end–user. The product is totally visible all the way through.

Generally, an ASN relationship is built on a high degree of accuracy. Let's say that the distributor and customer have a relationship that includes an agreement to be 99.9% accurate with shipments. The customer knows the shipment will be accurate as well as the date and time that it will arrive. Often the agreement is structured so that distributors and manufacturers that provide ASNs for their customers can request shipping performance reports from their customers. The reports indicate the degree of accuracy of the ASN and what the customers like and don't like about the shipments.

EDI is the industry-accepted standard for developing information and electronically sending it from one point to another in the supply chain. Why not simply use fax? Because EDI is computer controlled. A host computer can automatically collect, format and distribute timely information to all concerned, including the warehouse, purchasing, expediting, and customer service departments as well as other "need-to-know" entities. EDI collects information that would otherwise be too labor-intensive to accumulate, like lot serial numbers and other unique data about a carton or shipment.

What size company typically uses EDI? The answer today is quite different from five years ago. Using EDI has become a required way of doing business. Mass retailers are insisting on using EDI to exchange information with their business partners; many refuse to do business with suppliers that do not possess EDI capabilities. These retailers are large enough to demand that smaller companies provide it.

Being able to send ASNs by EDI is practical even for small companies, although their method of implementation may involve a limited degree of automation. Since small companies tend to be less sophisticated in computer capabilities than larger companies, many formulate information in some manual way and key it back into some type of EDI transaction instead of having each internal process capture information automatically. Furthermore, not all companies provide their business partners with the same degree of detail in ASNs.

Preparing information, getting it to the EDI translator, and then sending it is not particularly costly. In the world of RF and computer controlled operations, formulation of that data is just part of the normal work process. The distributor who does not use EDI pays the truly high cost in business limitations.

How EDI and Warehouse Control Systems Can Affect Operations

We have seen how EDI can reduce administrative costs by eliminating keystroke data entry. We have also seen how EDI can affect conventional warehouse operations. But with the two technologies, EDI and WMS, are coupled with bar codes, we have a system for the accurate tracking of inventory and the efficient distribution of inventory information. Such a system is an unparalleled tool for effective planning and maximizing customer service while minimizing costs. It is also the basis of a process called supply chain synthesis.

Supply chain synthesis initiatives such as Quick Response, Efficient Consumer Response, and Just-In-Time all benefit from the use of a WMS with EDI. Each of these initiatives is engaged in re-engineering the process of supplying the product to the end user, and treating the costs of end product as being a factor of all the steps between raw materials and the finished product.

EDI allows suppliers and retailers to interchange information quickly and efficiently. This "paperless" communication system has benefited from the use of open computer systems using Windows. As effective as EDI has been, Quick Response (QR) and Efficient Customer Response (ECR) software are advanced adaptations that work even better.

QR establishes a just-in-time replenishment system between venders and dealers. QR software channels bar code scanning through EDI from the point of sale to place real-time orders and replenish inventory.

Efficient Consumer Response (ECR) is a variation of QR and EDI adopted by the supermarket industry as a business strategy in which distributors, suppliers, and grocers work closely together to bring products to consumers. Retailers use bar code and EDI to increase savings by reducing supply chain costs and inventory.

Currently the dry grocery segment of the industry maintains a 104-day inventory in the supply chain. If ECR received industry-wide implementation, the supply chain inventory would be reduced to 61 days at savings of more than $30 billion. These savings could potentially reduce consumer prices an average of 10.8%.

Currently, manufacturers push products on the markets by offering low prices on large quantities. A few times a year the manufacturer offers the grocer a low price on a large quantity of product, this is called "forward buying." The manufacturer then works with the supermarket to offer coupons and incentives to entice customers to buy the product during a promotion. Products not sold during the promotion are stored in inventory to carry that supermarket until the next manufacturer's promotional deal.

ECR focuses on the customers to drive the system, not the manufacturers' deals. Customers pull goods through the store and through the pipeline by their purchases. This permits the system to carry reduced inventory.

Progress Check #4

1. Approximately what quantity of data entering business computers comes from other computers?

2. EDI dictates that data be transmitted in the form of

3. What one factor accounts most for the increased speed of data communication with EDI?

4. The ASN communicates _____ to the WMS.

5. What three data components must be in place for business partners to use EDI?

6. Information delays can interfere with the efficiency that EDI can provide. Describe one reason that data entry could be delayed.

7. If ECR was installed throughout the dry goods segment of the grocery industry, what buying practice could be eliminated?

Manufacturing Resource Planning (MRP II)

MRP II is a fully integrated planning and control system providing coordination and communication among finance, marketing and production departments. The goals of MPR II are to:

- Make what we plan to make
- Manufacture to the highest quality standards
- Deliver product on time

MRP II is a management tool used in developing a production plan that can be adjusted as needed to satisfy changes in demand. Performance measures are built into the system to provide a feedback loop. MRP II integrates information from all manufacturing departments and adjusts production in an attempt to maximize company resources. The complex, interactive, and powerful nature of MRP II requires that all company data sources, such as EDI, ASNs, BOMs, etc., be supplied to the MRP II system so that timely and informed decisions can be made and enacted.

The MRP II Manufacturing Process

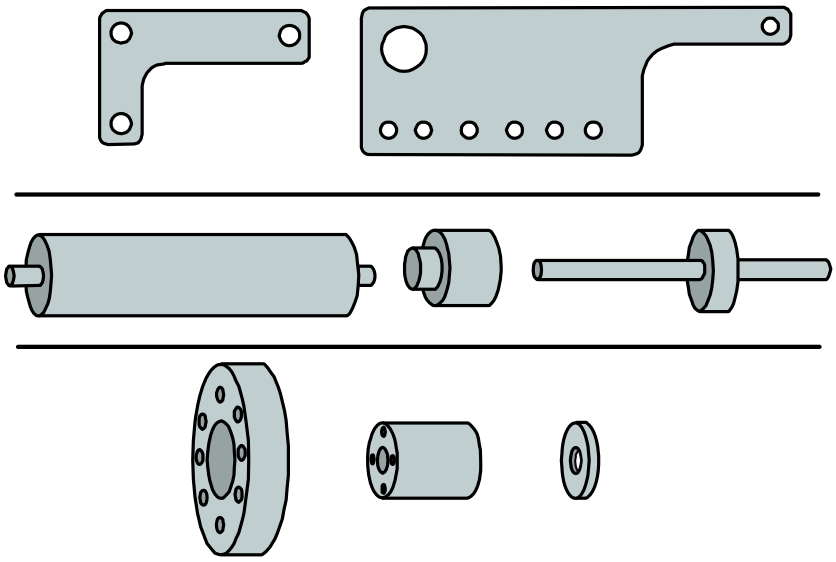
When MRP II has good sources of data the system can properly schedule and produce the company's products using the following steps:

- Accept engineer's design
- Generate a BOM file
- Forecast demand for the product
- Develop a master production schedule
- Check the inventory record
- Order raw materials
- Compute the work center capacity and load
- Schedule production
- Arrange warehousing
- Schedule transportation and distribution

Manufacturing with MRP II

Product Design

Under MRP II, Computer Integrated Manufacturing (CIM) controls the part design, analysis, and manufacturing process. Using Computer-aided design (CAD) the engineer polls the host database for designs in the same "part family." By altering an existing design much time is saved when compared to designing from scratch. The CAD program invokes other software such as Computer Assisted Engineering (CAE), Computer-aided process planning (CAPP) and Computer-aided manufacturing (CAM) to generate computer numerical control (CNC) programs for production machines.



Part Families

Production Logistics

Once the part has been designed, tested and the manufacturing process has been planned, MRP II will use the BOM file to check the inventory of materials. Whatever materials may be lacking will be ordered and entered into the Inventory Records File. The Inventory Records File contains every detail of production history for the product. In addition the Inventory Records File lists vendor identification, material costs and lead times.

Forecasting Product Demand

When material arrival dates are confirmed, MRP II will then poll the MPS system for product demand information derived from firm orders from known customers, random orders and forecast demand. MPS uses qualitative, time series analysis, casual, or simulation models techniques to forecast product demand.

Production Scheduling

MRP II can now plan product production according to availability of manufacturing capacity and demand information. Production scheduling is planned by one of the following lot sizing techniques.

- Lot-for-lot (L4L)
- Least Total Cost (LTC)
- Least Unit Cost (LUC)

Finally, MRP II can initiate production when materials, manufacturing capacity, personnel, warehouse capacity and management resources coincide with the MPS.

Future of MRP II

In the future MRP II will probably be replaced with Optimized Planning and Synchronized Manufacturing. Optimized Planning and Synchronized Manufacturing will include supply chain synchronization as manufacturers continue to gain control of the entire manufacturing process. Optimized planning and supply chain synchronization is a real-time system which supports line balancing, mixed model production scheduling, and other business processes, and is suitable for continuous flow manufacturing, job shops, and hybrid operations.

Progress Check #5

1. MRP II provides coordination and communication between which three departments?

2. What are the goals of MRP II?

3. Which of the following is not a function of MRP II manufacturing?

   a. Product Design

   b. Production Logistics

   c. Shipping coordination

   d. Forecasting product demand

   e. Production scheduling

Summary

Warehouse data technology has become increasingly important in recent years. Inventory accuracy problems have been identified as an economic drain as well as an annoyance to daily operation. Businesses are addressing the problems presented by the warehouse through the use of modern technology. Companies are investing in computerized warehouse control systems to gain strict accounting for stock-on-hand, material and products to be received, and production deliverables. When these systems are in place and communication networks are available businesses will be able to produce and deliver manufactured goods with greater efficiency than ever before. Almost all industries are using AIDC, EDI, and MRP II in one form or another in order to increase efficiency and serve their customers better. Since warehousing is the central function between manufacturing and delivering finished goods, warehouse operations must be accurate
and timely for the rest of the processes to operate smoothly.

Notes:

Glossary

2D Two-dimensional bar code.

Active Tag Active Tags are radio frequency identification devices that require batteries in order to operate.

AIDC Automatic Identification and Data Capture.

Alignment In an AIDC system, the relative position and orientation of a scanner to the symbol.

Alphanumeric The character set that contains letters, numbers and may contain other characters such as punctuation marks or control characters.

ANSI The American National Standards Institute is a non-government organization responsible for the development of voluntary industry standards.

Antenna In a radio frequency identification system, the antenna is the device that radiates and/or receives the RF energy.

ASCII The character set and code described in American National Standard Code for Information Interchange. Each ASCII character is encoded with 7 bits (8 bits including parity check). The ASCII character set is used for information interchange between data processing systems, communication systems, and associated equipment. The ASCII set consists of both control and printing characters.

ASN Advanced Shipping Notice.

Aspect Ratio	The ratio of bar height to symbol length when used in a bar code symbol.
Auto-discrimination	The ability of bar code reading equipment to recognize and correctly decode more than one type of bar code symbology.
Average Background Reflectance	An arithmetic average of the background reflectance, expressed as a percent, from at least five different points on an AIDC data sheet.
Background	The spaces, quiet zones, and area surrounding a printed symbol.
Bar	The darker element of a printed bar code symbol.
Bar Character	A single group of bars and spaces that represent an individual number, letter, punctuation mark, or other symbol.
Bar Code	An AIDC technology that encodes information into an array of varying width parallel rectangle bars and spaces.
Bar Code Density	The number of data characters that can be represented in a linear unit of measure often expressed in characters per inch (CPI).
Bar Code Label	A label that carries a bar code symbol and is suitable to be affixed to an article.
Bar Code Reader	A device used to read a bar code symbol.
Bar Code Symbol	See "Symbol."

Bar Height	See "Bar Length."
Bar Length	The bar dimension perpendicular to the bar width; also called height.
Bar Width	The thickness of a bar measured from the edge closest to the symbol start character to the trailing edge of the same bar.
Bar Width Reduction	Reduction of the nominal bar width dimension on film masters or printing plates to compensate for systematic errors in some printing processes.
Base Line	A reference line used to specify the desired vertical position of characters printed on the same line.
BCD	Binary Coded Decimal, see "Decimal, Binary."
Bidirectional	A bar code symbol capable of being read successfully independent of scanning direction.
Binary	The number system that uses only ones and zeros.
Bit	An abbreviation for "binary digit"; a single element (0 or 1) in a binary number.
BOM	Bill of Materials – MRP file that contains a complete product description listing materials, parts, components and the manufacturing sequence.
CAD	Computer-aided Design.
CAE	Computer-aided Engineering.
CAM	Computer-aided Manufacturing.

CAPP	Computer-aided Process Planning.
CIM	Computer-integrated Manufacturing.
CNC	Computer Numerical Control.
Capture Window	In an automatic identification system employing RF, that volume which defines the active portion of the radio frequency antenna pattern.
Centerline	The vertical axis around which character elements are located for letters, numerals, or symbols.
Character	A single group of bars and spaces that represent an individual number, letter, punctuation mark, or other symbol. A graphic shape representing a letter, numeral, or symbol. A letter, digit, or other symbol that is used as part of the organization, control, or representation of data.
Character Alignment	The vertical or horizontal position of characters with respect to a given set of reference lines.
Character Set	Those characters available for encoding in a particular automatic identification technology.
Check Character	A character included within a message whose value is used for the purpose of performing a mathematical check to ensure the accuracy of that message.

Check Digit	See "Check Character."
Clear Area	See "Quiet Zone."
Code	See "Bar Code."
Code Reader	See "Bar Code Reader."
Continuous Code	A bar code symbology in which all spaces within the symbol are parts of the characters, there is no gap between characters in a continuous code.
CPI	Characters per inch (see "Bar Code Density").
Data Capacity	The amount of memory available in an RF tag or in a buffer.
Data Rate	In an automatic identification system employing RF, the rate at which data is communicated between the identification tag and interrogator measured in bits per second or bytes per second.
Decimal, Binary Coded (BCD)	A numbering system using base 2 that represents each decimal digit by four binary bits, with the place values equal to 8, 4, 2, and 1, reading from left to right.
Decoder	As part of a bar code reading system, the electronic package that receives the signals from the scanner, performs the algorithm to interpret the signals into meaningful data, and provides the interface to other devices.
Density	See "Bar Code Density."

Depth of Field	The distance between the maximum and minimum plane in which a code reader is capable of reading symbols.
Diffuse Reflection	The component of reflected light, which emanates in all directions from the reflecting surface.
Discrete Code	A bar code symbology where the inter-character gap, spaces between characters, are not part of the code.
EAS	Electronic Article Surveillance.
ECR	Efficient Customer Response; A variation of EDI and QR adopted by the supermarket industry.
EDI	Electronic Data Interchange (EDI) is the electronic transmission of standard structured documents between computer applications in two organizations or remote sites of the same organization.
EDIFACT	EDI for Administration, Commerce, and Trade.
EDP	Electronic Data Processing.
Electrostatic	A method of printing that utilizes a special electrostatic paper or a charged drum, both of which attract toner to the charged area.
Element	In a bar code symbol, a single bar or space.
EOQ	Economic Order Quantity.
ERP	Enterprise Resource Planning.

Film Master — A photographic film representation of a specific bar code or OCR symbol from which a printing plate is produced.

First–Read Rate — See "Read–Rate."

Fixed Beam Scanner — Either a visible light or laser scanner reading in a fixed plane. Requires a more exact positioning of bar code than with a moving beam scanner.

Font — A specific size and style of printer's type.

Formed Font Impact — A printing method for labels consisting of a rotating drum etched with raised bars and characters.

Guard Bars — The bars that are at both ends and center of a UPC and EAN symbol. They provide reference points for scanning.

GUI — Graphic User Interface.

Hand Laser Gun — See "Laser Scanner."

Helium Neon Laser — A type of laser commonly used in bar code scanners. It emits coherent red light at a wavelength of 633 nanometers.

He-Ne — Common name for helium neon laser.

Horizontal Bar Code — A bar code or symbol presented in such a manner that its overall length dimension is parallel to the horizon. The bars are presented in an array, which look like a picket fence.

ID — Identification.

Impact Printing	Any printing system where a microprocessor controlled hammer impacts against a ribbon and a substrate.
Ink Jet	A method of printing using liquid ink, projected a drop at a time against the printing media.
Inter-Character Gap	The space between two adjacent bar code characters in a discrete code.
Interleaved Bar Code	A bar code in which characters are paired together using bars to represent the first character and spaces to represent the second.
Interrogator	In an automatic identification system employing RF, the device, which triggers the identifying, tags to respond with a modulated RF message.
Ion Deposition	See "Electrostatic."
ISO	International Organization for Standardization.
IT	Information Technology.
IVR	Interactive Voice Response.
L4L	Lot for Lot; The simplest lot-sizing technique that supplies the required quantity of product exactly when it is due.
Ladder Code	See "Vertical Bar Code."
LAN	Local Area Network.

Laser Scanner An optical bar code reading device using a low energy laser light beam as its source of illumination that is often handheld.

Lead Time The cycle time needed for the raw-material-to-market cycle.

LED Light emitting diode; A semiconductor that produces light at a wavelength determined by its chemical composition. The light source often used in bar code readers.

LF Low frequency; 30-300 KHz.

Light Pen In a bar code system, a hand held scanning wand, which is used as a contact bar code reader held in the hand (see "Wand Scanner").

LTC Least Total Cost; A dynamic lot-sizing technique that calculates the order quantity by comparing the carrying cost and the setup (or ordering) costs for various lot sizes selecting the lot size for which these are most nearly equal.

LTL Less than Truckload.

LUC Least Unit Cost; A dynamic lot-sizing technique that adds ordering and inventory carrying costs for many different lot sizes dividing total cost by the number of units and selecting the lot size with the lowest unit cost.

Misread	A condition, which occurs when the data output of a reader does not agree with the data encoded in the bar code symbol.
Module	The narrowest nominal width unit of measure in a bar code.
Modular Check Digit or Character	See "Check Character."
Moving Beam Scanner	A scanning device where scanning motion is achieved by mechanically moving the light beam through the bars.
MPS	Master Production Schedule.
MRP	Material Requirements Planning.
MRP II	Manufacturing Resource Planning.
Nanometer	A unit of measure used to define the wavelength of light. Many standards require scanning in the 633-900 range.
NIST	National Institute of Standardized Testing.
Nominal	The exact (or ideal) intended value for a specified parameter. Tolerances are specified as positive and negative deviations from this value.
Non-Read	In a bar code system, the absence of data at the scanner output after an attempted scan due to no code, defective code, scanner failure or operator error.

Number System

A method of identifying individual or groups of objects. Number systems are of two types: 1) Significant digit where each item is uniquely identified and 2) Nonsignificant digit where sequential numbers are assigned regardless of product or item description.

Numeric

A character set that includes only numbers.

Opacity

The optical property of a substrate material that minimizes show-through from the backside or the next sheet. The ratio of the reflectance with a black backing to the reflectance with a white backing.

Ink opacity is the property of an ink that prevents the substrate from showing through.

Orientation

The alignment of a bar code symbol with respect to the horizontal axis. Two possible orientations are horizontal with vertical bars and spaces (picket fence) and vertical with horizontal bars and spaces (ladder).

Overhead

In a bar code system, the fixed number of characters required for start, stop and checking in a given symbol. For example, a symbol requiring a start/stop and two check characters contains four characters of overhead. Thus, to encode three characters, seven characters are required to be printed.

Part Family

Parts that are so similar in design that one design can be transformed into another by changing dimensions etc.

Passive Tag	Passive tags are radio frequency identification devices that do not have any internal power source. Their energy source is the power emitted from adjacent antennas.
PCS	Print Contrast Signal; a measurement of the ratio of the reflectivity between the bars and spaces of a symbol, commonly expressed as a percent
PDF417	A 2D Stacked bar code symbology.
Pen Scanner	A pen like device either connected by wire to a device or self-contained, used to read bar codes. Requires direct contact with the symbol.
Picket Fence Code	See "Horizontal Bar Code."
PIN	Personal Identification Number.
Pitch	Rotation of a bar code symbol about an axis parallel to the direction of the bars.
POS	Point-of-Sale.
Preprinted Symbol	A symbol that is printed in advance of application either on a label or on the article to be identified.
Print Contrast	See "PCS."
Print Quality	The measure of compliance of a bar code symbol to the requirements of dimensional tolerance, edge roughness, spots, voids, reflectance, PCS, quiet zone, and encoding.

Quiet Zone	A clear space, containing no machine-readable marks, which precedes the start character of a bar code symbol and follows the stop characters. 125 Sometimes called the "Clear Area."
RF	Radio Frequency; an electromagnetic wave.
RFID	Radio Frequency Identification (see "Radio Frequency Tag").
Radio Frequency Tag	An electronic tag capable of receiving/storing and/or transmitting digital information by means of, and in response to, RF energy.
Range	In a radio frequency system, range is defined as the maximum allowable distance between the antenna and the tag.
Read/Only	AIDC systems that employ radio frequency tags, which contain pre-programmed data.
Read/Only Tag	In an RF AIDC system, an RF tag that is capable of only being read.
Read/Write	In an RF AIDC system, an RF tag with the capability to have their stored data changed by an external RF signal.
Read/Write Tag	In AIDC systems employing RF, an electronic tag capable of receiving, storing, and transmitting digital information.
Read Rate	The ratio of the number of successful reads on the first attempt to scan to the total number of attempts.

Reflectance	The ratio of the amount of light of a specified wavelength or series of wavelengths reflected from a test surface to the amount of light reflected from a barium oxide or magnesium oxide standard under similar illumination conditions.
Resolution	In a bar code AIDC system, the narrowest element dimension that can be distinguished by a particular reading device or printed with a particular device or method.
Scanner	An electronic device used in AIDC systems to read bar codes that electro-optically converts bars and spaces into electrical signals.
Self-Checking	A bar code or symbol using a checking algorithm which can be independently applied to each character to guard against undetected read errors.
Show-Through	The generally undesirable property of a substrate that permits underlying markings to be seen and may adversely affect read rate.
SI	Systems Integration.
Skew	Rotation of a bar code symbol about an axis parallel to the symbol's length.
SKU	Stock Keeping Unit.
Sniff Mode	Occurs when some radio frequency based systems are searching for a radio frequency tag. The interrogator continually emits trace amounts of radio waves until a tag is detected. Upon detection, interrogation is made at the maximum power.

Space	The lighter element of a bar code usually formed by the background between bars.
Space Width	The thickness of a space measured from the edge closest to the symbol start character to the trailing edge of the same space.
Spectral Response	The variation in sensitivity of a reading device to light of different wavelengths.
Specular Reflection	The mirrorlike reflection of light from a surface
Spot	The undesirable presence of ink or dirt in a bar code space.
Standard	A set of rules, specifications, instructions and directions to use a bar code or other AIDC system to your profit. Usually issued by an organization, e.g. Logmars, HIBCC, U.C.C, etc.
Start Stop Character or Pattern	A special bar code character that provides the scanner with start and stop reading instructions as well as a scanning direction indicator. The start character is normally at the left-end of a horizontally oriented symbol. The stop character is normally at the right-end of a horizontally oriented symbol.
Substrate	The surface on which a bar code symbol is printed.
Symbol	A combination of bar code characters including start/stop characters, quiet zones/data characters, and check characters required by a particular symbology, which form a complete, scannable entity.
Symbol Density	The number of data characters per unit length.

Symbol Length	The distance between the outside edges of the quiet zones.
Thermal	A printing system where dots are selectively heated and cooled and drag upon a heat sensitive paper. The paper turns dark in the heated areas.
Thermal Transfer	A printing system like thermal except a onetime ribbon is used and common paper is used as a substrate. Eliminates the problems of fading or changing color inherent in thermal.
Tilt	Rotation of a bar code symbol about an axis perpendicular to the substrate.
UCS	Uniform Container Symbol
UHF	Ultra-High Frequency; 300 to 3000 MHz
UPC	Universal Product Code - The standard bar code symbol for retail food packages in the United States.
UPCC	Universal Product Carton Code - A standard administered by the UCC.
UPN	Universal Product Number
USS	Uniform Symbol Specification; the current series of bar code symbology specifications.
UV	Ultra Violet
VAN	Value Added Network – A computer network that translates specific documents from one standard to another.

VAR — Value-Added Reseller – An organization that buys a product and adds value by enhancing one or more aspects of the original product.

Verifier — A device that makes measurements of the bars, spaces, quiet zones, and optical characteristics of a symbol to determine if the symbol meets the requirements of a specification or standard.

Vertical Bar Code — A code pattern presented in such orientation that the axis of the symbol from start to stop is perpendicular to the horizon. The individual bars are in an array appearing as rungs of a ladder.

VLF — Very Low Frequency; frequency less than 30 KHz.

Void — The undesirable absence of ink in a bar code bar.

Wand — See "Wand Scanner."

Wand Scanner — A hand-held AIDC scanning device used as a contact bar code or OCR reader.

WIP — Work in Progress/Process.