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INTRODUCTION

This booklet is to help you understand bar codes so that you can better plan for your bar coding applications.

The use of bar coding has grown dramatically over the last 15 years. With the adoption of UPC as the standard for retail grocery stores in the late 70's, bar codes have become an everyday experience for most people.

Bar codes are a fast, easy, and accurate data entry method. The correct use of bar codes can decrease employee time required and increase an organization's efficiency.

One thing to remember with bar codes: the application software that accepts the bar code data is in 95% control of the success or failure of an application. Bar codes are the sizzle on the software steak. You can eat steak without sizzle, but you can't eat sizzle without steak. Remember that bar codes are just another data input method; what you do with the data is most important.

With the introduction of the IBM PC in the early 80's, bar coding applications expanded along with the PC explosion. Worth Data was and is a pioneer in providing bar code hardware and printing software to the PC (and Macintosh) user. Most of this booklet is devoted to bar coding in the microcomputer marketplace.

We hope this booklet proves of benefit to you in understanding bar codes and their associated technology. We wish you well in your undertakings and hope to be able to supply you with equipment and software to meet your needs.

Feel free to call our Sales Engineers to discuss your needs, or if you have already purchased equipment and need assistance, call the same toll free number which is:

For Germany 0800 1 815 084
For France 0800 90 65 47
For the UK 0800 393 213
For the US and Canada 1-800-345-4220

If you are in other countries in Europe, Africa, or the Middle East call our European Office in Ireland at:

353 1 6614 566 Phone, or 353 1 6614 622 Fax

If you are in other countries, call our US Headquarters at:

831-458-9938 Phone, or 831-458-9964 Fax

What's in a Bar Code

There is a mystique surrounding bar codes that intimidates many people. Let's eliminate it quickly. First the bar code usually doesn't contain descriptive data, (just like your social security number or car's license plate number doesn't have anything about your name or where you live). The data in a bar code is just a reference number that the computer uses to look up associated computer disk record(s) which contain descriptive data and other pertinent information.

For example, the bar codes found on food items at grocery stores **don't** contain the price or description of the food item; instead the bar code has a "product number" (12 digits) in it. When read by a bar code reader and transmitted to the computer, the computer finds the disk file item record(s) associated with that item number. In the disk file is the price, vendor name, quantity on-hand, description, etc. The computer does a "price lookup" by reading the bar code, and then it creates a register of the items and adds the price to the subtotal of the groceries purchased. (It also subtracts the quantity from the "on-hand" total.)

Another example of bar code data might be in a quality reporting application. The bar code may have only a single digit in it, but it may be titled "Failed Vibration Test". The computer associates the single digit with the test result.

In conclusion, bar codes typically have only ID data in them; the ID data is used by the computer to look up all the pertinent detailed data associated with the ID data.

Bar Code Structure

A bar code is a series of varying width vertical lines (called bars) and spaces. Bars and spaces together are called "elements". Different combinations of the bars and spaces represent different characters.

When a bar code scanner is passed over the bar code, the light source from the scanner is absorbed by the dark bars and is reflected by the light spaces. A

photocell detector in the scanner receives the reflected light and converts the light into an electrical signal.

As the wand is passed over the bar code, the scanner creates a low electrical signal for the spaces (reflected light) and a high electrical signal for the bars (nothing is reflected). The duration of the electrical signal determines wide vs. narrow elements. This signal can be "decoded" by the bar code reader's decoder into the characters that the bar code represents. The decoded data is then passed to the computer in a traditional data format.

Types of Bar Codes

There are lots of different bar codes. Some bar codes are numeric only, (i.e. UPC,EAN,Interleaved 2 of 5). Some bar codes are fixed length, (i.e. UPC-A is 12 digits, UPC-E is 6 digits, EAN-13 is 13 digits, and EAN-8 is 8 digits). Some bar codes can have numbers and alphabetic characters, (i.e. Code 93, Code 128, and Code 39). One bar codes allow you to encode all 128 characters, (Code 128).

Many were invented some time ago and have been superseded by newer bar codes. Some industries standardized on older bar codes before the better ones had been invented, thus there is a continuing requirement for their use in particular industries.

Lets sort out some older vs. newer codes:

Bar code	Variable Length	Allowable Characters	Industries in Use
Older Bar Codes			
Code 11	YES	0-9 -	AT&T pre 1990
Codabar	YES	0-9,$+.:/	Blood Banks,Cotton,Transp
Plessey	YES	0-9,A-F	Shelf Labels (UK)
MSI	YES	0-9	Shelf Labels
2 of 5	YES	0-9	UPC Shipping Container
UPC and EAN	NO	0-9	Food/Discount Store Items
Newer Bar Codes			
Code 39	YES	0-9,A-Z ./+-%$ Spc (2 character pairings for Full ASCII)	LOGMARS,HIBCC,AIAG, TCIF
Code 128	YES	Full ASCII	UCC-128, EAN-128
Code 93	YES	0-9,A-Z ./+%$ Spc (2 character pairings for Full ASCII)	HIBCC Alternative, Canadian Postal

Many of this booklet's readers have to comply with their customer's or industry's bar coding specifications; no choice is possible, just compliance.

Look at the following samples of printed bar codes:

UPC-A 100% Density

Interleaved 2 of 5

Code 39 Medium Density

Code 128

The classic bar code type is Code 39, (also called Code 3 of 9) which has 9 bars and spaces; three are wide, and the other 6 are narrow. In Code 39, 3 of 9 total bars and spaces are wide; hence the name, Code 3 of 9. For example, look at the following character representations with Code 39:

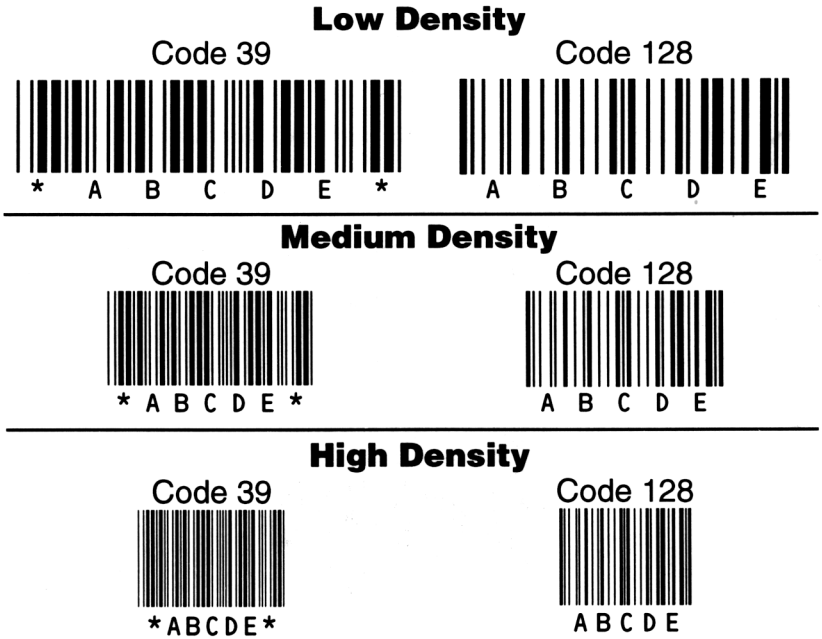
Notice there are two widths of bars and two widths of spaces. If you want to print a bar code of ABCDE, you need to start and end it with a special Start/Stop code character -- the * (asterisk) is used for Code 39. To print a bar code of ABCDE, you would need to enter the data as *ABCDE*. There should be at least 1/4" of white space to the left and right of the code; this helps the bar code reader pick out where a bar code begins and ends.

Other bar code types are similarly constructed. UPC and EAN bar codes have four widths of bars and spaces; so does Code 128.

Bar Code Selection Recommendations

For new bar coding projects that don't have industry or customer standards, Code 39 is the typical non-food standard, mostly because almost all bar code equipment reads/prints Code 39. However, Code 39 produces relatively long bar codes; it is not particularly efficient in it's bar code density (the maximum density is 9.4 characters per inch, including 2 start/stop characters). Where the label width is an issue and there is numeric data or lower case letters in the data, Code 128 is the best alternative. Code 128 has an extra-efficient numeric-only packing scheme to produce very dense bar codes and Code 128 can encode all 128 ASCII characters. Not all bar code readers read Code 128, so before settling on it as a standard, make sure that your reader is 128 capable. Code 93 has been promoted by only one vendor; it requires two characters to make Full ASCII; and it doesn't have a numeric packing option. For these reasons, Code 128 is usually preferable over Code 93.

The larger the width of the elements, the more space it takes to print the bar code; therefore, the ***lower*** the bar code density. The thinner the bar and spaces, the less space is required and the ***higher*** the bar code density. Look at the samples below of different densities.



The lower density bar codes are more reliably printed and more consistently read than higher density bar codes due to the fact that minor variations (from printing or damage) are much more serious with high-density bar codes -- the percentage of distortion is larger.

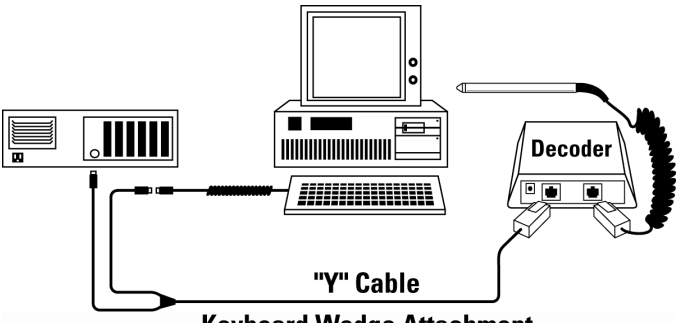
Bar Code Readers

There are three basic types of bar code readers: fixed, portable batch, and portable RF. Fixed readers remain attached to their host computer or terminal and transmit one data item at a time as the data is scanned. Portable batch readers are battery operated and store data into memory for later batch transfer to a host computer. Some advanced portable readers can operate in non-portable mode too, often eliminating the need for a separate fixed reader. Portable RF Readers are battery operated and transmit data real-time on-line. More importantly, the real-time two-way communication allows the host to instruct the operator what to do next based on what has just happened.

A basic bar code reader consists of a decoder and a scanner, (a cable is also required to interface the decoder to the computer or terminal). The basic operation of a scanner is to scan a bar code symbol and provide an electrical output that corresponds to the bars and spaces of a bar code. A decoder is usually a separate box which takes the digitized bar space patterns, decodes them to the correct data, and transmits the data to the computer over wires or wireless, immediately or on a batch basis.

Personal Computer Keyboard Wedge Readers

If the bar code reader is attached through the keyboard interface, the bar code reader sends data in key codes, exactly as though the data had been keyed on the keyboard. Keyboard interface readers are nicknamed "wedge readers", because they physically wedge between the keyboard and the computer (or mainframe terminal) and attach as a 2nd keyboard. The great advantage of "wedge readers" is that bar code reading can be added with no software changes necessary; the software thinks that the data received was produced by a fast typist. (Of course the keyboard remains usable too!). With a wedge reader, **any program that accepts keyed data will accept bar code data with no change.** The following figure shows a keyboard wedge reader attachment.



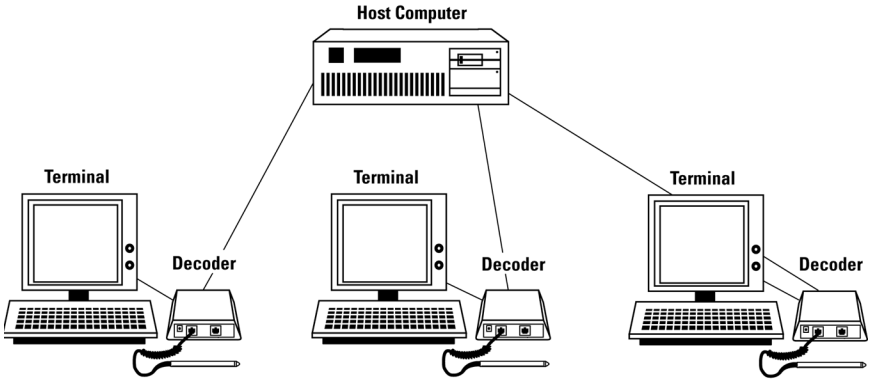
Keyboard Wedge Attachment

A keyboard wedge reader which emulates all of the keys including function keys, Ctrl, Alt, Page Up, etc. is preferable.

You cannot place a keyboard wedge reader more than 10 feet from the computer. You can get an extension cable for the scanner, allowing you to range up to 35-100 feet from the computer. For these applications a cordless radio frequency wand would be better; the wand has a transmitter and the decoder has a receiver so that the wand can transmit digitized data to the decoder over RF instead of a cord. RF wand readers transmit up to 150 feet; at these distances the trick is to hear the decoder's beep.

Serial Bar Code Readers

Another method of data transmission from the bar code reader to the computer is by RS-232 Serial ASCII format. If you have a multi-user computer, (for example a UNIX system), with serial ASCII terminals for each user, the bar code reader can attach between the terminal and host computer, transmitting ASCII data just like the terminal; in fact the **bar code data looks just like keyed data** when attached like the following figure:

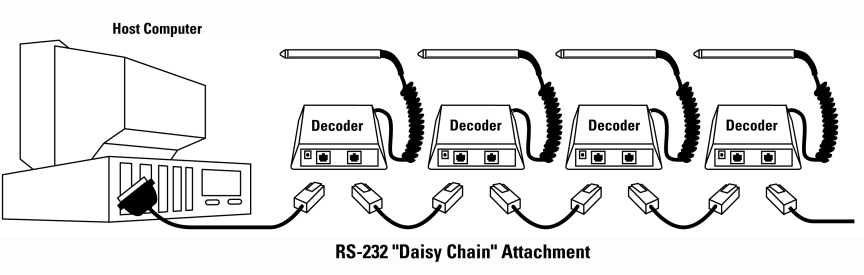


Multi-user Terminal Attachment

Single user computers without an external keyboard (most notebooks) must use the serial port for interface of a bar code reader; to get the bar code data to appear as keyed data, a TSR or device driver program is also necessary. Typically requiring only 2K of RAM memory, the program takes data from the COM port and places it into the keyboard data buffer, so **bar code data appears to have been keyed**. If your computer program can read a serial port directly, no additional program is necessary.

Serial readers can be placed several hundred feet from the computer, (keyboard wedge readers cannot be placed beyond 10 feet.)

Also multiple serial readers can be attached to the same computer, (keyboard wedge readers cannot). The PC runs a program to to poll the readers one at a time.



RS-232 "Daisy Chain" Attachment

Mainframe Bar Code Readers

Mainframe computers often have terminals with unique data connectors and data formats, (different from ASCII or PC key codes). The IBM System 36-38, AS/400, 4300, 9000, etc., have such terminals. To use bar codes with these computer systems, you must use a keyboard wedge reader specifically designed for the terminal to be attached to. Vendors such as Compsee, Intermec and Welch-Allyn specialize in readers which attach to mainframe terminals.

The alternative is to have a PC with a terminal emulation card in it attached to the mainframe; then a less expensive PC bar code reader and laser printer can be used on the PC.

Portable Readers

Portable readers are handheld battery operated readers which store the data in memory for later uploading. In addition to a bar code scanner, a portable reader usually has an LCD display to prompt the user what to do; and they usually have a keyboard to enter variable data such as quantities. Ease of programmability is a key issue in selecting a portable, and that depends on your programming abilities; lots of vendors say it's easy, (as long as you can program in C++ or go to their two week school). Other variables to consider are: battery life (at least 20,000 scans), ease of reading the display, size/weight of the unit, who repairs it, and where it is to be repaired in the event of a malfunction.

Worth Data has pioneered and patented voice prompt messages to supplement the display messages in a portable unit, overcoming lighting, language, and message clarity problems; this unit actually announces when you have entered incorrect data and when to change the batteries or upload data, plus you can customize any or all voice prompts for your applications.

Most of you will want a unit that requires no programming for inventory -- a unit that has built-in inventory data collection programs - on which you can easily create custom programs.

Radio Frequency Readers

Radio frequency readers are the ultimate solution to many applications' needs -- especially any computer remote application that can benefit from the computer checking and instructing the operator. Warehousing applications such as picking, put-aways, shipping, and receiving are typically better performed by RF readers because the computer can instruct the operator where to go and what to do based on everything that has just happened, plus the computer files are current as to exact status and location of available inventory.

RF Readers are like on-line terminals, but wireless. The user can roam around his local facility scanning and keying data and getting a response from the computer with each entry. Therefore the computer can very carefully edit the data for errors as well as prompt the user for what to do next considering the data that has just been entered. The classic RF applications and associated advantages are:

1) **Picking** - routing of the picker; computer instructed substitutions; real-time status of the order.

2) **Put-Aways** - inventory is available for sale or for manufacturing immediately.

3) **Receiving** - purchase order shortages can be immediately determined. Critical parts can be routed to manufacturing immediately.

4) **Shipping** - eliminating wrong or incomplete shipments by computer- checking before loading or even computer-led loading.

There are two basic types of RF Readers on the market:

- Readers that emulate terminals or PCs, and
- simpler Readers which talk to a computers serial port.

A brief explanation follows:

RF Readers that Emulate Terminals

These readers started out as mainframe terminal emulators such as IBM 3270 or 5250 terminal emulation. To emulate an IBM mainframe terminal is no easy task, so the cost was very high, (i.e. $10,000 per control unit, $4000 per terminal).

Today there are several emerging terminals that emulate PC workstations (i.e., Symbol Technologies and Intermec) on NT or Netware Local Area Networks. These machines are 486 computers with lots of memory and download their software from the network server. They are relatively expensive, about $3000-$5000 per terminal, require an operating LAN, mostly require applications to be written to the upper left hand corner of the screen, and usually require a network

controller that is $3k-$10 in cost. These terminals almost always require a C++ program to be written on the terminal and the host programs to be modified to just use the upper left hand corner of the screen. Competent network management personnel are also required for each location.

RF Readers that Talk to a Serial Port

These readers require programming on the host computer to read and write to a serial port. Such programming is relatively trivial and can be written in almost any language or any platform. Existing application packages can be modified to include these simple RF Readers, but programming is required. It could be argued that the amount of effort is considerably less than with terminal emulation, because all programming in on the host computer; the terminal emulation programs require host programming (for the upper left hand corner) and programming on the terminal too.

These readers that communicate to the host computers serial port are usually less than 1/2 the price of the more complicated "Terminal Emulators". They also often have faster response time due to less software overhead. No network is required -- even a slow 286 can drive them at maximum speed. They are far simpler - thus less costly, BUT they do require programming to get their full potential. Even though you can run them in "One-Way" mode without programming, that misses the greatest potential of computer-led activities, (often referred to as Event Driven Applications).

Spread Spectrum Terminals vs. Narrow Band Terminals

Narrow band refers to radios that operated within a narrow band of radio frequencies. Spread spectrum refers to radios that jump around on a wide band of frequencies to avoid interference. Narrow band can be licensed at high power and unlicensed at low power. Spread spectrum is almost always unlicensed at high power. Spread spectrum is superior for very large networks of RF terminals - 150 plus terminals in the same building. For terminal networks below that number, unlicensed narrow band is usually less expensive, far less difficult to program, and transmits just as far with considerably less power and battery size/weight.

A narrow band radio with a user changeable frequency has the same advantage as spread spectrum in avoiding interference. In fact, it can be argued that 10 plus channels of user selectability are at least as safe as spread spectrum with a fixed pattern. What you really want to avoid is narrow band terminals with a fixed frequency that cannot be changed unless sent back to the manufacturer. More and more devices are going wireless; so, the channel interference is expected to increase substantially in the future.

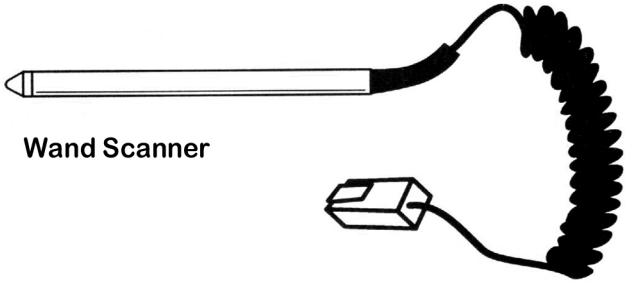
Worth Data's R/F Terminal

We offer a narrow band radio that has up to 16 user selectable frequencies, thus avoiding interference with other devices that might operate in the same band. Because its receiver is so sensitive, the coverage is outstanding- typically 500,000 square feet without relays and up to 3,000,000 square feet with relays. Each base station can handle 300 transactions per minute.

The cost is 1/2 of most Spread Spectrum systems. All programming is on the host computer using any platform and language that can read/write to the host's serial port. Using multiple base stations with split traffic, the number of terminals per site can easily go up to the 50-100 per site. Models are available for the US (911MHz), UK (458MHz), Continental Europe (434MHz), Australia/NewZealand (921MHz), and Singapore (451MHz).

Wand Scanners

Wand Scanners are the least expensive and the oldest type of bar code scanner. A wand is typically made from 1/2" stainless steel tubing or from plastic; optics are in the front with a cord out the back. The wand scanner must be moved by the user's hand across and in contact with the bar code. While the wand is moving across the bar code, the reflected light is converted to electrical signals through a photocell in the wand.



Wand Scanner

A wand requires a little technique; it is not a "can't miss" scanner. Even without directions, most people can master the use of a wand in 30-45 seconds; but some need directions and training for a few minutes to learn the proper wanding techniques. These techniques are detailed in most product manuals, but consist of common sense rules such as:

1) Place the wand down to the left or right of the bar code in a clean white area. Tilt the wand to a 30 degree angle.

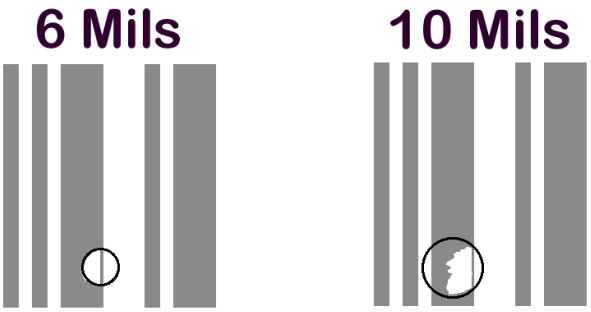
2) Quickly draw an imaginary line through the entire bar code. (Pressing down hard and going slow doesn't help.)

Wands can read any length of bar code. Wands typically can read through laminates of thickness up to 1/10" inch. Many wands can read through CD cases and audio tape cases.

You can't judge a wand by whether it is steel or plastic. Most plastic wands are inferior, but not all steel wands are superior. Metal wands made in the USA or Japan are generally superior to wands made in Taiwan. Check out the warranty period and check out if there is a flat rate repair charge after the warranty. Wands are more likely to deteriorate than decoders.

Wand Resolutions

Wands come in a variety of resolutions, usually low, medium, and high resolution; this allows for reading bar codes printed by different methods and for reading very small element widths, (high density). Low resolution wands have a larger diameter aperture for the reflected light to pass through to the photocell; therefore, if there is a void (tiny white space) in a dot matrix printed bar, the bar is still interpreted as a bar.



A high- resolution wand has a smaller diameter aperture and sees the same void in a bar as a space -- thus it can't read dot matrix code as well as lower resolution wands.

A low resolution wand will have an aperture opening so large that it will view very narrow bars and spaces at the same time -- thus being unable to decode a high density bar code. A high resolution wand will see only one bar or space element at a time, thus it is able to decode a high density bar code correctly. So, if you are reading dot matrix codes only, use low resolution. If you are reading laser or thermal only, use high resolution. If you are reading a mixture of dot matrix with other types of printed codes, use a medium resolution wand.

Wand type with associated resolutions and uses are:

Type of Wand	Aperture Diameter	Use
Low Resolution	10 to 16 mils*	for dot matrix only
Medium	8 mils	mixtures of printer types
High	6 mils	thermal or laser only
Ultra High	4 mils	for ultra high density codes

*a mil is 1/1000 of an inch

Some Xerox high speed mainframe laser printers (not the desktop laser printers from HP et.al.) can produce bars with voids in them also, (just like dot matrix printers); high resolution wands would not be satisfactory for such codes.

Scanner Light Source

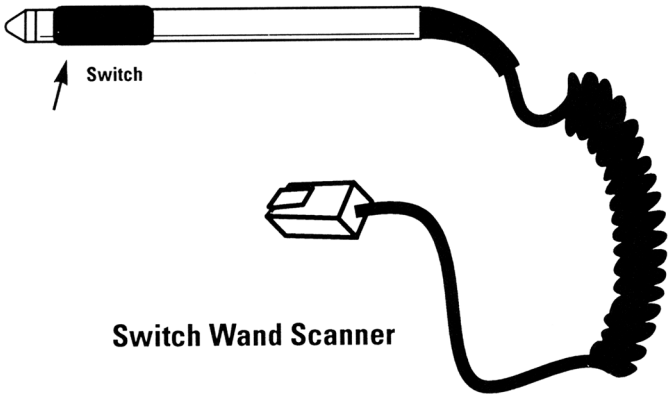
Wands also vary with the type of light used. Today, most wands have visible red light (670nm) as the light source reflect from the spaces and bars. If you can see the light being emitted from a visible wand's tip, it is visible. Visible light can read any bar code that you can see. It can read thermal printed bar codes, whereas wands with infrared light (870nm) cannot read thermal printed bar codes; you cannot see light emitted from an infrared wand's tip.

One advantage of infrared light wands is reading bar codes that can't be photocopied. A bar code can be printed with infrared absorbing ink (carbon based) and covered with a black laminate window which is infrared blind, giving you a security bar code for use on badges that you don't want to be photocopied. A "black on black" bar code requires infrared scanners to be read.

Switch Scanners

With the typical wand on most bar code readers, power is always applied to the wand unless power is turned off at the computer or terminal. This should be of no concern to the user; the LED will last 20 years.

However, with a portable bar code reader, battery power is to be conserved. A wand with a switch is the best solution. No power is lost as long as the switch is open or off. When the user wants to read, the switch is depressed to provide power to the wand.



Switch Wand Scanner

When finished reading, the switch is released turning off power.

Radio Frequency Wands

Cordless RF Wands are used for tetherless scanning. The wand has a battery, antenna, and transmitter built-in. The radio simply substitutes for the cord between the wand and the decoder. Below is a picture of the Worth Data R/F Wand.

There is not a beeper in the wand to confirm a "good read"; since it is exactly like a corded wand with the radio substituting for the cord, the base station/decoder beeps to confirm a "good read". Therefore the operating distance is limited by being able to hear the "good read" beep. Amplified external speakers can be added to the base station and Range Extenders can be added to increase the operating range. There is also a remote beeper available, "wireless headphones", from RECOTON for $80 at Sears, Circuit City, Fry's, or most stereo stores.

Range Extenders

Range extenders consist of an extra receiving antenna and a an extra beeper. Adding multiple R/F Range Extenders can provide extra distance of coverage, BUT the operator is still dependent on hearing a beeper somewhere across the room. Depending on the noise of the environment, the RF Wands can be effective or ineffective. Typical applications are shipping and receiving. Variable data, such as quantities, can be entered by wanding a special "numeric barpad" which causes the reader to act like a keyboard, "accumulating wanded data "until the "ENTER" code is scanned.

Slot Badge Scanners

Slot badge scanners require only one hand for operation; the user simply slides his badge with a bar code on the bottom edge through the scanner. These are typically used in unattended entry/exit stations for payroll, club membership accounting, school lunch assistance programs, etc. Slot badge scanners are similar to wand scanners, but usually refined so that one resolution can read most types of bar codes with no difficulty. Slot Scanners utilize the additional space for larger optics; a slot badge scanner usually has a vertical aperture to look at the elements, thus allowing a high resolution slot badge scanner to read almost all types of printed bar codes, from dot matrix to high density.

Slot Badge Scanner

Slot Badge scanners also come with visible or infrared light sources. Visible can read any bar code which can be seen with the eye including bar codes printed on thermal printers, (infrared cannot read thermal printed bar codes); infrared slot badge scanners would be used for security "black on black" bar codes, (the black bar code is covered by a black window on the badge, but the black window looks clear under infrared light).

Laser Scanners

Laser scanners have a very precise beam of light which can be reflected accurately several inches to several feet. Almost all laser scanners today have a moving beam which sweeps back and forth, (some older laser scanners required the user to move the beam across the bar code). The advantages of moving beam laser scanners are:

- Reading bar codes from a distance (typically 3-18 inches, or up to 17 feet with reading low density bar codes).
- Reading moving objects on an assembly line.
- No-hands operation. Some lasers can be mounted to turn on automatically when an object passes under the scanner. Typically used in blood banks, library check out, etc.
- Reading through glass windows or thick laminates.
- Reading bar codes on curved surfaces, (bags of parts).
- Reading bar codes inside difficult to reach enclosures.

Laser scanners emit a laser light beam which sweeps back and forth across the bar code 36 times per second. At this rate, unsuccessful reading attempts go unnoticed; you will only be aware of the one successful decode. Once a read has occurred, the laser turns off, requiring you to release and pull the trigger again to reactivate the laser scanner.

The lower the density of the bar code, the further the laser scanner can read a bar code. The higher the density of the bar code, the closer to the bar code the laser scanner must be.

Triggered Laser Scanners

Scanners are virtually "can't miss". Just "point and shoot". Face the bar code so that the bars point up (the laser light will then form a red line across the bar code when the trigger is pulled). Aim the gun scanner at a bar code, and pull the trigger; reading is instantaneous. You may have to move the scanner closer to the bar code to get a read, but that's it. Triggered laser scanners are about 5-10 times more expensive than a wand scanner, but scanning is significantly easier. Pay attention to the length of the warranty on laser scanners; it could prove to be very important with heavy usage.

Below is pictured the Worth Data LZ200 Laser Scanner, which has a 3 year warranty, the industry's longest. (It reads up to 20 inches from a typical medium density bar code).

The basic laser scanners read up to 10-20" distance, depending on the brand of the laser scanner. There are hand held triggered long range laser scanners that can read up to 33 feet distance, (using retro-reflective low density bar codes) or 10 feet distance using paper low density bar codes. Long range laser scanners are naturally more expensive than the standard laser scanners.

We have tested the LZ100 and the LZ200 by hard throwing (not just dropping) them to the floor. They survived every repeated throw. The scan element has a lifetime warranty; both scanners use models of the Symbol 1200 Scan Engine, (this engine is rated to withstand 2000Gs of force on impact). We developed this laser scanner after years of frustration with other laser manufacturers' product reliability. Symbol lasers had superior reliability to anything else we sold, but they were difficult to integrate with our reader's unique feature offerings. Therefore, we were forced to manufacture our own laser scanners using Symbol engines. Being the manufacturer, we can more closely control function and reliability.

Cordless Laser Scanners

There are at least four RF Laser Scanners available on the market. These units have decoder, battery, and transmitter built into the laser scanner -- allowing tetherless laser scanning back to a base station/decoder. Their range varies from 20-30 feet from the base station.

Below is pictured the Worth Data R/F Laser Scanner. It has a range of 100 feet. It reads 0-18" away from the bar code. Competitive RF Laser Scanners cost considerably more. The two-way laser version has a "good read" indicator as well as a confirmation "base received data" beeper in the laser scanner, so you don't have to the base station to hear a "good read" received. The Base Station connects to a PC or Mac in series with the keyboard or it connects to a serial port. Multiple 2-way laser scanners per base station are possible.

Supermarket Slot Scanners

These devices are continuously emitting multi-directional light beams to maximize the reading of a bar code regardless of the orientation of the bar code to the scanner. Unless the bar code is on the surface of the item pointing straight up, the bar code reader has a good chance of reading it. These devices are required to be integrated into the sales counter. They typically directly interface with a retail POS terminal.

On Counter Scanners

These devices are the smaller cousins of the Supermarket Slot Scanner. They were developed for the convenience stores that wanted automation but didn't have the counter space required for a slot scanner installation. They also have a omnidirectional light source to free the user to present the bar code in any orientation. They sit on a counter, or they sit on a stand that sits on the counter. Items are passed a few inches in front of the scanner to get a successful read.

Industrial Scanners

There are also a whole line of scanners made just for industrial applications including small under $1000 scanners that read a few inches distance and large $20,000 long range scanners that read twenty feet away. These are typically mounted adjacent to conveyor lines to read bar codes on passing items; the host computer then directs the items to the appropriate branching line. A classic example of such scanners use is airport baggage sortation; (those bar codes that are placed on your luggage are actually used in the large airports to get your luggage to the right place.) This type of equipment is almost always sold with turnkey hardware (including conveyors) and software by specialty integrators. Sources for industrial laser scanners are:

- Lazerdata Corp. 407-843-8975
- Microscan 206-226-5700

CCD Scanners

CCD Scanners are a "can't miss" scanner too. Most have to be placed on the code for reading, but some have "laser-like" distance reading. Some are triggerless and some require the trigger or button to be pushed to initiate reading. CCD scanners scan up to 200 times per second, so several unsuccessful attempts concluded by one good read are unnoticed. CCD scanners have an LED array with CCD light detectors for the reflected light. There are no moving parts in a CCD Scanner.

Most CCD Scanners have a "depth of field", (how far you can be away from the bar code and still get a read), of only 1/2". They have to be placed on the code to get a read. In the last 2-3 years, CCD Scanners have been developed with depth of field up to 8 inches. We have manufactured such a unit and have put it in the same case as our laser scanner. It has less depth of field than a laser scanner and it doesn't read very high- density bar codes but it is less cost -- an excellent trade off for many people.

Most CCD Scanners have a front opening, typically 2 inches or 3 inches. If you suddenly need to read a larger bar code than the width of the CCD scanner front opening, it can't be done. Recent developments in CCD scanners have resulted in CCD's that can read from a distance (up to 5") and read bar codes up to 4.2" wide.

Scanner Comparisons

	Wand	CCD	Laser
Cost	$100	$375	$695
Limitation on Width of Bar Codes Readable	None	2"-3"	12"
Multiple Trys/Second	No	Yes	Yes
Distance Reading	.2"	0"-5"	2-20"
Irregular Surface Reading Capability	No	Yes	Yes
Moving Parts	No	No	Yes
"Can't Miss Reading" (Sure Thing)	No	Yes	Yes

Integrated Readers

Most bar code readers have separate decoders, but decoders can also be integrated into the scanner, usually the handle. An integrated reader is usually less expensive and saves the space of the separate decoder. The disadvantages of integrated readers are: 1) you can't have a 2nd scanner such as an inexpensive wand for backup to a laser or CCD, and 2) power supplies cannot be added for low power keyboard ports.

LZ 200 WDP
Integrated Laser Scanner

WDP-P16 Integrated Long Range
CCD Scanner

Printing Bar Codes

There are several methods of getting printed bar codes:

1) Buying photocomposed bar codes from a label manufacturer.

2) Printing your bar codes with inexpensive labeling software on your personal computer's dot matrix, laser, or inkjet printer.

3) Printing bar codes on a specialized bar code label printer.

4) For manufacturers who need bar codes printed in their product's packaging, use purchased film masters or use bar code fonts suitable for the Linotronix.

Whatever printing source you decide upon, there are a few common sense tips to pass on:

1) Stay away from colored bar codes (use black) and colored backgrounds (use white). Any other colors lower the contrast between bars and spaces and therefore lower readability.

2) Do thorough readability testing on any labels before distribution. Be careful. Don't discover a problem after you have distributed 10,000 labels that need to be recalled.

Pre-printed Labels

If the only bar code application you are doing is an application such as fixed asset inventory tracking and employee badges, pre-printed serialized labels make a lot of sense. Photocomposed labels are usually very high quality and you can buy 5000 for around $300. Libraries typically use pre-printed labels...Why? Because the labels need to last for 25 years and the volume is usually 100,000 per library. High quality, durable, laminated photocomposed labels are usually used. Companies like **Data2 (800-227-2121)** supply such labels.

**You can also print high quality durable labels on a thermal transfer printer using XT Polyester label stock or on a laser printer with a vinyl label stock; such stock is more expensive than paper.*

Printing on PC Printers

With the proper PC software, today's dot matrix and laser printers are capable of printing excellent quality bar codes. Dot matrix printers cannot print high-density bar codes, but laser printers can. Laser printers actually print the best quality bar codes of any commonly available printing technology.

Dot Matrix Printing

Dot matrix printers can produce good quality low volume bar code labels. When printing low-medium (3.7cpi or lower for Code 39), the labels can be excellent quality. The Epson, IBM, and Okidata printers have adequate graphics capability to yield good quality bar codes. You will need a dot matrix printer with a pin feed platen to successfully print the variety of label sizes.

There's one catch though -- you must not wait too long to change the ribbon. The printer operator must make a judgment call on when to change the ribbon. It's best to tape a bar code of minimum acceptable darkness on the printer, so the operator can't make a judgment error. Programs that can strike the bar codes multiple times can keep the ribbon expense down.

9 Pin or 24 Pin Printers

Both 24 pin and 9 pin printers can produce good quality bar codes. The 24 pin printers produce better bar codes than 9 pin printers do, especially as the ribbon is getting low on ink. The 24 pins simply put more ink on the paper.

Ink Jet Printers

These printers are getting better and better. The HP Deskjet 600/800 produces great bar codes for all densities but high. They print pages of labels, so refer to the page label stock discussion below regarding page laser label stock. Be leery of using a DeskJet 500/550 for bar codes; the print quality is not sufficient.

These ink jet printers are almost exclusively supported by Windows programs, but beware; the new device drivers are flaky and often need updating by the manufacturer to work properly. Also, be sure to to select a printer that has a separate black cartridge in addition to the color cartridge.

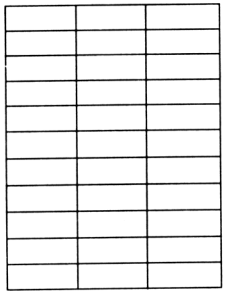
If labels you are printing are going to be exposed to water, don't use the inkjet printers -- the ink is water-soluble.

Beware, the inkjet cost per page in color is twice cost of a black and white print.

Laser Printing

Laser printers (the desktop HP variety) can produce outstanding quality bar codes. The quality is consistent; even when toner gets low; it is obvious and is not subject to interpretation. (When the toner cartridge is changed, it is important to follow the replacement cleaning instructions, including cleaning the corona wire, especially for high density bar code printing.)

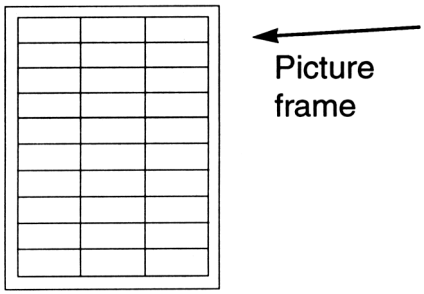
33/page



Labels are sectionalized on an 8 1/2" x 11" page in multiple columns and/or rows. For example, mailing labels (1" by 2.8") appear in 3 columns and 11 rows, 33 labels per page. Since laser printers feed one sheet at a time, it is impractical to print one label at a time.

There is an unprintable area 1/4" inch to the left, right, top, and bottom of any form; this makes full labels impossible unless you sacrifice the top row and maybe the bottom row of labels. One trick in laser printing is to use label stock with the laser's unprintable areas cut as a border picture frame around the printable label's area. For example, the previous example of 33 mailing labels per page would be 30 labels per page with the unprintable area isolated as a picture frame border. The top and left margin settings in the program would adjust the labeling program to the picture frame label stock's unprintable borders.

30/page



Laser printers are great for producing batches of labels, but if you need only one label (where there are multiple labels per page) at a time, dot matrix or thermal transfer printers are required. **Laser printing is the best quality of all types.** Windows programs usually give you rich text fonts, more rotations, and excellent PCX image graphics printing. The labeling programs for Windows often support Postscript printers.

Watch out for "HP Compatibles". Don't expect the labeling software vendor to be able to keep up with the incompatibilities of "compatibles"; they change rapidly, (one unnamed vendor changes from compatible to incompatible and vice versa with each new firmware release). The large vendors such as IBM, Epson, and Okidata tend to stay compatible, but only they can guarantee such, not the labeling software vendor. Windows software will be more likely to support a "compatible" that is not really so compatible, because there is a separate printer driver in Windows for each printer.

Continuous Form Laser Printers

In 1990, several laser printers which had a pin feed continuous form movement appeared. They generated great excitement and promise, but failed repeatedly to measure up to "as-advertised". As of 1994, these printers are fussy, messy, unreliable, and a big problem to almost everyone. They could change someday and be wonderful -- we are waiting. For the time being, consider yourself warned. We tried them ourselves twice and even sold them for 3 months; we had to abandon them both times. We remain very skeptical.

Thermal Transfer Printing

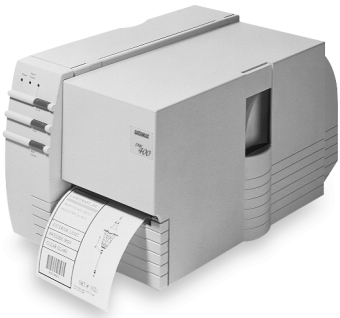
Thermal transfer printers are required when you need either to print one label at a time or when you need to print a roll of labels so that labels can be applied by applicators directly to boxes. Volume industrial printing in the 90's is done mostly by thermal transfer printers. They are fast and produce excellent quality bar codes.

Thermal transfer refers to the printhead heating up and melting a ribbon onto the label surface. Most thermal transfer printers can also produce "direct thermal" labels, but paper instead of a soft ribbon wears out the printhead 10 times faster; another disadvantage of thermal printing is that most thermal labels cannot be read with IR light and deteriorate in sunlight to non-readability over time. The media cost is about the same as laser and direct thermal. Thermal transfer printing is far more popular than thermal printing for serious label production.

Beware of the CoStar and Seiko thermal printers for producing serious bar codes. They have two problems:

1) the bar codes are just a little off, (the naked eye can often see 3 sizes of bars when only two are supposed to be possible), and

2) They are ***thermal*** printers producing bar code labels that deteriorate to unreadability in sunlight. They are inexpensive, thus very attractive, but beware.



Datamax DMX400 Thermal Transfer Printer

Most popular thermal transfer printers can produce labels up to about 4" wide (more expensive models can print at 6" or even 8") and lengths up to 8 inches plus. Smaller widths can of course be accommodated. Sato, Zebra, and Datamax manufacture popular thermal transfer printers; these are the major brands.

You can get almost any type of label stock imaginable for thermal transfer printers; high temperature, weather proof, surface laminated, jewelry ring stock, card stock, tag stock, etc.

The basic paper labels with inexpensive ribbons produce bar codes that can be smeared or smudged with hard rubbing by the fingers. Smudge proof labels can be produced with more expensive synthetic label stock and a ribbon with less wax and more resin (hybrid or P2 Ribbon). Scratch- proof laminated labels can be produced with XT Polyester and a high resin ribbon; when heated, the resin and polyester coating fuse to make a very durable label.

These printers generally print from 2" to 12" per second; at any width up to the maximum. Find out if the rated speed quoted for the printer you are considering is to be expected when printing bar codes or graphics -- for this, many printers slow down to less than 1/2 their quoted speed.

The print heads wear out on thermal or thermal transfer printers. To maximize the print head life, clean it between every ribbon change with a cleaning card or with a lint-free q-tip soaked in alcohol --a MUST to avoid continually replacing printheads.

Unlike most dot matrix and laser printers, the thermal transfer printers discussed have scalable text fonts and bar code fonts resident in the printer's firmware. The software necessary to print the bar codes is a series of special command

sequences, allowing you to add thermal transfer printing to one of your existing programs providing there is someone semi-skilled at programming.

However, most users want a general-purpose label design program that requires no programming. It helps to buy the printer from the developer of the labeling software so that you have a single party who has an interest in keeping the software bug-free and matching the printer's capabilities that you want.

Labeling Software

Because dot matrix, Deskjet and LaserJet printers are in such widespread use, labeling software to make these printers capable of printing bar codes has become readily available. There are two general types of bar code printing programs available:

1) Menu-driven programs for operators to design and print labels.

2) Bar code font programs to allow printing of bar codes within other Macintosh or Windows programs; no programming is necessary by the user.

Since DOS doesn't have integral fonts, DOS TSR programs have generally been used to print bar codes; only programmers are capable of using the DOS TSR programs with ease.

Stand-Alone Menu-Driven Programs

These programs allow the user to design different label formats and save them to disk for label runs. Usually there is a WYSIWYG design interface to view the label on screen as it is being designed, especially Windows programs. These programs usually have most of the following features: scalable fonts, graphic image import, all popular bar codes, data file import, easy custom operator interface, popular data base access, and/or built-in label data base. Look for a program that doesn't combine support for laser/dot matrix with thermal transfer. Separate programs for common PC desktop printers vs. thermal transfer printers keep it simple for the user. Here are some printing tips:

- DOS programs print faster than Windows programs
- Windows programs have better font selection, rotations, etc.
- Windows programs support the Deskjet Printer, including color
- Windows programs have better WYSIWYG design interface
- Windows programs handle more printer types, Windows programs can print multiple densities/label.
- Windows programs support color laser printers

Besides the ability to design and print labels, you should look for a program with a simple operator interface. The label designer creates custom prompts for a label format; then the operator answers simple questions that lead him to enter

the variable data for the labels to be printed. With a label database, you can select which labels to print. You don't want the operator to have to deal with the more complicated label design screens.

Font Programs

In the Windows and Mac environments, any font based program can select fonts for printing. This makes it possible to use bar code fonts from such programs as Wordperfect, Word, Lotus, Pagemaker, Quark, etc. Problems include:

1) Scaling - When scaling, Windows and the Mac can make little adjustments that really mess up the bar codes. Most programs give you fonts at a certain point size and density that are very accurate for the printer they were designed for, however, if you change printers or change point sizes, anything can happen. Be careful when straying outside the standard point size for printer specific fonts.

2) When printing UPC, a 0 can be represented by four different bar/space patterns, depending on where it is in the code and the computed parity of the data. Therefore it is necessary to have a translator program to switch to, enter the data you wish to print, copy it to the clipboard, then copy the translated strings into your application. At least one program has a "hot-key" sequence which copies the bar code into your application without having to first translate and then copy from the clipboard. After setting the bar code type and density from the translator, any highlighted data in the application is translated with the "hot key".

Using fonts, labels can be printed from your favorite word processing program, or you can add bar codes to a form from almost any font-based Windows program.

DOS TSR Programs

Since DOS users don't have font-based programs, printing bar codes from inside another program is usually done with a TSR (Terminate and Stay Resident) program. TSR's print bar codes by using text surrounded by special prefix and suffixes. For example, to print the bar code TEST, the program would expect: @@BCTEST@@BE. The @@BC and @@BE would trigger the printing the enclosed data. These programs usually require a skilled programmer as they are not as easy to use as a Macintosh or Windows font bar code package.

Bar Codes on Packaging or Film Masters

How to Get a UPC Number

If you haven't already been assigned your manufacturer's number by the Uniform Code Council or appropriate EAN authority, call (**UCC is 937-435-3870**) to get

registered. You will pay a charge to get a manufacturer's number assigned, (digits 2-6 in the UPC code), plus you will get an information packet. You then can create up to 99999 unique UPC numbers for all of your products.

For users who wish to have the bar codes printing as an integral part of their packaging (such as a sugar bag) there are three ways:

1) Create your packaging design with a Windows or Mac-based program, using a postscript bar code font package to add the bar codes to the whole packaging design. The film for the packaging would include the bar code.

2) Order separate film masters from organizations that specialize in bar code film masters (such as **Symbology Inc. 1-800-328-2612**). Have your printer strip in the bar code film to the packaging film so that the whole packaging prints with the bar code included.

3) A third method that must be done with **caution** is to print bar codes on paper with a good bar code printing program, photograph the printed bar code, and then use the film as in 2 above.

After printing, the ink in bars tends to bleed slightly into the spaces. When creating film masters, the bars should be slightly narrower, (about 1/1000 inch narrower), to allow for ink spread during printing. Turn down the darkness on the laser printer if printing bar codes on paper to be photographed.

Whatever method you use, you should have your printer make test print runs. If you don't use a verifier to test the accuracy of the bar codes, at least:

1) Test them with a bar code reader for readability. You should get 20 out of 20 reads with reasonably careful wanding. Don't accept any bar code that has less than 100% readability. AND

2) Have your printer (the person doing the printing) microscopically inspect the narrowest bar and narrowest space after printing (wait about 30 minutes to 1 hour for any bleeding of the ink to complete). They should be very close to equal. If they vary by more than 10% from each other, then the exposure on the film must be changed; if the bars are too big, expose less; if the spaces are too big, increase the exposure.

Don't forget to leave a 1/4" white space to the left of the bar code and a 1/4" white space to the right of the bar code (no text or other graphics in these areas).

Bar Code Applications

Bar Code applications are growing by the day as creative people find ways to enjoy data entry efficiency possible with bar codes. The following is a brief discussion of some major applications: (the key to all of these applications is the software; the software is the steak, the bar code is the sizzle).

Data Capture Applications

Assembly Checking - Usually done with custom assemblies, a terminal leads the operator in what to assemble; as the operator scans each part or subassembly added, the computer can monitor for correct specifications.

Fixed Asset Inventory Control - Large organizations have multitudes of furniture, PC's, fixtures, etc. The exact location for each item determines cost allocations. Bar codes are placed on all items and bar codes are placed on walls of each location. With a portable bar code reader, the location is wanded and then all items in that location are wanded; the data is then uploaded to the computer for accurate depreciation cost allocation.

Job Costing and Tracking - As item(s) are completed, scanning results into a terminal. (Multiple operators use a single terminal).

Labor Distribution - Using employee badges, as employees move from department to another, the employee scans in his badge at the new department's terminal. This allows payroll cost allocation to departments.

Library Automation - Automatic check out. Bar codes on ID cards of patrons and bar codes on books.

Meter Reading - Similar to a pick list, but downloading to portable terminal the list of addresses to be read, along with the bar code ID of the meter, so that the terminal checks that the operator is indeed reading the right meter.

Order Books - Catalogs of items with associated bar codes. Used for order taking, estimating car repair costs, route accounting, etc.

Point of Sale - At the cash register (or equivalent), scanning the bar code into a computer which looks up the item scanned and displays the description and price plus decreasing the on-hand inventory by the quantity purchased.

Records Management -For patient records, case records, loan records, etc., a bar code is placed on the folder. As the units are checked out, the folder is scanned and the borrower's ID card is scanned. When the unit is passed from one station to another, the item is scanned so that it can be tracked through the organization.

Remittance Processing - printing a bar code on the remittance stub or the invoice stub so that when the customer returns the stub with his payment, it can be wanded to bring up the data or to complete full payments.

Stock Taking - the classic portable bar code reader application. The operator scans the codes of the items (perhaps scanning only one of multiple items and then entering the quantity for that item) and then uploading the stored scanned data to the computer later, thereby correcting the computer's files for what is actually on the floor.

Time and Attendance - employee badges with bar codes are read at clock-in and clock-out into a computer or terminal to provide attendance data to the computerized payroll program.

Warehouse Picking - the computer downloads a table to a portable terminal and the operator is prompted to pick a list of items associated with a specific order. After picking the order, the operator goes back to the terminal to upload the data and receive his next order to pick. As locations are reached or items are picked, the bar codes are scanned and the terminal compares what was scanned to be sure the right location or item is being picked.

Warehouse Putaways - as the operator stores items in a warehouse, the operator scans the items and the location. This data is the uploaded to the computer so it can keep track of the inventory quantity on hand and locations.

Warranty and Service Tracking- as units are received, the bar code on the case of the unit is scanned, bringing up the computer history for that unit. As the unit is repaired, scanning what failures and what new parts are required to repair for costing and failure analysis.

Work-In-Process Inventory Tracking - with on-line readers or portable readers, scanning the routing sheets with bar codes on them as parts or subassemblies are completed, often including yield data, so the work-in-process costs and progress can be tracked. (Usually one terminal per operator).

Event Time Applications

There is now a variety of hand held bar code terminals which are linked by Radio Frequency (RF) back to a host computer. This makes possible portable interactive applications in the stock room, the warehouse, shipping, receiving, etc.

Whatever the cost of the hardware, the application software investment is intense for most companies. It is really an extension of MRP II software into the portable hand held terminals.

Applications include:

Rental Car Check in and Billing - Anyone who has rented a car lately has experience the convenience and speed of RF Terminal check-in at the curb.

Massive Table Lookup - The simplest application is the computer performing validity checks on data entered from its large up-to-date computer files and notifying the operator of any invalid data.

A classic example of this would be grocery price validation. Instead of downloading a 10 MB file into a hand held, the computer does the table lookup and lets the operator know what prices need to be changed on the floor. Any store without prices on the items must have price validation by RF Terminal to be sure the prices on the floor are the same as the price in the computer. Direct Store Delivery by vendors is also a must for RF Terminals, allowing the store to monitor the price being charged by the delivery personnel to the store.

The best example is stock taking. Based on the outage or overage, the computer would instruct the operator in different things to do: count again, see supervisor, etc. The counts could be double-checked on the spot, yielding a faster more accurate inventory count.

Receiving - As a purchase order is received, the operator scans and key what has been received, with the computer pointing out shortages that are double checked on the spot rather than after the items have been moved or partially used.

Shipping - As items are loaded, they are scanned. Shortages or misloads can be detected immediately.

Put-Aways - The computer can tell the operator where in the warehouse to place items from receiving and the items are then immediately available for picking to satisfy the next order.

Warehouse Picking - The computer instructs each picker what to do with up to the second stock status from Put Aways. This would be especially valuable with items in multiple locations and where substitutions are possible.

Resources

To get a manufacturer's number assigned for UPC bar codes:	Uniform Code Council 513-435-3870
For industrial laser scanners	Lazerdata Corp. Microscan 407-843-8975 206-226-5700
For dot matrix and laser labels	Ardon Business Forms 819-377-6160
For thermal transfer labels and thermal transfer ribbons	Mabi Label 408-283-1600
For bar code verifiers	Accugraphix 714-847-6674
For badges and badge supplies	Caulistics 415-585-9600
For Code 39, I 2of5, and Codabar Specifications	ANSI Sales Dept. 1430 Broadway NY, NY 10018 (Enclose $9)
For most other bar code specifications (fee)	AIM USA 412-963-8588
For Film Masters	Symbology Inc. 800-328-2612
Assembly Line Label Applicator	Lord Label Systems 214-647-2504
PrePrinted Bar Code Labels	Data2 800-227-2121
Bar Code Readers (PC and Serial Multi-User)	Worth Data 800-345-4220
Bar Code Readers (IBM Mainframe)	Lowry/Data Recall 408-980-5200
Laser Scanners	Worth Data 800-345-4220
CCD Scanners	Worth Data 800-345-4220
Radio Frequency	Worth Data 800-345-4220
Portable Bar Code Readers	Worth Data 800-345-4220
Labeling Software & Fonts DOS, Windows, Macintosh	Worth Data 800-345-4220

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