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## Designing a Barcode System

Barcode systems require three elements:

**Origin:** You must have a source of barcodes. These can be preprinted or printed on demand.

**Reader:** You must have a reader to read the barcodes into the computer. The reader includes an input device to scan the barcode, a decoder to convert the symbology to ASCII text, and a cable to connect the device to your computer. Datalogic markets a variety of hand-held products, which are decoders and input device all in one.

**Computer System:** You must have a system to process the barcode input. These can be single-user, multi-user, or network systems.

### Origins of barcodes

A barcode system must have a source of barcodes and a way to read them. Barcode labels fall into one of the following categories: preprinted or printed-on-demand.

### Pre printed barcodes

Using preprinted labels is the most economical way to get high-quality barcodes. This places some restrictions on you, because the information in the barcodes must be determined in advance. In many cases this is acceptable, but in some it is not.

Preprinted barcodes are used where very durable, high-quality labels are necessary to withstand the environment (such as on printed circuit boards), or where high-volume packaging or labeling is done. Examples of preprinted barcodes are:

- 1. Barcodes on Packaging** - The most common example of preprinted barcodes are those you see on packaging for retail sale. Grocery stores are the most common application, but the system is gradually working its way up the manufacturing chain.
- 2. Stickers or Tags** - In many cases, you need to identify a particular item as unique. There are several companies that will print stickers, pallet tags, item tags, or other types of very high quality barcode labels in any required sequence. Either of these systems works very well when you can manage the assignment of codes beforehand. In many cases, you can also use assigned codes by generating a correlation between the barcode and another significant value. For example, you could use a randomly numbered sticker or tag and have the user type in the corresponding invoice number, control number, or other information that goes with it.



## **Printed On-Demand barcodes**

On-demand barcodes are used where the barcode must contain some information that is available only when the barcode is generated. Datalogic produces products to help with creating on-demand barcodes.

On-demand barcodes can be produced in small quantities for less money than preprinted barcodes, and in less time. They can be printed with:

- 1. Dedicated Barcode Printers:** These produce very rugged barcodes. Dedicated printers come in several varieties, including thermal and thermal transfer. The best of them can produce barcodes that are not bothered by acids, rain, sunlight, or various other problems. These printers can also print a single tag or sticker easily and remove the label backing automatically.
- 2. Laser and Ink Jet Printers:** Barcodes printed by these printers are comparable to those printed on dedicated label printers. In fact, the print quality is almost as good as on preprinted barcodes. However, laser printers are not quite as rugged as dedicated label printers, and they print a full sheet of labels at a time.
- 3. Label Printers:** Avery™ and Costar™ make small, thermal label printers that can print barcodes. These printers may not be the best choice for high-volume printing.

## **Reading barcodes**

Once you have a barcode in hand, you must read it and process the information. Reading barcodes requires three basic decisions. You must decide on the input device, the decoder, and the interface. The input device reads the barcode and transmits the data to the decoder, which converts the data to ASCII characters. The interface is the connection between the decoder and the computer.

## **Input Devices**

Input devices (wands, CCDs, badge scanners, and lasers) are the direct contact between the user and the barcode. No other choice you make will have a greater impact on the usability of the system. Naturally, there are several choices, in a range of prices. In general, you will get better service from more expensive devices, but this is not automatically so. The choice of input device is controlled by these factors:

- 1. Volume:** Some input devices are inherently more usable and reliable than others. If you have a low-volume application, any input device will probably work well for you. A high-volume operation will generally be better off with a high-grade input device. High-grade input devices are fast and reliable.



**2. Barcode Quality:** One of the advantages of high-grade input devices is their ability to read low-quality barcodes. In applications where barcodes are of poor quality to start with or are likely to be damaged, use of high-quality input devices can save time and reduce errors.

To select an input device, you must take all of these factors into consideration. Once you have made a tentative decision, you should test the system in as many real-world conditions as you can simulate.

Get the input device a little dirty, damage the barcodes, print them with a slightly worn ribbon or cartridge, test it with an untrained employee, and try to anticipate other problems that may happen during normal operation. This way you can make sure you have made the right choice. The most common input devices are:

**1. Wands:** These are the most inexpensive input devices available. They work well for low-volume scanning but have some disadvantages. They require a relatively flat surface, a fairly high quality barcode, and some skill on the part of the person operating it. However, in applications where someone must scan one barcode on a sheet full of barcodes, these are a good choice.

**2. CCD (Charge-Coupled Device) Readers:** These are the next step up from wands. A CCD has a read head the same width as the barcode (2 to 4" / 5 to 10 cm). The user sets the head of the reader on the barcode, and a series of LEDs illuminate the barcode so it can be read. This requires less skill than the wand, and it will work with most low-quality barcodes. They still require a relatively flat surface, and the CCD must be within 0.25" / 0.5 cm of the barcode to read it. The surface can be slightly curved in the direction of the bars, but no more than about the curve of a 1-liter bottle.

**3. Laser Scanners:** These are the best type of input device and are therefore the most expensive of the hand-held options. They will work with curved or uneven surfaces and will read most very low quality barcodes. They will also read over a much greater distance than wands or CCDs, usually 5" to 27" (12 to 65 cm). Laser scanners come in general-purpose and heavy-duty versions.

**4. In and/or On-Counter Laser Scanners:** These systems use laser readers that are fixed in place, and the barcodes are brought to the scanners. The most common example is the scanners in used in grocery stores. Another example is a conveyor controlled fixed-mount laser scanner that reads the labels on boxes or packages as they move down a line. These are used in the airline industry to process baggage, in warehousing to control conveyors or other devices, and in many types of manufacturing.



**5. Slot Scanners:** Slot scanners are used for time-and-attendance, security, and other systems. Each scanner has a slot that you slide bar-coded cards through. These scanners look much like the credit card readers you see in retail settings, but they read barcodes instead of magnetic coding.

**6. Combination Scanners:** You can frequently mix two different types of input devices. For example, you can attach a slot scanner and a laser scanner to a decoder to allow users to enter information either way. Many models allow you to attach magnetic card scanners to barcode readers. This way, you could process credit or ATM cards with the same system that reads barcodes on packages.

## **Interfaces**

Once you have selected an input device, you must select a decoder and the type of interface to the computer. Most batch systems use a periodic download over serial ports, and you don't have much choice in the interface method. Interactive systems have a choice of several interfaces.

When choosing the interface, you must keep the following factors in mind:

**Existing equipment:** If you plan to use existing equipment (computers, terminals, etc.), you will need to make sure the interface type you choose is compatible with the equipment you currently have.

**Data Reliability:** Interface types vary in ease of use. One interface may allow the user to affect the data, while another may not. This does not mean that one interface type is inherently better than another. It does mean that where user error can affect data, more follow-up will be required.

**Locations of Readers:** The location of the readers can have a profound impact on the design of the system. For example, most shop floor environments are too crowded or are unsuitable for PCs. This limits the type of system interface you can use. As with the input device, you should test the system architecture you choose in as many real-world conditions as possible.

Interfaces come in these basic types:

## **Interactive Systems**

**Wedge Readers:** These systems are the least expensive and the easiest to implement. The barcode reader connects between the keyboard and the computer and simulates keyboard input. The application program does not know the difference, and the user can always type in the numbers if the barcode is unreadable. This is the best choice in many cases.



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**Serial Readers:** These systems are more flexible than the ones using wedge readers. In this case the reader is connected to the computer or terminal over a serial port to the computer. Since serial communication is standardized, you can typically use a serial decoder with almost any computer or terminal (cabling may vary). Serial readers are ideal for terminals, since most terminals are serial devices themselves. If your terminal does not have a port available for a serial scanner, you can use a “serial eavesdrop” cable to connect the scanner between the terminal and the host computer. When using serial scanners with PCs, keep in mind that your application needs to “monitor” the serial port for incoming data. Most applications do not do this, and so an additional piece of software, called a “software wedge”, may be required.

## **Operating Systems**

Once you have decided on the scanner technology, you must design the system. These systems can be set up in several configurations. Some applications will work with only one particular system type, but most applications allow you to select the system to meet the best cost/performance requirements. The basic system types are:

**Single User:** These systems use a single PC with a single barcode reader to process data. These are generally the best type of system to start with, as they give you experience with barcode technology without some of the complexities of multi-user systems. An example of a site with a single-user system is a small video store that uses a wand to read barcodes on movies and stickers on customer cards. The store might also use a slot scanner for customer cards.

**Multi-user:** This was once the most common type of system. It consists of a single computer that is hooked to several barcode readers, terminals, or both. A multi-user operating system manages the data collection.

**Local Area Network:** These systems connect several essentially single-user systems and a common file server using a network. These are the most flexible systems and currently the most popular.

**Portable Systems:** Prices of portable data terminals and mobile computers have fallen over the last few years, making portables one of the best solutions for barcode applications. Portables are used with computers to keep data current either in real time or in batch mode.



## **Single user systems**

A single-user system is simply a PC with a barcode scanner attached. The system generally uses a wedge to simulate keyboard input. A wedge can be used with any PC that has the same keyboard interface as the wedge. Most computers have either a DIN connector (like that on IBM computers through the AT) or a PS/2-style keyboard connector. A few companies make their own, nonstandard keyboard connectors. You must be sure to get the right kind of wedge for the computer you are using.

The normal action of a barcode reader is to simulate typing the keystrokes for the characters in the barcode and then press the Enter key. You can change the Enter key to a tab key or any other key for specific situations.

When the reader must be remote from the PC or terminal, you can later connect it reader to a serial port and use a “software wedge” to send the data into the keyboard buffer. Another possibility is to write the application so that it monitors the serial port for incoming data. Serial decoders are also useful if you must support a computer that uses a nonstandard keyboard interface and when you want to use a single barcode reader with a combination of PC, Macintosh, or UNIX systems. Software wedges are available for a variety of operating systems.

## **Multi-user systems**

Multi-user systems have traditionally been the most common type of barcode system. This system uses serial ports to connect a single PC or other computer system to multiple barcode readers, terminals, or both. Each terminal runs a single session on the multi-user operating system. Cheaper PC prices and the availability of very basic network PCs will undoubtedly sway some users away from multi-user systems. Clearly the multi-user system is on its way out.

## **Networks**

Networks work just like several single-user systems connected together to share data. These work much like the multi-user systems shown above, except that each station is able to run any application. Networked PCs can run graphics-based and text only applications and perform any other MS-DOS or Windows functions. The multi-user systems mentioned above will work with any text-based program.

Networks provide this flexibility at the expense of cost. These systems also require a PC at each station.



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## **Developing a barcode single user system**

If you wish to create simple single-user systems, all you need is a wedge reader to connect to your PC. If you wish to print on demand barcodes, you will also need barcode printing software. There are many good products on the market today. We recommend BarTender from Seagull Scientific. Since a wedge reader simulates keyboard input (it connects between the CPU and keyboard), you simply plug it in and scan the barcode. You can improve the reliability of your scans when printing on-demand barcodes by encoding a special character into the barcodes. For example, you could put an “E” at the beginning of employee badge numbers, and a “D” before a department number. Then you can check for this when a field is read to be sure that the user is not scanning the wrong type of barcode.

## **Have more questions?**

Please contact us at 603.527.0256 or [tburrell@PaladinID.com](mailto:tburrell@PaladinID.com). PaladinID has been in the business of designing and implementing barcode systems for over two decades and we’d love to help you solve your business problem with a barcode solution.

Thank you for your interest in PaladinID, LLC. We are here to help you “Make Your Mark.”

Toby Burrell

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