DYNAMIC SYSTEMS INCORPORATED

Barcode Systems and Data Collection

Overview

Prepared by
John VanZanten - Systems Consultant,
Dynamic Systems, Inc.
Toll free) **800-342-3999** Cell) 206-940-1386
E-mail) **JVZ@dsisales.com**
WA Office) 425-483-0844 FAX) 425-487-9598
OR Office) 503-297-0827 FAX) 503-297-0828

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I. About Dynamic Systems

Dynamic Systems, Inc. (DSI) was founded in 1981 as a woman-owned business to provide systems solutions to the fledgling bar code industry. As the original Pacific Northwest distributor for Intermec, DSI quickly became well known as the expert in integrating automated data collection solutions. The quality of DSI's sales and support team has allowed us to stay on the leading edge for all these years. Today DSI is known throughout the Pacific Northwest as a premium provider of barcode printer support for Zebra, Printronix, Datamax, Intermec, and other manufacturers. DSI's focus on customer service means that we are continuing to provide solutions to the same companies we were serving in 1981. We at DSI are proud of our reputation as a full-service company. "We hold ourselves accountable for your success."

II. Components of a Barcode System

The basic components of a barcode system are:

- Media (labels, reports, and other surfaces which may have a barcode symbol)
- Printers, Printing, and Barcode Generation Software
- Scanners and Imagers
- Portable Data Terminals
- Connectivity – Batch or RF
- Software
- Professional Services

Media

The correct media is important in connecting the system whatever is being tracked. A barcode symbol must be readable, accessible, and resilient.

- Barcode symbols can be directly on existing documents and printed by most laser printers.
- Pre-printed barcode labels are popular when sequential numbering is needed, but variable numbers and information is not (such as when asset tags are applied to existing assets and other units.
- Barcode label stock is available in with various properties such as resistance to photocopying, resistance to successful removal, resistance to harsh environments, and adherence to various surfaces.
- There are several symbologies available for barcodes. Some are more efficient than others – especially when printing alphabetic characters. Some symbologies have error-checking characters to avoid misreads. Some symbologies have strict standards for use (such as UPC).
- 1-dimentional barcodes are normally a single "license plate" value, which is an index to all the other information associated with that unit.
- 2-dimentional or stacked patterns to allow much more information to be included than the single string of characters (usually less than 25) in the standard 1D barcodes. These kinds of symbols are more popular when extended information needs to travel with the symbol to other locations that do not have convenient access to the source database.

- Many barcodes contain data identifiers. A data identifier is usually the first character(s) of a barcode and signifies what the barcode is (i.e. "L104" means "Location 104" or "I104" means "Item 104". Data identifiers can be stripped before processing, but can make the application quicker to utilize. For example, the user who is scanning all the pallets in several locations can simply scan "location – item – item – item – item – location2 – item – item – item. . .." Instead of having to key in that they are scanning a new location then scanning the location, etc. because the barcode itself specifies its meaning.
- Thermal transfer and direct thermal are the most common methods of generating barcode symbols on label stock.
    - Thermal Transfer utilizes a ribbon to transfer (using heat) the barcode symbol from the ribbon to the label media. It creates a sharper image, which is critical with denser (smaller) barcode symbologies. Thermal transfer is more resistant to most environmental harshness, but requires slightly more labor due to the need to replace the ribbon along with the media.
    - Direct Thermal utilizes a media that becomes black when heated – thus requiring only the media (no transfer ribbon). It is marginally less expensive – there is no thermal transfer ribbon, but the media is a bit more costly. The barcode symbol is slightly fuzzy on the edges and is therefore not recommended for denser barcodes. Direct Thermal labels can be erased (become completely black) if heated beyond human conditions (such as in a hot trunk or near a heating element).
- Barcodes maybe printed directly on to relatively flat surfaces with ink-jets without the use of a label. This kind of application requires consideration of the bleeding properties of the surface, the available surface area for the symbol, and the speed at which the unit passes the inkjet.

Printers, Printing, and Barcode Generation Software

Printers

- Barcodes are most commonly printed by label printers. They can also be included in office documents and reports and printed on laser or dot matrix line (and other common) printers.
- Label printers can be connected directly to network computers, to handheld computers (normally portable), or directly to a network.
- The price of most barcode printers ranges between $300 and $6000, with the most common printers in the $1000-$2500 range. The features which drive up the cost and quality are the following:
    - Ruggedness
        - How many labels can be expected per day
        - How long the components can be expected to last and warranty coverage
        - Resistance to environmental elements, vibration, movement, and human use
    - Speed
        - Measured in inches per second (ips)
        - Normally between 1 ips and 12 ips
        - Configurable on most printers (quality of barcode can be reduced by speed)
    - Resolution
        - Measured in dots per inch (dpi)
        - Normally between 203 dpi and 600 dpi
        - Higher resolution required for smaller barcodes and graphics
    - Width
        - Print head width range is normally between 2" and 8"
        - Width of print head tends to dictate the width and footprint of the printer
    - Print method

        - Direct Thermal or Thermal Transfer
        - Many printers offer both
        - The very smallest printers allow only Direct Thermal because there is no room for the additional spool required for Thermal Transfer
    - Memory
        - Memory allows for storage of label formats, graphics, and other processing elements
        - More memory can allow for faster printing because less information will need to be included in print messages
    - Other features
        - Verifiers allow for verification of barcode quality after printing and the ability to automatically reject and reprint flawed labels
        - Cutters allow for automatic bursting of labels after printing
        - Internal rewinders allow printers to rewind label for reprint or realignment
        - LCD screen size, programming buttons, status lights

Printing

- Barcodes can be printed automatically from existing applications (many software packages include this option)
- Barcodes can be printed manually as needed with minimal programming and integration
- Barcodes are usually printed from fixed location printers connected directly or indirectly to a PC or network
- Barcodes can be printed from portable printers which are usually connected to portable handheld computers
- Barcodes can be included in existing documents and reports – in some cases only slightly more complicated than utilizing a special font.
- Printing on label printers usually involves communication to the printer using a proprietary printer language (i.e. each printer manufacturer has its own). Applications can be written to utilize these individual languages, or label software can be utilized to handle the printer language translations automatically.
- Data identifiers

Barcode Generation Software

- allows a more graphical and efficient design process with the report
- provides relatively seamless translation from printers from different manufacturers (each utilizing its own printer language)
- allows application programming for many solutions without any other software platforms
- can act as an interface to legacy reports and print streams, thus allowing add-on barcode generation in legacy systems
- can provide objects and controls which can allow incorporation of barcode symbols in other software packages such as Microsoft Office applications
- tends to range between $200 and $3000 depending functionality, portability, support, and number of user licensed users.

Scanners and Imagers

Scanners vs. Imagers

- Scanners utilize a laser reflected off of a moving mirror which passes over the barcode symbol and decodes it as a sequence of reflections (black and white).

- Imagers capture and the decode the barcode as part of a single image which is capture all at once without moving parts.
- Scanners are slightly (almost not noticeable) faster than Imagers in decoding
- Imagers are much more rugged due to the lack of moving parts

Wedge vs. Serial

- Scanners and Imagers are normally connected to a PC or terminal via the serial port or as a keyboard wedge.
- A keyboard wedge interface is where all barcode input is accepted as if it was typed in on the keyboard. It connects between the keyboard and the computer
- Serial input is connected to the serial port and accepted as serial input – differentiating it from keyboard input

Cordless vs. Corded

- Cordless and Corded are similar in nature to cordless and corded phones.
- Cordless scanners and imagers connect to one PC via an antenna, which is connected where a corded scanner or imager would be connected (serial port or keyboard wedge).
- Corded costs less, but cordless allows about the same distance from the PC as a cordless phone would from its base station

Programming

- Scanners and Imagers can actually be programmed. This is done by scanning certain barcodes, which are included in the associated documentation.
- Typical programming might be to
    - strip data identifiers,
    - automatically append an ENTER keystroke to the end of the data,
    - add zeros or spaces to the beginning of numeric data
    - only allow certain formats

Considerations

- Scanners and Imagers range in price from $100 to $2000 (for some extremely rugged highly-programmable cordless models with memory).
- Some scanners and imagers are designed for longer range than others, but can be less convenient at close range.
- Some scanners, imagers, and host antennae for cordless scanners/imagers require AC power and some operate connected only to the serial keyboard port on the host
- Some scanners and imagers are designed (or can be configured) specifically for being mounted into a counter-top or onto a desktop and require only that a barcode symbol be placed in front of it (no trigger) to activate input.
- Factors which affect value and price are:
    - Ruggedness
    - Ability to decipher 2D barcodes
    - Ability to decipher damaged or poor quality, or barcodes obscured by glass or plastic
    - Range (distance for long-range scanners still requires that the barcode be somewhat large, and for ranges beyond 15 feet, the barcode must be reflective)
    - In general, cordless costs more than corded

Portable Data Terminals

Portable Data Terminals (PDTs) differ from scanners and imagers in that PDTs act *as computers* rather than as being simply *input tools for computers*. PDTs allow keyed input, have a screen for prompting the user and presenting information to the user, can store large amounts of data, can be addressable on a network, can connect directly to a printer, and have all of the basic components of a computer other than a disk drive.

Attributes of PDTs

- Flash memory, the equivalent of the disk drive, is memory made up of EPROM (Erasable Programmable Read-Only Memory) chips. This memory is "flashed" or written relatively permanently with application software and will remain resident without power until explicitly re-flashed.
- PDTs usually include integrated scanners for collecting barcodes
- PDTs can be character-based (lines and characters per line) or …
- PDTs can be pixel-based like Palm computers, CE devices, and other devices which display various font-sizes, graphics, and windows of input down the pixel (picture-element) based

PDTs are either Batch or RF

- Batch devices have a resident application, which collects data into memory, and then is connected to a host computer onto which that data is transferred (uploaded).
- RF (Radio Frequency) devices connect to a host computer using some form of radio. Data can reside on the PDT but is usually validated and then immediately sent to the host computer. RF PDTs do not always have a resident application – sometimes they are simply acting as a dumb terminal (no resident logic) for the host computer using radio as a connection.

PDT categories

PDTs tend to fall into the following categories:

- Gun-like or calculator-like devices with integrated scanners and input keys,
- Wearable devices which allow the user to use both hands – the keys connected to the wrist or hand, and the scanner connected to a finger or the back of the hand,
- Palm and CE devices which are can be placed in the pocket and receive input primarily by touch screen and integrated scanner,
- Vehicle-mount devices which are mounted and powered by vehicles like fork-lifts,
- Pen-tablets which have a larger screen (often using a Windows operating system), a virtual keyboard (keyboard displayed on screen) and receive most input by touch screen and integrated scanner.
- Data phones, which act as a hybrid between a PDT and a cellular phone, utilizing one or both connectivity's.
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Considerations

- All scanner/imager considerations, other than "corded vs. cordless", apply to the integrated scanner included in most PDTs.
- Some PDTs (such as Pen Tablets) allow for scanners or imagers to be connected as input devices rather than having integrated scanners. In these cases cordless scanners could be considered.
- PDTs can range in cost from $300 for the most lightweight Palm devices with integrated scanners, to vehicle-mount Windows terminals with RF connectivity for over $5000.
- Costs are related to

- Ruggedness
- RF vs. batch (RF costs more)
- Keyboard options
- Scanning and RF range
- Size factors (not necessarily bigger = better or smaller = better)
- Battery-life

Connectivity – Batch vs. RF

Batch

- Batch PDTs have a resident application program, which does not communicate with any outside processor except when docked.
- Normally a batch device collects data without validation, although validation is possible when the validation table is resident on the PDT.
- Periodically the user will dock the batch PDT (connect it to a PC or network) and upload the collected data to the host system. Data is normally uploaded as fixed-length text, comma-delimited text, spreadsheet, or directly to an ODBC-compliant database.
- Batch applications must be somewhat more extensive in some cases, because there may not be a database to validate the data against.

RF

- RF (usually Real-Time) data collection uses radio to maintain constant communication with a host system.
- Data can be validated against a central database, and the database can be immediately updated upon collection
- PDTs act as concurrent users, and are many times recognized as virtual mainframe terminals, IP-addresses, individual database connections, and individual system sessions and/or threads.
- RF PDTs tend to connect in the following manners:
    - Resident Application – application resides completely on the PDT and operates the session only using the RF connection to validate, upload, and download data. In this model the PDT can temporarily operate without RF connectivity and operate in batch if the RF system is down or congested.
    - Thin Client – custom application session runs on the host, while the PDT operates a functional application, which interprets efficient messages from the host that specify what the terminal should do. Constant connectivity to host is required.
    - Terminal Emulation – PDT acts as a dumb-terminal, displaying and collecting exactly what the host computer sends and prompting a full-screen at a time. Keystrokes are accepted one at a time in most cases. Not very efficient communication, but usually very easy to set up if the host application is conducive to PDT data collection.
    - Screen Scraping – similar to Terminal Emulation, except that a small application is running which accepts a full screen terminal (normally designed for a mainframe terminal) and then only displays the portions of it that are needed on the PDT. Screen –scraping applications often skip un-necessary steps and screens, and have a filtered menu structure, all the while maintaining the protocol of a normal mainframe terminal.

Software

Off-the-shelf software with data collection functionality

- There countless software packages which include mobile and handheld data collection functionality.
- Most of them are included in warehouse management, inventory, accounting, asset tracking, point of sale, and stockroom software suites. Most of these packages allow configuration and localization of the software.
- Some of these software packages support the PDT product(s) of one manufacturer. Others support a more open interface to PDT data collection.

Application Development and Connectivity Software

- Most PDTs allow development of applications using C++, Visual Basic, or other languages.
- These languages are fairly simple to learn. There are tools available which make it much simpler and quicker for the user to learn how to develop these applications.
- Some of this software is designed exclusively for use with
    - one line of products
    - one type of connectivity
    - one type of input or output.
- Others are more inclusive and offer many options with multiple manufactures, connectivities, and interfaces.
- Some software tools are designed as a set of objects for use with a mainstream programming language such as C or Visual Basic.
- Some software is designed for developing screen-scraping applications for connecting to legacy systems.
- Many terminal emulation software applications are available at no charge from the hardware manufacturers.
- Most of the software allows unlimited users for batch applications, and has per-user charges for RF applications.
- Some software is so easy to use that anyone who can build an excel spreadsheet can create a basic PDT application – others can be very complex and object-oriented in nature.
- 1-user costs can be as low as $200 for simple development tools, and as much as $5000 for multi-function object-oriented development packages. Costs increment with the number of licensed users for most software packages.

Professional Services

Professional Services associated with a data collection system may include some of the following:

- Preliminary Definition - Information gathering and definition of project. This activity is usually not billable
- Specification generation and system definition - This activity usually results in a deliverable document such as a System Requirements Definition (SRD). This process is between 1 and 3 days ($1200 - $3600 at DSI), however at DSI we offer a partial credit for professional services resulting from the continuation of the project defined by the SRD.
- Site-survey – The measuring of a building or area for a proposed RF system. The area is tested and plotted for the optimal placement of RF Access Points and antennae. The cost of a site-survey is approximately $2500. It can be more for a larger or more complex facility. Utilizing a site-survey will guarantee RF coverage when the system is implemented.
- Return On Investment study. An ROI study can be helpful in determining (or selling to superiors) the value of implementing one or more data collection system scenarios.

- Project Management – Many times a data collection system requires the coordination of many resources and persons. A project manager facilitates this coordination, communicates project status to all affected areas, and helps eliminate problems before they affect project costs. Normally a project manager devotes relatively few hours each week to any particular project.
- Training – Training of the users will always occur shortly before implementation. If a customer has IT resources, it can be helpful to train those persons in programming and maintaining the data collection applications and equipment.

II. Methodology of a Barcode System

The following list of process components are generally in chronological order, however many of these components will overlap a great deal on the project schedule. The basic components of a barcode solution project at DSI are:

- Preliminary qualification
- Information gathering
- Scope Of Work
- Site Survey
- Hardware Order
- System Requirement Definition
- Functional Design Specification
- Software Development or Configuration and Testing
- Hardware Installation
- Acceptance Testing and User Training
- System Implementation
- Evaluation and Follow-up Support

Preliminary qualification

During this step the solution provider does the due diligence to verify:

- that there is a need which can be addressed and the basic parameters of that need
- the budget and a commitment to address that need
- that the budget and schedule expectations are reasonable.

Information gathering

Information is gathered by the solution provider:

- to fully understand the existing needs and problems, and what the customer is expecting from the solution-provider,
- to understand the business as a whole and the facility which may be affected with a solution,
- regarding persons of influence and expertise which could affect a proposed solution success.

Scope Of Work

- The Scope Of Work (SOW) document is a general but complete explanation of what the solution provider believes that customer is requesting.
- Although the SOW is not a billable deliverable, it is normal to request a signature on this document before taking steps towards the specification of any solution components or towards starting or completing any development.
- If there are choices to be made regarding solution possibilities, they may be described in general terms in the SOW.
- The SOW is not a quote on hardware, software, or services.

Site Survey

A Site Survey is the procedure to measure a building or area for RF reflectivity and coverage system. The area is tested and plotted for the optimal placement of RF Access Points and antennae. Deliverable is the Site Survey Report, which specifies:

- which hardware is optimal or information regarding choices thereof,
- where to place the Access Points and/or antennae,
- where to draw network cable and where to place AC power (possibly with dedicated circuits),
- the parameters of the RF coverage (such as area which have coverage from more than one Access Point),
- and other Wireless LAN considerations (such as bridges and switches).

It is normal to have 2-6 weeks lead time for scheduling a site-survey. Because the site-survey specifies how many Access Points and antennae are required, it is important to schedule it as soon as possible – both internally and with the site-survey provider.

Prior to scheduling a Site Survey, a site survey questionnaire must normally be filled out by the customer. The Site Survey is then scheduled – optimally for a day when stock levels are as high as possible. On the day of the site-survey, the customer should provide:

- equipment to facilitate the safe mounting (temporarily) of RF near the ceiling throughout the facility (normally a man-up lift),
- one or more persons to offer support to the technicians as they run tests,
- access to network and facility experts
- security clearance to all required areas.

Hardware Order

Although hardware can normally be pre-ordered, the actual hardware order cannot be placed until the purchase order is received from the customer. The Site Survey report (if the system is RF) must be complete in order to know exactly how many and which pieces of equipment are required for optimal coverage. Lead-time for equipment varies, but is usually known at the time of ordering.

System Requirements Definition

The System Requirements Definition (SRD) is a billable document that describes all aspects of a proposed solution. Included in the SRD may be:

- descriptions of the companies involved and of the existing system,
- specific needs to be met,
- components of proposed solution,
- hardware and software requirements included in solution,
- assumptions, disclaimers, and project responsibilities,
- project schedule(s) and contact information,
- general flowcharts and data flow diagrams,
- networking and layout considerations,
- procedures by which the SRD may be changed,
- service contract and warranty information
- acceptance testing and implementation procedures,
- post-implementation support expectations,
- signatures page.

Functional Design Specification

The Functional Design Specification (FDS) is a billable document that describes all functional aspects of a proposed software application. The functionality of the FSD can be included in the SRD in smaller applications. Included in the FDS (or also included in the SRD) may be the following:

- data element definitions,
- interfaces to host systems,
- specific flow-charts and data flow diagrams,
- software logic,
- database definitions,
- screen descriptions,
- text and spread-sheet file definitions,
- method descriptions and messaging heuristics,
- prompts and formats,
- test scripts and acceptance criteria,
- procedures by which the FDS may be changed,
- error handling information, system log, and archiving descriptions
- maintenance and standard operating procedures
- signatures page.

Software Development or Configuration and Testing

Software is developed, configured, and tested based on the written information in the SRD and FDS. There should be a process in place to allow for changes to these specifications, and a process in place for correcting deficiencies found in the process of development and testing. Normally this kind of change process requires a single focal point for reviewing changes and deficiencies, and for prioritizing and coordinating these changes. Test scripts should be designed to fully verify the entire system, and the followed during the system acceptance process.

Hardware Installation

The solution provider will normally test the hardware equipment off-site, possibly using it during the off-site development and configuration process, and then install the equipment according to the project schedule. Upon installation all the equipment is tested on the basic functional level. The solution provider may or may not perform the actual installation, depending on the expertise required for the specific installation.

Acceptance Testing and User Training

The complete solution is tested on site, normally involving representatives of all involved parties. The solution is accepted or reworked based on the result of this testing. The criteria for this test are specified in the SRD.

System Implementation

Once the system is accepted based the results of the acceptance testing, the system is implemented based on the agreed-upon implementation plan – specified in the SRD. On site support from the solution provider, and other experts, can be included for a specified period of time following implementation.

Evaluation and Follow-up Support

Scheduled evaluations and follow-up support, normally specified in the SRD, can be included in the solution. The expectations of post-implementation professional services should be specified in detail in the SRD, and based on the date of system acceptance and/or implementation.

V. The First Step

When a company is investigating a new technology it is quite understandable that uncertainties might exist. These uncertainties might be whether barcode is the answer, how to investigate barcode scenarios, how to judge return on barcode system investments, and what kinds of guarantees are available after implementation. Although adding a barcode or mobile data collection system is not always the only needed change in a growing enterprise, in most cases this kind of automation can be an important tool in improving accuracy, efficiency, volume, and speed. Many companies have seen 50%-75% productivity increases from implementing a relatively simple barcode data collection solution.

DSI has built its solid reputation on partnering, maintaining long-term relationships, providing an abundance of information to customers in order to allow informed decisions, and sharing the responsibility for our customers' satisfaction. If you have any questions about how barcode and mobile data collection systems might apply to your business, please contact us with your questions. You will find that DSI consultants and account managers help you become completely educated prior to making any commitments. As a matter of fact, DSI's mission statement is to *build long-term relationships*.

"We hold ourselves accountable for your success."

Dynamic Systems, Inc.
Toll free) **800-342-3999** E-mail) **Info@dsisales.com**
WA Office) 425-483-0844 FAX) 425-487-9598
OR Office) 503-297-0827 FAX) 503-297-0828