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Bar Coding Technology

Bar Code Systems: Applicability to U.S. Army DEH Supply Function and Review of Software Packages

by
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Conclusions are that the incorporation of some form of bar-coded data entry into FE supply operations could: (1) allow the FESS data base to better represent actual material supply conditions; (2) make inventory accounting procedures more efficient; (3) make inventory accounting more accurate; (4) make the process of issuing stock material more efficient.

The investigation revealed that the Motorola Four Phase computer, the mainframe computer used at most installations to run FESS, will not directly accept bar-coded input data. This precludes a direct interface of commercially available bar-coding systems with FESS as it is now configured.

The survey of commercial systems revealed that the Spacesaver and the ASAP software packages ranked highest for suitability to DEH needs, and (assuming an indirect interface with the Motorola Four Phase computer) application to the DEH FESS. This finding was based on a survey of the performance and functional features of the packages.

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FOREWORD

This study was conducted for the U.S. Army Corps of Engineers Housing and Support Center (CEHSC) under the Operations and Maintenance, Army (OMA) project "Bar Code Technology," received under Funding Acquisition Document (FAD) No. 89-08004, dated October 1988. The technical monitor was Mr. Walter Seip, CEHSC-FB-I.

This study was performed by the Facilities Systems Division (FS) of the U.S. Army Construction Engineering Research Laboratory (USACERL). Mr. Donald Hicks was principal investigator. Mr. Douglas L. Radius, was the USACERL Research Assistant for the study. Dr. Michael J. O'Connor is Chief, USACERL-FS. The USACERL technical editor was Mr. William J. Wolfe, Information Management Office.

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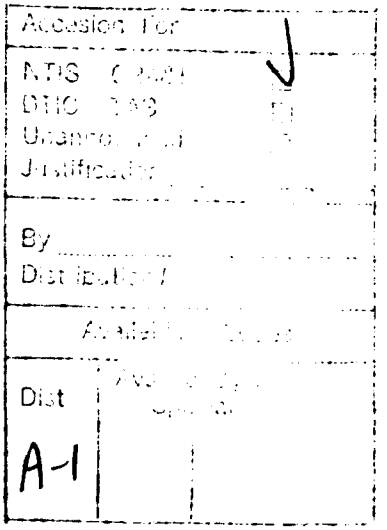

BAR CODE SYSTEMS: APPLICABILITY TO THE U.S. ARMY DEH SUPPLY FUNCTION AND REVIEW OF SOFTWARE PACKAGES

1 INTRODUCTION

Background

From an economic and responsiveness perspective, the Real Property Management Activities (RPMA) at U.S. Army installations must be supported by the most cost-effective and efficient supply system possible. The Facilities Engineering Supply System (FESS) is the Army's computer-based supply system.

Since operational procedures, functions, and requirements of private industry and Directorate of Engineering and Housing (DEH) supply systems are similar, of new commercial products developed for private industry maybe the applicable or adaptable to DEH operations to improve the cost effectiveness and responsiveness of the Facilities Engineering (FE) supply function by automating some or all of the functions associated with receipts and issues, inventory management, stock record and cost accounting, warehousing, and ordering procedures

Private industry has been developing automated solutions to material management problems which incorporate data processing and bar code technology. A commercially available system that meets or can be modified to meet DEH Supply Function requirements may substantially reduce operating costs and improve mission responsiveness and customer satisfaction with the DEH supply function.

Objectives

The objectives for this investigation were:

1. To survey, analyze, and catalog the DEH supply function of the FESS DEH supply function at U.S. Army facilities in the United States

2. To determine the applicability of bar coded data entry systems to this function

3. To describe a system that automates material management using bar code technology, that meets the needs of Army installation DEH supply facilities

4. To survey and rate/material management commercially available software/systems that meet the requirements of the DEH supply activity

5. To recommend one or more systems for further evaluation and field testing at a host Army installation.

Approach

This study was conducted in two parts: first, to analyze the needs of the DEH supply function (Chapter 2), and second, to review and recommend applicable systems to incorporate bar code technology into FESS (Chapter 3).

Information was gathered by telephone survey to analyze and evaluate the FE supply function as it currently exists at U.S. Army installations in the United States. The 13 facilities contacted were: Fort Benning, Fort Campbell, Fort Devens, Fort Dix, Fort Eustis, Fort Hood, Fort Leavenworth, Fort Lee, Fort Lewis, Fort McCoy, Fort Polk, Fort Riley, and Fort Stewart. In addition to the telephone survey, site visits were made to Fort Riley and Fort McCoy for a more detailed understanding of how material supplies are managed. The purpose of the survey was to determine:

1. The current use of the FESS system
2. Whether other automation is used to account for supplies
3. The methods used to account for supplies
4. Whether further automation could help DEH operations
5. Whether bar coding could help the inventory process.

Survey results were analyzed to provide background data for investigating the potential application of bar code technology to the DEH supply function. The report describes a model commercial inventory system that employs bar coded data and includes the requirements for interfacing with FESS.

A general survey of the manufacturers and vendors of bar code hardware and software was completed through a review of trade publications, journals, and registers. Based on this review, 25 suppliers of turnkey, bar code-based material management systems were contacted. Information from these manufacturers and vendors, and the timeliness of their responses were evaluated against the requirements of the DEH supply system. From this evaluation, two potential sources were selected and client references were obtained. Site visits were made to evaluate the performance of the candidate systems. Based on scored evaluations, final vendors were recommended for participation in a field test at a host Army installation.

Mode of Technology Transfer

The commercial inventory management system that is determined, after further testing, to be best suited to DEH needs, will be forwarded to the Engineering and Housing Support Center at Fort Belvoir, VA, for distribution through DEH workshops. Further information will be disseminated through EHSC Newsletters, DEH Digest, and FEAP Sheets.

2 SURVEY OF CURRENT TECHNOLOGY

Overview of the Functional Requirements for the FE Supply System

General

Evaluating the application of commercial material management systems to U.S. Army installations requires a familiarity with the material management supply system used at those installations. U.S. Army installations in the United States use FESS, an automated inventory control system that provides up-to-date information on material supply for the DEH at the installation level. FESS has a dollar value inventory accounting interface with SAILSS (Standard Army Intermediate Level Supply System) and a line item inventory accounting capability.

Hardware Configuration

FESS requires a minicomputer with 1.5 megabytes of memory and 67.5 to 135 megabytes of fixed and removable disc storage. Most installations run FESS on a Motorola Four Phase mainframe computer system configured with disc drives, printer, tape drives, and numerous video display units usually located throughout the stock control area. By design, FESS is interactive; the people using it have direct access to and control of all data files in the system while FESS software is running.

Description of Functional Areas

The FESS is organized according to six functional areas: Stock Control, Issuing, Receiving, Estimating/Planning, Work Order Inquiry, and Material Coordination.

Stock Control. Initially, the Stock Control Functional Area creates the stock file and thereafter is responsible for determining which stock items are added, maintained, or dropped. Stock Control must:

1. Create purchase orders and reorder stock

2. Control the items to be stocked

3. Classify items as stock, fringe, or standby

4. Maintain the source of supply file, a listing of government sources and local vendors from whom materials are ordered

5. Share with the Work Order Area the task of entering work orders into the system

6. Check inventory by comparing on-hand quantity of stock items, as displayed on the screen, with the manual inventory count of stock items in the warehouse

7. Use a variety of system-generated reports

8. Print authorized reports requested by other functional users of FESS

9. Maintain a catalog file.

Stock Control personnel must:

1. Inquire inventory status
2. Inquire supply status
3. Update catalog index
4. Inquire and update catalog
5. Inquire and update source of supply file
6. Inquire and update stock
7. Create and update work orders
8. Issue work orders
9. Update purchase orders
10. Update history file.

Issuing. Issuing consists primarily of dispensing materials requested in work orders and entering the quantity of materials issued into the FESS system. Issuing is based at the DEH supply warehouse. Issuing personnel must:

1. Inquire stock
2. Inquire inventory status
3. Inquire supply status
4. Inquire purchase orders
5. Inquire work orders
6. Inquire catalog
7. Enter quantity of issued material against work orders
8. Obtain inventory work sheets.

Receiving: Receiving consists primarily of accepting material ordered in purchase orders, and entering the quantity received into the FESS system. Receiving is based at the DEH supply warehouse. Receiving personnel must:

1. Inquire source of supply
2. Inquire stock
3. Inquire inventory status
4. Inquire purchase orders
5. Inquire catalog
6. Enter quantity of issued material against work orders
7. Receive purchase orders.

Planning/Estimating. The Estimator assesses the cost of jobs to be performed and develops work orders for these jobs. Estimating personnel must:

1. Inquire source of supply
2. Inquire stock
3. Inquire inventory status
4. Inquire supply status
5. Inquire purchase orders
6. Inquire work orders
7. Inquire catalog.

Work Order Clerk. The Work Order Clerk creates and updates work orders (the authorized documents that list the services and materials needed to accomplish a job). Each work order has a unique work document number and may be comprised of several phases. A Work Order Clerk creates and updates work orders, and inquires work orders.

Material Coordination. The Material Coordinator gathers materials needed to accomplish any given job. If items on a work order's bill of material are not available in the warehouse, the Material Coordinator forwards the bill of material to Stock Control for ordering. The Material Coordinator serves a general function in the process of the flow of material.

Evaluation of the Functional Requirements of FESS

General

At a typical FESS installation, issues that characterize material inventory and supply operations fall into three major categories: Individual Job Orders (IJOs), Standard Operating Orders (SOOs) and Shop Stock/Physical Inventory. Each of these categories requires approximately the same amount of time and effort of material management and supply operations personnel.

Individual Job Orders (IJO). Nonrecurring work or work that occurs infrequently usually falls into the category of Individual Job Orders. An IJO is processed in the following steps:

1. A Requester writes a description of work to be done, or material needed, on a work order form and obtains the approval of an authorized person.

2. A Work Order Clerk assigns a Work Order Number and enters the information on the work order form into FESS.

3. An Estimator prepares a bill of material, which identifies the component materials and labor tasks of a work order. In the process, the Estimator inquires FESS regarding source of supply, stock on hand, catalog, and other information.

4. Stock planning and control that the estimator has entered into FESS is used to generate further information, primarily the bill of material. Subsequent steps depend on whether the requested material is in stock or must be ordered.

5. If material in stock is sufficient to fill the work order, the work order is forwarded to the Issuing Area. The Issuing Clerk pulls the material from the warehouse supply and issues it to the Requester. The Issuing Clerk usually forwards all paperwork to Stock Control where FESS is updated to reflect the transaction. Occasionally, the Issuing Clerk updates FESS directly at a terminal in the Issuing room.

6. If inventory levels are depleted in the course of filling a Work Order, FESS flags that material for reorder. The material on hand is released for issue. Stock Control generates a purchase order to cover the additional material needed to finish filling the work order and to return inventory to prescribed levels. Because this entire step is performed by FESS, all necessary inventory accounting takes place automatically.

7. When reordered stock arrives, the Receiving Area places the material on the shelf and updates FESS accordingly. Occasionally, Receiving passes the paperwork on to Stock Control where the actual

interaction with FESS occurs. FESS flags the portion of the material received that was back-ordered and Issuing is so notified.

8. If the material requested is not a stock item, Stock Control completes a purchase order according to instructions from Estimating, and places the order with the appropriate suppliers, often after an extensive bidding process. FESS is updated to account for the transaction as if a new item has been added to inventory.

Standing Operating Orders (SOOs) or Shop Stock. For continuous work such as replacing furnace filters, a Standing Operating Order (SOO) is issued once a year so that an IJO need not be prepared every time the work occurs.

Shop Stock is handled similarly. Once a year a Work Order Number is assigned for a particular shop or portion of a shop. All of that shop's stock materials are ordered and issued under that number for the entire year. As with SOOs, an IJO need not be prepared for every material order. All supplies (shop, maintenance, and facilities) can be monitored under one system.

Inventory Maintenance. At least once a year, a physical inventory is taken of stock in the warehouse (currently performed manually by warehouse personnel). This inventory is compared to the information contained in FESS and any discrepancies are evaluated and rectified.

The inventory may occur more often than once annually. Some installations conduct a physical inventory of 10 percent of the warehouse stock every month. Inventories may be continuous; 2 percent of the stock could be inventoried every week, or 0.385 percent every day. Portions of stock material with higher turnover rates should be inventoried more often than stock with low turnover.

Description of Bar Code Technology

Bar code is the predominant automatic ID technology used for (among other things) item tracking, inventory control, monitoring work in progress, check-in/out, order entry, document tracking, shipping and receiving, warehousing, and point of sale operations.

Bar codes are a pattern of bars and spaces of varying widths that record digits, letters, and other punctuation symbols used to identify an item or regulate its movement. In use, a beam of light scans a bar code, and dark bars absorb the light while spaces reflect the light back into the scanner. The scanner transforms the light fluctuations into electrical impulses which represent the pattern in the bar code. A decoder uses mathematical algorithms to translate the electrical impulses and transmit the encoded data message to a personal computer, controller, or host computer.

Bar code is not a system, but an effective communication tool that provides accurate and timely support of the data requirements for sophisticated management systems. Using bar code generally increases productivity, creates cost savings, and improves business operations.

Evaluation of FESS as It Applies to Bar Code Technology

Methods Used to Account for Supplies

All of the surveyed installations used FESS in some way to account for supplies. The installations used several methods of accounting for stock with FESS: direct entry, indirect entry, and a combination of direct and indirect entry.

Direct Entry. In the direct entry method, the personnel who check in shipments or check out stock items also enter all necessary information directly into FESS. Data entry terminals are located nearby for this purpose. The data entry transaction occurs at about the same time that the item is issued or received. Sometimes an item can be issued only if the transaction has been entered properly into the data entry terminal.

Indirect Entry. The indirect entry method encompasses a wide variety of approaches. Commonly, Receiving or Issuing Clerks complete paperwork when an item is received or issued. This paperwork is then passed on for entry into FESS to another person, who is usually located in a place other than where receipt or issuance occurs, sometimes in a different building. Thus, the person entering the data can be trained specifically for that task. (Some warehouse personnel object to keying in data on terminals on the basis that data entry is not part of their job.

Some installations allow maintenance personnel (the end users of the stock items in this case) to select their own items from stock. They present the items to the Issuing Clerk, who checks the items out and passes on the paperwork for entry into FESS. Management maintains that this is the most efficient issuing method because personnel do not waste time completing forms or describing in writing precisely what they need, but simply take the items off the shelf themselves.

Combination of Direct and Indirect Entry. Sometimes a combination of direct and indirect entry methods is used to enter data into FESS. The most common procedure entails directly entering data at the point of issuance. However, when items are received paperwork is forwarded to others for entry of data into FESS.

Where Bar Code Technology Would Help

The reaction of installation personnel to the possible introduction of bar code technology was mixed. Generally, some type of bar coding was seen as a benefit to material management in general and FESS in particular. Several installations volunteered to be test facilities.

The most frequently cited advantages of bar code technology were:

1. Information will be more accurate. Errors due to data transcription are reduced. Such errors are often caused by unclear handwriting or wrongly transposed information during copying. This is particularly troublesome at installations with a high turnover of personnel or other personnel problems.

2. Information will be more timely. The lag that normally occurs between the time a transaction takes place and the time the information is entered into FESS can be up to two days. Theoretically, a bar code data entry system can be instantaneous.

3. For the above reasoning, bar coding will allow the FESS data base to more closely represent actual material supply conditions.

4. Bar code could be immediately applied to inventory control and issuing, although implementing bar code in receiving would be more difficult.

Automation

All contacted facilities presently use FESS as a sole form of automation for material management.

Miscellaneous

A concern common to all installations is that the unit of order is different from the unit of issue. For example, an item may be ordered by weight but issued by count. A particular bolt may be ordered by weight and issued by quantity. Of course, this problem is not limited to bar code use.

A Functional Description of Automated Support Employing Bar Code Data Entry System

General

A phased approach should be taken when converting to a bar-coded data entry system. Such an approach allows personnel to become gradually accustomed to the new system. The following approach divides the effort into eight separate stages, each of which can be implemented in discrete phases.

Bar Code the Warehouse Stock

In the first phase, bar codes are affixed to the warehouse stock. However, some people are reluctant to incorporate bar code technology into FESS procedures. A reason often given is that it may not be practical to attach a bar code label to every item in stock. Another reason cited is that the bar code labels may fall off some items or be mutilated beyond the point of readability.

These problems, although viable, are not insurmountable. Not every item in stock must have a bar code label affixed to it. For items kept in racks, pallets, bins, hoppers, or shelves, the bar code label need only be affixed at some convenient location on the physical apparatus used to confine the material, not on the item itself. Only those items that are too big or cumbersome to be kept this way would need bar code labels attached directly on the item.

Bar code labels should be made of material appropriate for the use, or abuse, it is expected to get, such as paper, plastic, or metal. A protective cover of plexiglass may be placed over some labels.

Perform a Physical Inventory

Once bar codes are fixed to all stock, inventorying should be a simple task and should yield a more accurate accounting than usually obtained from manual methods. To perform the inventory process:

1. Select an area of the warehouse to be inventoried.

2. Select an item in that area.

3. Using a portable, hand-held, bar code scanning device, read the bar code label associated with that item. The bar code may be affixed to the item itself, or to the bin or shelf, where the item is kept.

4. Count the number of items, and key that number into the portable bar code scanning device.

5. Repeat the process for all the items in the area to be inventoried.

6. When all the items have been processed, download the information in the bar code scanning device into FESS. Once the scanning device reaches its capacity, it must be downloaded before scanning can continue. When this is done, the inventory is complete.

Bar Code Work Orders

At the time the Work Order Clerk assigns a Work Order Number, a bar code label should be generated and made part of the Work Order. The Facility Systems Division of the U.S. Army Construction Engineering Research Laboratory (USACERL-FS) is developing this capacity as part of the Integrated Facilities System-Micro/Mini (IFS-M) system for DEH. The method used to make the label is not important as long as the bar code is part of the Work Order. This permits the Work Order itself to be scanned by a bar code reader to help eliminate manual transcription.

Procedure for the Issue Of Stock Material

After the stock has been bar coded and inventoried and Work Order Numbers have been bar coded, bar codes can aid in the issuing of stock materials. The procedure for issuing material is as follows:

1. A Requestor presents the Work Order to the Issue Clerk.

2. The Issue Clerk Scans the bar code on the Work Order using the specially equipped data terminal tied into FESS and located at or near the issue counter.

3. The clerk proceeds to the stock bin where the item is stored.

4. The clerk scans the bar code label affixed to the bin where the item is stored and keys into the scanner the quantity of items being removed from the bin.

5. The clerk brings the item back to the issue counter and downloads the scanner into the specially equipped data terminal. FESS is updated immediately when the scanner is downloaded.

6. The terminal generates a hardcopy printout of the transaction and makes a duplicate for the Requestor as a receipt of the transaction.

7. The Issue Clerk manually overrides any errors generated during the downloading.

Equipment and Interface Requirements

Manufacturers of bar code equipment number in the thousands. Evaluating and recommending bar code vendors is beyond the scope of this report.

The following equipment is needed to provide the functions discussed above:

1. Bar code readers
2. Bar code label makers or printers
3. Data collection devices
4. Hard copy printers.

Portable bar code reading devices, or scanners, are available in a large variety of configurations. The devices are either portable or fixed position. For the applications needed here, portable devices are preferable. The following features are highly desirable for scanners:

1. Data storage capability within the scanner itself.

2. Capability to accept numeric data entry.

3. Easy for the user to hold in the hand, that is, lightweight and compact.

4. Data stored in the scanner should be easily downloaded. Ideally, the scanner will download directly into FESS.

5. Capability to read variable types of bar codes, to accommodate bar code material in the condition as it is received.

Bar code label printed and data collection devices are readily available from a large number of vendors. Care should be taken to ensure that the point of data entry provides a smooth interface between the material management system (FESS) and the bar-coded data. The information contained in the bar code scanner must be accepted by the computer.

Printer selection depends partly on the hardware configuration chosen for downloading the bar code data. Vendors for this equipment are abundant.

Interfacing with FESS

The above functional description of a bar code system for FESS assumes that the computer system on which FESS runs can directly accept downloaded bar code information. Ideally, FESS will not distinguish between data entry made from downloaded bar code scanners and data entry from display terminals.

The Motorola Four Phase computer, the mainframe computer which most installations use to run FESS, will not accept direct entry of bar-coded input data. No vendors currently manufacture a bar code wedge (a device functioning as a keyboard emulator which allows the direct entry of bar code data fields into a computer) compatible with the Motorola Four Phase computer.

Some data collection interface devices are available that use a serial port for data entry. To perform properly, these devices require that software be running on the main computer. Doing so is not possible with the Four Phase computer because FESS is proprietary software, and the source code is protected.

This constraint does not preclude using commercially available bar-coding systems in conjunction with FESS under current operating procedures. It does, however, preclude directly entering bar-coded information. One way to circumvent this problem is to download the bar code reading device into a

personal computer (PC). The PC could be connected to the Four Phase through one of its three serial ports, and could also edit the bar-coded data for errors before interfacing with the Four Phase.

Other Applications of Bar Code Technology to Material Management and Supply

Once a system for bar coding is in place for FESS, other applications for bar codes will become apparent. These applications include:

1. Labor and Equipment Processing (L and E) — Bar coding of L and Es will be simplified when bar code labels include name, shop code, and social security number.

2. SOO work orders — Bar coding of SOO work orders will eliminate keying at the time of computer input.

3. Name Tags — The name of the person receiving material can be scanned to eliminate the need for signatures of warehouse and shop personnel. The tags should contain a code unique to each person, including name, shop code, and social security number. (Social security number should be used to identify issues made to people outside the directorate.)

4. Asset Management (Property Book Inventory) — Identifying and tracking fixed assets.

5. Access Control — Regulating entry and exit of buildings and/or grounds.

6. Work Order Tracking — Automatic tracking of an item's status, quantity, and location during the manufacturing or maintenance process.

7. Document Tracking — Following a document through various stages or locations so its status is available to central control.

8. Shop Floor Data Collection (Hold Area Inventory/Issue) Tool Room Issue/Return/Inventory, using automated data capture to generate real-time production reports from the factory floor.

9. Job Costing — Subassembly and component pricing, quantity, and status for bids, proposals, and other cost estimating needs.

10. Security — Taking readings at checkpoints to verify that sensitive areas are inspected and secured.

The Field Test

More investigation is necessary before bar code technology can be applied to FESS. Actual hardware must be obtained and tested in a working environment. Based on the results of such a test, a full-scale test of the bar code system should take place at a host installation, through the following steps:

1. Prepare a requirements statement enumerating the desirable software and hardware requirements.

2. From this list of desirable features, determine equipment availability. (USACERL personnel and vendors can provide assistance in this step.)

3. Redefine the requirements based on the findings of item 2 above, and develop specifications for software and hardware.

4. Develop a benchmark test (at USACERL) for directly comparing the performance of various equipment.

5. Recommend hardware based on the results of the testing.

6. Develop a user's manual.

7. Procure hardware for testing at a host installation.

8. Select a host installation and test the bar code system by conducting a series of mini-tests during off hours.

9. Upgrade the user's manual based on the results of the test.

10. Conduct an extensive test by completely converting the host installation to the bar code system, and operating the system during normal business hours.

11. Modify the bar code system as a result of the experience gained from operating at the test site.

12. Verify the results of the initial test installation by conducting a field test at a second installation.

13. Once the results have been verified, make the bar code system available for general use.

3 RESULTS AND ANALYSIS OF PROPOSED TECHNOLOGY

Review of Vendors

General

Presently, the bar code or automated ID products and services range from individual preprinted bar code labels to complete bar code hardware and software systems. An evaluation of bar code equipment vendors begins with the purchasing process. This process varies with the vendor. A large hardware supplier such as Intermec usually deals as through an Intermec Value Added Re-seller (VAR). This process is similar to buying minicomputer from a commercial retailer. Intermec provides the VAR with hardware, and software for programming the hardware at a minimal level. Usually, the VAR or the user's own Management Information System (MIS) department writes the actual application software, which is used to integrate the various hardware, collect data, organize data into a database, and produce necessary reports. Sometimes suppliers provide an applications development software package which can be used to develop these specific applications. In other cases, the suppliers have used these development packages to develop specific application software modules, but it is usually the VAR or the user that develops the application software.

Sometimes the VARs that develop their own application development software develop and market specific applications. These applications are usually analogous to applications written using dBASE, rBASE, or similar software. While the functionality of the underlying package is not available in the run-time package, packages with functional underlying development software are available. Such packages can offer a turnkey system with the flexibility to customize.

The evaluation of bar code material management systems for the DEH supply function centered on applications development software, and on available specific applications packages. The degree of detail of evaluations varied according to the completeness of the material that vendors provided. Of the 25 vendors contacted, six provided software for evaluations. Three of the these (Lowry, DataNet, and Mars) provided demonstration diskettes only. These demonstration diskettes varied in detail but generally provided enough information to assess the applicability of the software to the DEH application. The other three vendors, Caere, ASAP, and Spacesaver, provided fully functional versions of their software, making a thorough evaluation of these systems possible. The following paragraphs describe the evaluations of the software of these six vendors.

ASAP Systems

ASAP Systems, of Santa Cruz, CA, markets an inventory control software package called !INSTOCK for IBM-compatible microcomputers. The !INSTOCK software package is designed to use ASAP's own applications development software, !BARSTOCK. As !INSTOCK is presently marketed, most of the applications development features of !BARSTOCK are functional. !INSTOCK is designed to track the flow of stock items to and from a central storage area. Quantities of stock items are traced from receipt to ultimate destination, which can be an individual, a job site, or a holding area. The software includes utilities to print bar code and import data from RS232 devices, portable and on-line scanners, and terminals. The software contains its own relational database, and can exchange data with Dbase, Lotus, and other PC software. ASAP is an Intermec VAR, and uses the Trakker 9400 series transaction managers, the 9570 series wedge reader, the 1260 series industrial wand, and the 1260 series

hand-held noncontact laser scanner. The ASAP system with !INSTOCK software and Intermec hardware can perform the following functions:

1. Receive stock into inventory
2. Issue stock out of inventory
3. Track location of stock on hand
4. List suppliers from whom stock is ordered
5. Track destinations of issued stock
6. Match physical inventory with book inventory
7. Automate reorder of stock
8. List current inventory count by stock number.

ASAP Systems provided a copy of the !INSTOCK software for evaluation, which was completed on an XT-class IBM-compatible computer operating at 4.77 MHz.

The !INSTOCK software installed in about 15 minutes and operated immediately with no problems. Installation took about 15 minutes. The software consists of a relational database supported by various functional modules and a sophisticated menu-driven interface. Two manuals accompany the software, the !INSTOCK manual which includes an excellent tutorial describing the user interface, and the !BARSTOCK manual describing in detail the underlying applications development software. Consulting the !BARSTOCK manual was not necessary during the evaluation.

The evaluation proceeded by following the tutorial and then building a hypothetical inventory of several items typically stocked in a typical DEH warehouse. Using the software entails interacting with various user interface screens for each function: stock items are identified through the stock information screen; suppliers of these stock items are identified through the supplier information screen; initial inventory of the stocked items is entered through the receive stock screen. Items from this inventory are then disbursed to various work orders using the issue stock screen, and further additions to inventory are made through the receive stock screen.

Overall, the software performed well. It closely parallels the needs of the DEH, and is easy to learn and use. The software is intuitive, and proceeding from the tutorial to setting up the evaluation inventory was effortless. Reconfiguring the software a simple process. For example, the provided report module did not originally produce report similar to a DEH Work Order Report, which lists all the material disbursed to a single work order number. (The program originally listed materials disbursed to all work order numbers) Developing and formatting the desired customized report was accomplished on the first try in about 15 minutes. Likewise, the original stock definition screens, stock receipt screens, and stock issue screens did not contain a variable indicating the units of the stock being inventoried. This could lead to problems if the person entering the stock transaction did not know the units by which the material was inventoried. For example, a receipt of 10 boxes of 100 parts each could be entered as 10 for the unit of boxes, or 1000 for the unit of parts. A new variable, "UNITS", was added to the appropriate transaction screens to remind the operator of the proper transaction units. This modification was easily accomplished, on the first try, in about 1 hour.

The software is not without flaws. One potential problem area is error correction on data input. It was somewhat difficult to locate and correct an entry once the final <CR> had been entered and the data was part of the data base. The data could be found, but researchers found the instructions in the documentation for doing so to be unclear.

A second area of possible concern is the operating speed of the system. Switching from one type of screen to another is somewhat slow, but the manual explains that once a pattern of operations is established, the system can be set to use shortcuts. Also, the program is hard disk intensive, and a lot of time seemed to go into addressing the hard disk. ASAP, when contacted about this issue, recommended using at least an IBM-AT-class machine with a fast (1 millisecond) hard disk. ASAP representatives did not express surprise on hearing that the program seemed a little slow on an IBM XT-class machine.

Another area of limitation is the fact that only one transaction can occur at a time. It is not possible, for example, to issue and receive stock simultaneously. This problem is not as serious as it first appears, because the system is designed for portable terminals. One portable could be used to receive stock, and another portable, or a PC with a wedge could be used to issue stock. At day's end or some other designated time, the portable(s) can be downloaded to the PC. The net effect is that transactions can occur simultaneously, even though the system is not updated in real time.

ASAP does have size and security limitations. Recommended inventory size is less than 10,000 different stock items, and a limitation (which ASAP can modify) to only two suppliers per stock number. Moreover, the software appears to have limited password protection; a password may be defined to control global access only. It would be preferable to allow different passwords for different areas of the program, so that people entering data would not have access to system maintenance functions. When contacted on this issue, ASAP stated that they can modify the program to allow multilevel passwords.

These limitations aside, the !INSTOCK program is excellent overall. It provides all the functions necessary for the DEH system, is easy to learn and use, and provides a powerful, flexible environment for customization. In addition, the ASAP System company responded promptly to the original request for software and to requests for additional information.

Caere Corporation

The Caere Corporation, located in Los Gatos, CA, produces the DataCaere data collection software package. Caere Corporation was contacted for information about their software and the product literature was received. The literature included the name of a regional representative who was contacted to obtain demonstration software. Caere does not generally provide a demonstration package because their software requires a multiplexor board in the PC. However, Caere did modify the software into a demonstration form, and this nearly fully functional software was received.

The DataCaere software implemented under Microsoft Windows, was evaluated using a Compaq 386 portable computer. The DataCaere system consists of an IBM PC/AT or compatible computer, Caere ScanNet 944 or 904 Multiplexor, ScanNet 900 terminals, and a Microsoft Windows compatible mouse. Downloading of portable scanners is supported through the auxiliary port of the ScanNet 900 terminals. The hardware is configured and controlled using the DataCaere software package.

Using the multiplexor card, DataCaere software allows simultaneous transactions from up to 124 terminals. This allows the development of a real-time inventory control system. Since DataCaere is multitasking software, system maintenance can be performed without interrupting data collection.

The DataCaere software is a data collection package. Transaction files are the basis of the system, and an individual transaction file structure is defined for each type of transaction. Modules exist for defining transaction files, configuring terminals, defining system security, operating and controlling data collection, querying the transaction data bases, and producing reports. However, one important limitation is that the software does not contain a relational data base. DataCaere intended as a data collection front

end for Dbase, Rbase, and similar relational data base packages. The DataCaere manual recommends the use of XQL, a Structured Query Language (SQL) data base.

To evaluate the characteristics of the software, a simple, limited inventory system with two transaction files, receive stock and issue stock, was developed using the transaction file module. The Windows interface was easy to use, but, a few idiosyncrasies and variations from the performance as described in the manual occurred. Even though these problems somewhat slowed the creation of transaction files, the effort took less than an hour. Because no multiplexor board was present, the data collection module could not be run. Although the data terminals could not be configured, the configuration module seemed easy to use and provided comprehensive support of all terminal functions. Because the data collection module could not be run, stock was added and received using the data base query module. The system security module is very flexible. Security is based on three access groups: employee groups, transaction groups, and terminal configuration groups. This system can specify the functions a particular employee can perform, and the terminals from which they can be performed.

The lack of a relational data base limited the ability to generate a report of inventory on hand. The report could not be generated because the data from the receipt transaction file and the issue transaction file could not be combined through the DataCaere system. Such a manipulation would have to be done outside the DataCaere software. Facilities are provided for transferring files to external databases.

Overall, the DataCaere software is a powerful, full-feature, real-time, data collection system. The use of Microsoft windows makes the interface relatively easy to use The ability to use the multitasking capabilities of 80286 and 80386 processors places the software among the most sophisticated packages evaluated. Use of the package as part of a turnkey DEH material handling system will require integration with an external relational data base, and application programming using that data base.

Data Net

Data Net Corporation, based in Miramar, FL, was contacted at their regional office, in Northbrook, IL, which responded to our request for information. The response from Data Net included product literature describing the various Data Net hardware and software, and software demonstration diskette. The demonstration software was not fully functional and only illustrated the features of the Data Net software package; therefore, the detail of the evaluation of the Data Net software was limited.

The Data Net hardware consists of a family of six different data collection terminals and a network controller board installed in a PC. Only one of these data collection terminals is suitable for portable operation. The network controller board allows a PC/AT or compatible to act as a communications controller for up to 128 data collection terminals.

The software portion of the Data Net system is the CO-LOG Data Collection Configuration and Control Software. CO-LOG is a menu-driven data collection software development application package. Using CO-LOG, the configuration of the data collection system can be tailored by the user through a prompted, question-and-answer interface. Data files created by CO-LOG are compatible with PC-based spreadsheet and data base software. The software demonstration diskette provided an overview of the CO-LOG software, and included examples of its user interface and the steps taken in configuring the Data Net system.

The CO-LOG software provides an on-screen function key menu to guide the user, and a text window which prompts the user and explains program options. Context sensitive help is available using the F1 key.

The first step in the data collection system configuration process is defining the various data items to be collected. Each data item can have several associated tests for data validation. Included in the tests specified for each item are: minimum and maximum lengths, minimum and maximum values, allowable input device, "must-match" picture strings, and host (mainframe) validation. If bar code is selected as the input device, the program prompts the user to determine what symbols will be used.

After definition of the data items is complete, the CO-LOG software prompts the user to develop Prompt/Response Operations (PROs). These PROs are used to control the data input and error handling operations of the individual data terminals. Following definition of the PROs, the program prompts the user to name a data base for the data gathered and to define its record structure. After this is complete, the user is asked to define the communication link between the PC and the host computer, including items such as the communications port and baud rate.

The Data Net system is intended for shop floor application, but the structure of the software allows development of many custom applications. The software is suitable for developing a data collection front end compatible with the FESS system. An advantage of the Data Net system is its network configuration, which allows many simultaneous transactions to occur. Also, while security was not specifically addressed in the demonstration, the ability to assign PROs to each terminal means, that security can be set at the terminal level. For example, a password or employee name can be assigned to each terminal.

The main drawback of the software is that it does not include a relational data base. This means that, to develop an application, all the data would need to be exported, and an external data base would need to be programmed to perform the necessary manipulations and produce reports. In addition, it appears that the hardware supports wands only, and will not support a laser scanner. This would limit its usefulness in selecting parts because repetitive reading of the bar code labels on the bins by wands would probably result in deterioration of the labels.

Lowry Computer Products, Inc.

Lowry Computer Products, Inc., in Brighton, MI, was contacted a Lowry ScanWare demonstration diskette was requested, and was received at a later date.

Lowry offers a complete line of bar code products. These products include labels, printers and printer supplies, scanners, wands, slot readers, terminals, and the ScanWare software system. The ScanWare software package consists of an application development system, a data collection module and relational data base, a host communications module, a scheduler, and a set of ready-to-use applications. The ready-to-use applications are oriented toward the factory floor environment. They consist of:

1. Time and attendance
2. Labor and production reporting
3. Work in progress
4. Lot tracking
5. Defect reporting
6. Shipping
7. Receiving.

The demonstration diskette provided an overview of the Lowry system, details on ready-to-use applications, and a description of the application development system.

The Lowry system consists of up to 64 data terminals connected to a single PC and controlled by the ScanWare software. Both fixed and portable terminals are available and laser scanners are supported. The software suppliers simultaneous multiple transactions and the networking of PCs.

The data collection module is used to configure the individual data terminals and define data transactions. The data collection module controls all data collection functions, including monitoring the network, moving and processing data, and providing a security system. Security can be controlled at the terminal and personnel levels.

The applications development system is used to customize existing ready-to-use applications or to develop new applications. This system consists of the following modules:

1. Screen Painter – used to develop screen forms for entering and/or viewing data.

2. Report Writer – used to create reports.

3. 4GL program language – used to develop programs to manipulate collected data. The 4GL language is the core of the applications development module. All Lowry standalone applications are written using 4GL.

Each of the modules is used through a screen form with pop-up menus that display the response options for a given parameter. Context sensitive help is also available.

All of the ready-to-use applications are oriented to a factory floor environment. The Work in Progress, Lot Tracking, Shipping, and Receiving applications can all be integrated into an Inventory application. However, they must be modified significantly for compatibility with FESS. Lowry was contacted for additional information on these programs on 31 October 1989. At that time they indicated they would call with further information; however, no additional information has been received as of the date of this report.

Overall, while the Lowry software has several strong features, it is generally incompatible with FESS. In addition, Lowry failed to follow up on a request for customer support.

Mars Electronics International

Mars Electronics International, in West Chester, PA, was contacted and product literature was requested for evaluation The product literature described Mars' MEQ hardware and MEQ-BASIC software. The literature indicated that a video tape and demonstration diskette could also be obtained. These items were requested and reviewed. The video tape was primarily sales oriented. The demonstration diskette was not fully functional but provided an overview of the MEQ system capabilities.

The Mars system hardware consists of three models of bar code terminals: the MEQ 300, 130, and 330 series. All are portable, single-hand operation units, which incorporate a noncontact laser scanner. The units can be rotated for either right- or left-hand operation. The 300 and 330 series incorporate a built-in RS232 port and the 130 series uses optical communications. Other Mars products include the MEQ 1600 series bar code label printer, MEQ 1260 Optical Communications node, and the MEQCOMM terminal emulation/RS232 communications software.

Mars's software for data collection and application development is MEQ-BASIC. MEQ-BASIC is a full featured BASIC interpreter similar to Microsoft BASIC and IBM BASICA interpreters. The MEQ

BASIC uses all BASIC commands and provides extensions to support bar code-related functions. The Mars literature and demonstration diskette indicate that third-party software developers can provide ready-to-run applications software, but they provide no additional information on these packages.

As described by the demonstration diskette, the primary use of the MEQ-BASIC software is to program the portable MEQ terminals. The programs are written on a PC, as any other BASIC programs, and are then downloaded to the portable terminal through the serial port using either DOS commands or any serial communications software. Memory in the MEQ terminal is treated by MEQ-BASIC as a hard disk, so that programs can easily store files for upload to the PC.

The demonstration and literature do not go beyond describing the use of the software as a data collection tool. Any number of applications can be written in BASIC to export data files to data bases such as Kbase or Dbase. From that standpoint, the MEQ system provides a good deal of flexibility. However, it does not qualify as a strong contender as a turnkey system for FESS.

Spacesaver Software Systems, Inc.

Spacesaver Software Systems, Inc. (Brookfield, WI), was contacted and their software package (Advanced Maintenance Management System ([AMMS]) was requested. A fully functional demonstration copy of AMMS was purchased from their local representative, Freston Company of Lincolnshire, IL.

The AMMS system software can operate on IBM-XT/AT, 386, PS/2 or compatible microcomputers with a minimum of 640K RAM, DOS 3.0 or greater, and a 20 megabyte or larger hard disk drive. A tape backup device is recommended. The basic configuration of the AMMS system is a microcomputer and the AMMS software. Although the base system requires all data be input from the keyboard, bar code input is available as an option. The bar code option utilizes the Telxon PTC-701 series portable bar code terminal. The four AMMS data files which can be updated using bar code are: the Inventory Activity file, which is used for recording inventory transactions; the Work Order file, which is used to draw parts used on a work order; the Purchase Order receive file, which stores a record for each part received; and the Synch Inventory file, which is used to adjust inventory stocking levels.

Two additional AMMS options are: a network option that provides for operation under any MS-DOS 3.1 compatible network and allows simultaneous transaction, and the User Customization System (UCS) option which allows users to change the structure and appearance of the program. The performance of these options could not be evaluated because neither option was available in the demonstration package.

The AMMS software is comprehensive. The major subsystems of the software are:

1. Equipment Management -- This subsystem contains all the information necessary to track equipment maintenance, including:

    a. Equipment data
    b. Preventive maintenance
    c. Work orders
    d. Work history.

2. Labor Management -- This subsystem has features for controlling labor assets. Modules are:

    a. Employee master
    b. Time reporting.

3. Inventory Management – This subsystem contains the information necessary to monitor inventory activity and purchasing. The modules of this subsystem are:

a. Inventory master
b. Inventory activity
c. Vendor information
d. Purchasing.

4. Maintenance Planning – this subsystem has modules that provide integrated maintenance forecasting, including:

a. Scheduling
b. Budgeting.

5. System Management – This subsystem provides system control features such as security, configuration, ASCII read/write, and others.

Evaluation of the AMMS system was done primarily on an XT-class computer, although it was also run briefly on a Compaq 386. Performance on the XT was slow because of the program's many calls to the hard disk drive. Performance on the 386 was excellent. Portions of the Systems Management, Inventory Management, and Equipment Management subsystems were evaluated.

Installation of the software was straightforward. Although the AMMS software does not have a tutorial, its pull-down menu system is easy to use and the manual is well written. After installation, the setup module was used to make recommended changes in the validation functions of some fields to prevent error messages during loading of preliminary data. This was easily accomplished.

After completing the setup tasks, initial inventory was entered using the Inventory Master module. The Inventory Master module contains all the information about each part in inventory, including classification, minimum and maximum inventory levels, and costs and totals information. Two windows may be opened on the Master Inventory screen. One window allows listing up to five vendors for a specific part, and the other window allows input of additional part descriptions. Using this module was relatively easy. Five part numbers with quantities and descriptions were added to the inventory. Vendor information was also added and the system detected errors where different vendors were identified by with the same vendor part number. Correcting errors in the vendor window was somewhat difficult; Once a field was filled, it could not be edited. A context sensitive help was available, but at one point, an entry error occurred and the operator was unable to correct it. After spending 15 minutes attempting to correct the error, it was decided to just leave it in the file. Also, the vendor window allowed input of a variable specifying lead time to acquire a part, but neither the software nor the user manual specified the units for this lead time. (Days were assumed.) Next, the vendor module was used to enter names and addresses of the vendor codes used in the vendor window of the master inventory.

After adding the vendor information, the Equipment Data module of the Equipment Management subsystem was used to enter information on a piece of "equipment," in this case a building to be maintained. Although the AMMS is aimed at equipment maintenance, this module contained additional information relevant to facilities to allow tracking of work done on specific buildings on an installation. Following definition of a hypothetical Building 2208 to be maintained, the Work Order module was used to generate a work order to perform a maintenance function, which in this case was replacement of window screens. The Work Order module is powerful, and includes automatic work-order generation based on a preventive maintenance schedule. The test case, however, used manual work-order generation.

The AMMS system generates work order numbers automatically based on calendar date and the number of work orders issued. A field titled "Request Number" is available for user-assigned work order numbers. The work order screen includes windows for describing the work, special tools required, action codes, and parts and labor required. Action codes are user generated to allow sorting of specific actions. For example, RB could stand for "replace bearing." A useful feature of the work order screen is the look-up field feature. When entering part numbers for a work order, it is possible to a list the complete parts inventory on the screen. Parts can be highlighted from this list and automatically transferred to the work order parts number list. Also included in the work order screen is a field for the cost account number. These are stored in the Code Reference File. The demonstration system already had account numbers assigned so that an error was flagged when a dummy account number was entered in the test. When this occurred, a window opened, displaying valid account numbers. One of these numbers was selected and the work order was successfully completed.

When a work order is entered into the system, parts are not removed from inventory until the work order is completed or until a "parts completed" function is initiated. The "parts completed" function is available in cases where parts are issued but the work order is not complete. In the test case, the Work Order completion mode was used. Completing the work order was an awkward process requiring two steps. First, the work order had to be retrieved in edit mode and a completion date added. Then this mode had to be exited and another menu entered to enter the work order completion command. Entering the work order completion date as part of the work order completion command seemed more logical. Once the work order was identified as complete, parts were automatically drawn from the inventory and the inventory quantities were updated. At this stage, the report-generating features of the software were examined.

The AMMS package performed well and matches FESS requirements. Features such as auto-scheduling of work orders and the pop-up lists of parts are particularly useful. One of the drawbacks of the program is that it uses bar code only as an option. Thus, it was not possible to determine from the demonstration which specific items can be input using bar code. Second, the base system can be modified very little, if at all, without the optional User Customization System. Because the demonstration package did not include this option, its performance could not be completely evaluated. AMMS is written with equipment maintenance in mind; substantial modification the fields would be necessary before using it with FESS. Similarly, because the program is comprehensive, the user must work within the program's restrictions. Because the total system structure is complex, it would be difficult to change the program's operation procedures. Although the AMMS system does all that FESS does, if AMMS requires different procedures, training or user acceptance may become an issue. Finally, error handling was occasionally a problem. For example, the Inventory Activity module allows manual additions or subtractions from inventory. The manual states that these records cannot be deleted or edited, and that error correction must be done by making a reversal entry after the information has been entered in the database. Novice users, making errors on an initial entry, may also make errors on subsequent reversal entries-in correcting the initial error, possibly leading to a number of "junk" entries in the data base.

These problems aside, the AMMS system is among the top contenders examined in this review. It is comprehensive, well written, compatible with FESS, and is relatively easy to use.

Ranking of the Software Packages

Each of the software packages evaluated was assigned a score from one to 10, with 10 being the best, in the following areas:

1. Ease of Use – In this area, characteristics such as the quality of the documentation, tutorials, user interface and occurrence of "glitches" were evaluated. The evaluator's experience in using these packages for the first time is likely to be similar to the experience of a DEH user, although the DEH user may have less computer literacy. Items which caused lower scores in this category were occurrences of "lock-ups" or entry into sections of a program where there was difficulty in exiting. Also contributing to low scores were instances in which the user's manual description of a function did not coincide with the actual operation of the software. Low scores in this area indicate that the system requires extensive training to implement, and may be unacceptance to users. (Nonfunctional demonstration packages may have unmerited low scores in this area.)

2. Match to DEH FESS Requirements – In particular, the ability to issue and receive bar coded stock, keep a record of suppliers, perform inventory functions, print bar code labels, and store, organize, and download data was evaluated. Also included in this evaluation item was consideration of the programming effort required to modify the system for FESS application. A low score in this category indicates that the package requires considerable setup and customization before implementation.

3. System Security – The packages were examined to determine the extent of security features available. Packages that do not allow the user to set security and function received lower scores. No attempt was made to breach the security of any of the systems.

4. Reporting – The ability of each package to produce useful reports was evaluated. In some cases this evaluation element overlapped that of system flexibility, as some systems' default reports required modification. Typical test reports included a work order summary showing parts issued to a specific work order, and summaries of total inventory on hand. For nonfunctional demonstrations, this factor was estimated based on sample reports. Some nonfunctional demonstrations with relational data bases received higher scores than functional packages without relational data bases. This is because without a relational data base, most useful reports must be developed in an external data base package.

5. Relational Data base – Each package was evaluated for the presence of a relational data base. Such data bases allow the software to function in a standalone fashion, without having to download data to an external data base. Scores among packages with relational data bases varied because of perceived different degrees of flexibility in manipulation of the data base.

6. Networking – The ability of each package to network, the number of terminals supported, and the ability to perform simultaneous transactions was evaluated. Scores were slightly higher for systems with dedicated network cards provided by the package vendors, based on the assumption that these systems, tailored for control of bar code terminals, will outperform standard network hardware.

7. Help Features – Presence and completeness of on-line, context-sensitive help were evaluated.

8. Flexibility – The flexibility of the packages in terms of their ability to be customized was examined. Programs having customization features were tested by making changes to entry screens, reports, and in some cases to the data elements used by the relational data base. A low score in this area indicates that the package is difficult to tailor to specific FESS requirements and has a higher potential for "dead-ending," as system requirements evolve.

9. Accuracy – This element was evaluated for each package by checking the numerical results of operations on a dummy data set. None of the functional packages produced any errors, and perfect accuracy was assumed for the nonfunctional packages. For this reason, this scoring factor had no impact on the final rankings.

10. Customer Support – Although customer support is difficult to assess before purchase, the potential quality of customer support was inferred from the actions of the vendors in response to requests for software, technical questions, and requests for customer references. Promptness and comprehensiveness of response were particularly important in this area. Vendors unable to keep promises for delivery of materials, or to return phone calls, scored low in this category.

The final scores for each area and the total of these scores are presented in Table 1. A low score for this evaluation is not a measure of the overall quality of a product, but only of its suitability to the FESS application.

Based on the total scores in Table 1, the final rankings of the software packages are, beginning with the highest score: Spacesaver, ASAP, Caere, Data Net, Lowry, and Mars. Appendix B contains product information for the ASAP and Spacesaver packages. The present scoring system gives equal weight to each of the scoring areas. Differences between the top two, and between numbers three and four are small enough so that they would be sensitive to relative weights assigned to each of the scoring areas. If, for example, flexibility and ease of use were weighted more heavily than security and networking, ASAP and Spacesaver would trade positions. The difference between Data Net and Caere is almost negligible. Users preferring a Windows interface and mouse would prefer Caere, while those desiring a step-by-step, almost expert system interface would prefer Data Net. Lowry's low score stemmed from a relatively weak demonstration diskette and poor marks for customer service. Mars's low ranking was not based on a weakness in the package, but rather because it is not a "package" per se, but a BASIC interpreter with bar code commands. A good BASIC programmer could probably develop the desired applications, but as a package, Mars did not compare well with the standalone capability of the other packages surveyed.

Table 1

Rankings of Software Packages

Feature	ASAP	Caere	DataNet	Lowry	Mars	Spacesaver
Ease of Use	10	7	8	6	5	8
Match FESS	8	7	6	5	4	9
Security	6	9	8	7	5	9
Reporting	9	3	3	6	3	8
Rel. Data base	10	1	1	8	1	9
Network	2	10	10	8	7	8
Help	9	7	8	7	5	8
Flexibility	10	8	7	7	8	7
Accuracy	10	10	(10)	(10)	(10)	10
Support	10	8	8	1	6	9
Total	83	70	69	65	54	85

4 CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The DEH Supply Function was analyzed through surveys and site visits to U.S. Army installations, to determine the nature of and similarities among existing supply service operations, and to explore the possibility of applying bar code technology to those operations. Results indicated a bar code application to FESS will produce several benefits:

1. The FESS data base will more closely represent actual material supply conditions.
2. Inventory accounting procedures will be more efficient.
3. Inventory accounting will be more accurate.
4. The process of issuing stock material will be more efficient.

The Motorola Four Phase computer (the mainframe computer used at most installations to run FESS) will not accept direct entry of bar coded input data. This constraint precludes the direct use of a commercially available bar coding systems in conjunction with the current operating configurations of FESS without system modifications to both hardware or software. There are two ways in which bar code technology may be interfaced with FESS:

1. By providing a preprocessing server to interpret the bar code data and exchange data files with the Motorola Four Phase machine

2. By replacing the Motorola Four Phase computer on which FESS operates.

Any conversion of the DEH supply function to bar code use should be implemented in phases to allow personnel to become gradually accustomed to the new system. Automating a system of material management with bar code technology would involve undertaking the following steps:

1. Acquiring the appropriate hardware and software to provide bar code inventory functions
2. Providing a direct interface or preprocessor for transfer of bar code data to FESS
3. Assigning bar codes to the entire warehouse stock inventory
4. Bar coding each work order
5. Establishing a set procedure for tracking the issue and receipt of stock material, and for taking staged or continuous warehouse inventory.

The use of bar code technology may be problematic for installations that allow shop and maintenance personnel to enter the warehouse to select items themselves. Because warehouse personnel are not always present when material is selected from the shelves, they will not always be able to scan bar codes affixed to the storage bins. It will take additional training to introduce maintenance personnel to the use of bar code tools.

Six software packages of various types and complexity were reviewed for suitability for DEH needs and potential for use with FESS. Of the six, the Spacesaver and the ASAP software ranked highest. Deciding between the two requires considering the relative merits of the two programs. Either (or both) of these two packages would be acceptable for pilot tests at host installations.

Recommendations

It is recommended that ASAP and/or Spacesaver be tested and evaluated for their applicability to DEH supply operation. The results of this test should be documented and published for general dissemination to all Army Installations. The test results should include adaptability, functionality, and the return on investment to the installation.

The test should include:

1. Selecting a host installation with both the desire and resources to participate in the test and evaluation of the system.

2. Provision of a server preprocessor for the Motorola Four Phase machine for data transfer to FESS. This server could be a node on an existing network and also serve as a supply system terminal.

3. Development of an interface for data transfer between the server and FESS.

4. A review of the specific requirements of the host installation's operations and business methods to help in selecting and purchase of an acceptable system.

5. A test of the application of the system and the technology as it applies to DEH supply function.

6. An evaluation of, and report on the results of the test.

APPENDIX: Telephone Survey Results

Fort Benning

General

FESS became operational here in 1984. The Management Engineering Services group maintains the mainframe computer, which is located across the street. This group provides good service, and the arrangement is satisfactory.

Is any automation being used to account for supplies?

Not beyond FESS.

What is the method of accounting for supplies?

Receiving logs in items and then forwards invoices for processing into FESS. Everything reaches FESS on the same day.

As items are issued out of the warehouse, the Issuing Clerk keys information into FESS on a terminal located at the issuing desk.

Where could automation help?

Primarily at the time of issuance, but also in inventory control.

Would bar code technology help?

Absolutely. It would be most helpful in issuing supplies. Bar code technology would not be very useful in the Receiving area, as Receiving only forwards invoices.

Proper instruction in the use of the bar coding equipment is most important.

Would be happy to be a test facility for a bar code system.

Miscellaneous:

The mainframe, a Burroughs computer, was down for about 6 weeks in October 1988. As a result, and because of the inability to restore backup tapes, they lost about 80 percent of the FESS data base.

They are planning to look into some kind of bar code system on their own.

Fort Campbell

General:

FESS has been operational since 1981.

The computer is located at the other end of the compound and belongs to the Resource Management Division.

Is any automation being used to account for supplies?

Yes. Reports are regularly generated from information in FESS. A resident programmer is available for this purpose.

What is the method of accounting for supplies?

Material is logged in as it is received via a data entry terminal located in the receiving area. When supplies are issued, a clerk completes a paper form which a Data Entry Clerk located in the same area transcribes into FESS.

Would bar code technology help?

Bar code would be a great help. There is enthusiasm for linking FESS with bar code. A hand-held bar code reading device is envisioned. The device would read bar code information, and would also accept information entered manually, such as numeric data. This information would be stored temporarily within the device until it could be downloaded into FESS. at the end of the day or at some other regularly scheduled convenient time. Receiving Clerks and Issuing Clerks would use the device to process incoming and outgoing supplies.

Miscellaneous:

There is a genuine interest in bar code applications to FESS. People here have been pushing for something for quite awhile.

Fort Devens

General:

FESS has been operating smoothly since 1980.

Is any automation being used to account for supplies?

Nothing other than FESS.

What is the method of accounting for supplies?

Warehouse personnel check in supplies, and then complete forms and send them to an administrative group located in a different building. Trained data entry personnel there transcribe the information from the forms into FESS. These personnel are quite conscientious and take the initiative to check with the warehouse if any information on the forms is not clear. The data in FESS is therefore relatively accurate and, as a result, people have confidence in the information they get from FESS.

The process of issuing supplies is slightly different. An "open warehouse" system is used, where shop personnel enter the storeroom and select their own supplies from the shelves. They then bring the supplies to the issuance desk where warehouse personnel check it out and complete the necessary forms. From this point the procedure is the same as for receiving supplies.

Operations generally run fairly smoothly. Shop personnel are pleased because this arrangement is easier for them. Because they can browse the warehouse shelves, they need not have a precise description of an item before they requisition it. Shop personnel would strongly resist changing this arrangement. They would argue that any changes that take away their authority to select items from the warehouse shelf would interfere with their work and would ultimately be counterproductive.

Where could automation help?

In general, any automation would be seen as unnecessary interference as discussed above.

Would bar code technology help?

There seems to be a reluctance to interfere with the way things are now handled when issuing supplies, as shop personnel are quite pleased with the current arrangement. Receiving personnel would probably be more accepting of bar code technology.

Miscellaneous:

There is a general satisfaction with the way things are, but new ideas are welcomed.

The FESS computer is in a different building from the warehouse. Thus, data entry terminals cannot easily be located in the receiving and issuing areas. Warehouse personnel are also reluctant to use the terminals. These wage grade, unionized personnel view data entry as outside the scope of their work.

Fort Dix

General:

The status quo is fine.

Is any automation being used to account for supplies?

Only FESS.

What is the method of accounting for supplies?

Clerks key information into CRTs immediately upon receipt and issuance. The clerks take the initiative to verify information that is unclear before they key it into FESS. The data contained in FESS is accurate and up to date.

Where could automation help?

Things are fine as they are.

Would bar code technology help?

Bar coding would be a mistake. No cost benefit would result, and serious problems could develop that would adversely affect FESS. As at the supermarket checkout, if the bar code system breaks down, operations revert to manually keyed data entry. So why bother converting to bar coding in the first place?

Miscellaneous:

Initially people were hesitant about converting over to FESS but now they are comfortable with the idea.

Fort Eustis

General:

FESS has been operational since 1983. The Management Engineering Services group maintains the mainframe computer, which is in a building about a half mile away. Underground cables link FESS to the mainframe. Previously, the mainframe was located in the same building as the warehouse, and other users tied into it from there. About 2600 items are in stock and another 4000 are in fringe.

Is any automation being used to account for supplies?

No.

What is the method of accounting for supplies?

After initial receipt of material, the Receiving Clerk gives the invoice to a terminal operator who keys the necessary information into FESS. When stock is issued, the Issuing Clerk gives the necessary paperwork to the terminal operator who keys it into FESS. All of this occurs in the warehouse, more or less at the point of transaction.

Would bar code technology help?

Bar code would be a big help for the property book. Bar code would not be of much help for FESS.

Miscellaneous:

Bar code is not in great demand here. Small tests of bar code have been tried for the property book, but never went far enough.

Fort Hood

General:

This is probably the largest installation in the country. Over 6000 items are stocked for operations that encompass 4600 buildings over 339 square miles.

Is any automation being used to account for supplies?

IFS-M is scheduled to be implemented this fall.

What is the method of accounting for supplies?

FESS is followed to the letter for inventorying DEH supplies. Data entry is initialized at the point of receipt or issue from the warehouse via terminals.

Would bar code technology help?

Some limited tests of bar codes have been run, but the results have not been favorable. Five hundred building materials items, such as plumbing and electrical supplies, were tested. The results were that (1) bar code labels did not adhere well to the surfaces of many items, (2) some items were too small for bar code labels to be attached directly, and (3) bar code labels came off easily or were ruined in normal handling.

Unit of order versus unit of issue is seen as a potential problem for bar coding. For example, nails that enter by the box are broken apart and issued by the pound.

Miscellaneous:

The mainframe computer was located in the same building as the stock warehouse for the first 2 years that FESS was operational. It was then moved to a different location so that it could be shared with other groups. The fact that the computer is located in a building removed from the data entry terminals does not seem to be a problem.

Fort Leavenworth

General:

FESS has been operational for about 10 years. Approximately 3000 items are kept in stock, and approximately 20,000 fringe transactions occur per year.

Is any automation being used to account for supplies?

No.

What is the method of accounting for supplies?

Material is inspected and inventoried as soon as it is received. Paperwork (Form 3161) is filled out at this time and turned over to a Data Entry Clerk who enters the information into FESS. Paperwork is again completed when material is issued, and is turned over to the Data Entry Clerk for entry into FESS.

Would bar code technology help?

Bar code would definitely help. Prison labor of short stay is frequently used in the warehouse. Numbers are often transposed when copied.

Miscellaneous:

The Motorola mainframe computer is located about two blocks away. More data entry terminals cannot be easily located in the warehouse. A new fiber optics cable is being installed that should alleviate this problem.

Fort Lee

General:

FESS has been operational since 1983. Approximately 2900 items are in stock and approximately 5000 fringe items are maintained in FESS.

Is any automation being used to account for supplies?

No.

What is the method of accounting for supplies?

Items come to Receiving where they are inspected and checked to determine whether they are acceptable. If so, the invoice is taken to the Stock Control Department where the information is entered into FESS. Concurrently the item is put in stock, if it is a stock item, or set aside for pick up, if it is a special order.

When items are issued from stock, warehouse personnel enter the information directly into FESS via a terminal located in the warehouse.

Would bar code technology help?

Overall, bar code technology would improve inventory control, as some paperwork would be eliminated and information would be more accurate.

Miscellaneous:

The mainframe computer is located in the warehouse.

Fort Lewis

General:

FESS has been operational since 1981. FESS shares the mainframe computer with the Management Engineering Services group. This arrangement causes the inventory control personnel to operate FESS differently from its intended use.

The computer is located approximately two blocks from the warehouse. Because of this distance, no Visual Display Units (VDUs) have been directly hooked up to enter information directly into FESS at the level where material is received or issued. The result resembles what probably would have happened had FESS never been implemented.

Warehouse clerks do not use VDUs because Issuing and Receiving personnel are reluctant to use VDUs, and few knowledgeable personnel are available to train others to process information into FESS using VDUs.

Is any automation being used to account for supplies?

FESS is the most automated tool being used to account for supplies.

What is the method of accounting for supplies?

A hybrid system of FESS and manual paper shuffling is employed to account for stock. For example, after receipt of a delivery of a stock item, forms are completed manually and passed through channels. At some point the forms reach someone who enters the necessary information into FESS. In the meantime, the item itself remains somewhere in Receiving until an FESS-generated report is received with instructions to place the item in stock. Until this happens the item is officially not in stock. The process can take as long as 2 days. A similar scenario occurs when items are issued from stock.

Because the mainframe computer is not located in the same building and is maintained by another group, the inventory control people believe that they have little control over the computer. They thus lack confidence in the accuracy of the information contained in FESS. Inventory is run every month on about 10 percent of the stock. To add to the problem, the mainframe computer was down for about 6 weeks during fall 1988.

Where could automation help?

It would be of great help if information could be directly entered into FESS whenever a receiving or issuing transaction occurs. This would speed up the processing cycle and should result in a more efficient operation in general.

Would bar code technology help?

A bar code system would be beneficial. Even if an intermediate transfer step were necessary, bar code would still improve the overall accuracy of the information contained in FESS, as bar codes improve the accuracy of transcription of any data.

Not only would information about stock be more accurate, but a bar code system would improve efficiency. Warehouse personnel who are now reluctant to enter information into terminals might more

readily accept a bar code system. Much, if not all, of the manual paperwork now associated with inventory control could be eliminated. The accuracy and efficiency of inventory control would be improved across the board.

Miscellaneous:

A complaint about FESS unrelated to bar coding is that FESS does not use a sound approach to determine what items to stock. FESS determines the demand for an item based on the number of times the item is requested, rather than the number of items actually drawn out of inventory. FESS will stock an item when six requests for that item have been received in 1 year. For example, a plumber might, for convenience, take 50 valves from stock at one time with a single work order request. FESS sees this as only one demand, not 50. Because FESS keys on the number of demands made in a year, rather than the number of items drawn out of inventory, valves might not be flagged for reorder.

Fort McCoy

General:

FESS has been operational since 1982.

Is any automation being used to account for supplies?

Not currently.

What is the method of accounting for supplies?

Clerks key information into terminals when material is received and when material is issued.

Where could automation help?

Anywhere and everywhere. It would be great simply to wave a bar code scanning device and get a printout instantaneously containing all the information needed for processing.

Would bar code technology help?

Yes, definitely. Bar code technology is enthusiastically supported. Some type of portable, hand-held device is envisioned, one that clerks could use when receiving or issuing material. Ideally, the bar code device could also be used for inventorying.

The Fort McCoy contact attended a conference on bar code technology in Milwaukee in early March. She volunteered Fort McCoy as a test facility and has invited USACERL to visit and see their operation first-hand to determine where bar code technology could be applied. They would like to work with USACERL, but will be moving ahead with their own plans to implement bar coding in the meantime.

Miscellaneous:

While the FESS manual does not reference the computer hardware by specific brand name, people believe that FESS was specifically designed to run on Motorola equipment and that any other manufacturer's hardware will not be compatible. If this is true, problems will arise. Apparently Motorola has been unwilling to support the system if peripheral equipment made by another manufacturer is hooked up. It seems unlikely that Motorola would object to interfacing with bar coding equipment if makes no such equipment. Nonetheless, this concern must be investigated carefully.

Fort Polk

General:

Is any automation being used to account for supplies?

No.

What is the method of accounting for supplies?

Receiving personnel sign shipping invoices to acknowledge receipt of material and pass those receipts on to the office. People in the office transpose information from the receipts into FESS from a terminal.

The personnel issuing supplies enter data into FESS at the time of issue.

Where could automation help?

If automation would reduce paperwork it would be welcomed.

Would bar code technology help?

Bar code technology would help eliminate errors made in transcribing data and therefore improve the accuracy of the information contained in FESS. It would also improve efficiency in general.

Using a bar code system for all supplies would be difficult, as many materials do not lend themselves to bar code labels.

Fort Riley

General:

Is any automation being used to account for supplies?

Nothing beyond FESS.

What is the method of accounting for supplies?

FESS is followed practically to the letter. Receiving and Issuing personnel key information for FESS into terminals at the point of receipt and point of issuance.

Where could automation help?

Automation is welcomed anywhere that it will improve overall efficiency.

Would bar code technology help?

Although operations are smooth, any improvements to efficiency are welcomed. While certain difficulties with bar code are foreseen, they are very willing to try bar code technology. They like the idea of a hand-held device that Receiving personnel could use to read bar code data that would then be downloaded directly into FESS.

Miscellaneous:

Materials coming from the DLA depot are already bar coded.

The Management Engineering Support branch maintains the mainframe computer, which is located in a separate building about 200 yards away. This arrangement seems to present no serious problems.

Fort Stewart

General:

Very enthusiastic about bar coding. Would like to have it as soon as possible. Would be happy to be the test facility. Bar coding could help alleviate some of the problems associated with personnel turnover. They envision applying bar coding to maintenance operations.

Is any automation being used to account for supplies?

No.

What is the method of accounting for supplies?

When stock is received it is keyed into FESS at a CRT in the warehouse. Two CRTs are located at the issue counter and information is keyed in before further action is taken. If the screen indicates any problems, the item is not issued.

Would bar code technology help?

Yes, definitely. Receiving and Issuing personnel could use hand-held bar code readers as they check stock in and out. Errors in transposing handwritten numbers would practically disappear. Handling small parts is not a concern, as bar code labels can be affixed to the bins that hold the parts. The same approach could be used for larger items such as lumber. For the system to operate properly, all stock and fringe items must be bar coded; the system will not work if some items are bar coded and others are not.

Miscellaneous:

The recurring situation of unit-of-order versus unit-of-issue is recognized as a problem area.

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