

A COMPUTERIZED BAR CODE SYSTEM FOR LABELING ENVIRONMENTAL SAMPLES

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ABSTRACT

A rapid, reliable, and labor saving sample identification system that uses a bar code labeling technique to identify environmental samples is described. This system consists of a commercial bar code light pen and decoder board interfaced to a portable micro-computer. Sample logging, data entry, display, and manipulation are accomplished by using a series of custom designed program menus and data record formats created in dBASE III. This system is operational and was used at sea in conjunction with the NOAA National Status and Trends Program.

1. INTRODUCTION

Cost effective, rapid, and reliable techniques for sample identification are important when collecting and archiving large numbers of environmental samples. The number and diversity of samples necessary to determine pollutant effects on the environment has become large which makes accurate accounting of often thousands of samples a major task. Rising costs of sample collection and handling warrant development of a labeling system to reduce costs and the probability of mislabeling valuable samples.

Bar code labeling techniques are efficient and cost effective in many applications, ranging from consumer products inventory to the control of government equipment and supplies. Application of such techniques to labeling environmental samples is relatively new, but offers to satisfy sample identification and data manipulation requirements in the field and laboratory. A bar code labeling system, when coupled to a suitable computer, becomes a powerful tool for keeping track of large numbers of samples. The use of a bar code labeling system will streamline data management, sample identification, classification, and inventory procedures.

2. THE BAR CODE PRINCIPLE

The three main components of a typical bar

code system are the reading wand (Fig.1), decoder board, and computer. A bar code system automatically reads digitally encoded information and enters it into a computer. Manual computer keyboard entries are thus replaced with automated reading, which virtually eliminates operator error and provides for fast and accurate data entry up to 1500 entries per minute.

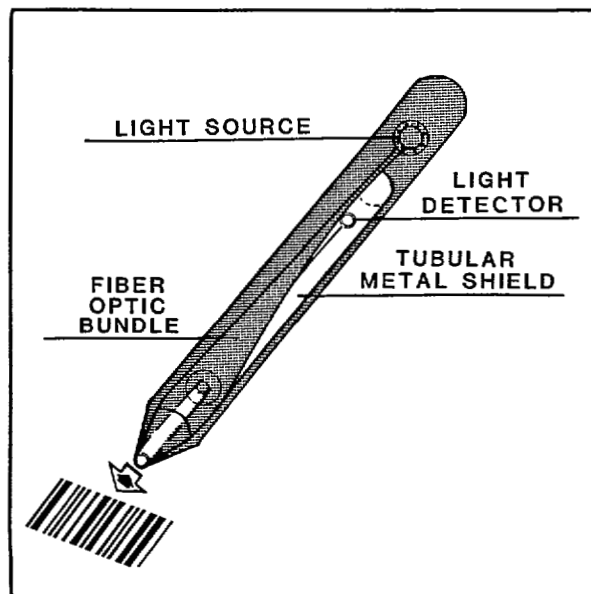


Fig. 1. A Barcode Reading Wand

Operating a bar code system requires minimal skill. The reading process is described as follows: A bar code is read using either a visible or infrared light-emitting diode (LED) contained within a wand, which is rapidly passed over the surface of a printed bar code label. A typical label consists of a specific pattern of light and dark colored bars that represents an individual ASCII character or group of characters. The transmitted light is absorbed by the dark bars and reflected by the light bars. Light that is reflected is detected by the LED within the wand and is translated into a voltage sequence by the decoder board. This voltage represents a selected ASCII character or character set. The characters

are then displayed on a monitor or entered into a computers data base.

Bar code labels can either be printed by the user on a variety of materials using commercially available software and electronic printers or purchased preprinted to user specifications. The latter method tends to be the most economical for the small volume user but may not always be appropriate for all sampling tasks. Labels can be custom designed to suit individual requirements and are available in a variety of sizes and colors and can be produced using water proof and freeze proof materials and adhesives. Bar code labels are usually printed with plain language identifiers below the code.

Different bar code labeling systems are used routinely by private industry and the Government. Probably the most familiar system is the Universal Product Code (UPC), which was adopted by the grocery industry in 1973. This system allows numbers from 0 to 9 to be represented on a bar code label. Another system called Code 39 is rapidly becoming the code format of most users because it can handle both numbers and letters. In 1982, the Department of Defense began incorporating Code 39 into the military stock inventory system to keep track of everything from tools to tanks.

There are many advantages to entering information into a computer using the bar code technique. Data entry is fast, accurate, and always entered correctly. The system responds with a distinctive "beep" when the information has been accepted by the computer. A properly designed bar code system interfaced to an appropriate computer and software, is a tool that saves money for inventory control and accounting of large numbers of individual items.

3. DESCRIPTION AND OPERATION

The bar code system described here consists of a Columbia Data products VP portable personal computer with a MS-DOS operating system interfaced to a Caere model 240 bar code reader. The Caere system hardware includes a wand type scanner, a decoder board, and a "Y" connector cable. The decoder board plugs directly into the expansion slot of the Columbia computer and performs the functions of reading the bar code information and making it appear as keyboard input to the computer. The "Y" cable connects the keyboard in series with the reading wand to allow the components to be operated independently of one another. This configuration can be used with any IBM compatible computer that has

a plug in key board. A printer may also be connected to the computer to generate hard copies of data and graphics.

The system software was written using dBASE III (Ashton Tate Inc.), which is well suited for this application. The software was developed to display a series of prompts in the form of user-friendly menus for entry and retrieval of information on samples numbered with bar code labels. The program is easy to use, highly versatile, and stores data efficiently. In its present configuration, the program allows storage of approximately 250 data records on a single soft diskette. The system can also be used with a hard disk drive, a feature which increases substantially the data storage capacity. Other features include the ability to enter or retrieve data, print and sort specific data files, and create statistical tables or graphs. An additional prompt allows the operator to exit the main program and to further manipulate data using standard dBASE III commands.

The system is being used in the Benthic Surveillance Project, a part of NOAA's National Status and Trends Program. Benthic Surveillance is designed to measure toxic chemicals in benthic fish and surficial bottom sediments collected at approximately 50 sites nationwide. The effectiveness and general utility of the system for labeling samples of both fish and sediment has been proven aboard ship during field sampling exercises in waters along the southeast Atlantic and Gulf of Mexico coast of the United States.

Since Benthic Surveillance is, in part, a survey program, the bar code labels were designed and preprinted in advance of the cruise. Code 39 was found to satisfy labeling requirements and allowed up to 15 characters to be represented on a single bar code label of convenient size (Fig.2). The labels contain plain language identifiers to allow quick visual reference to sample type and location. At the time of collection, sample parameters (cruise number, date, time, position, etc.) were entered manually into the computer and then associated with individual samples through the computer data base. Depending on the data acquisition capability of a particular ship and the versatility of software and computer, direct input of sample parameters into a data base is possible.

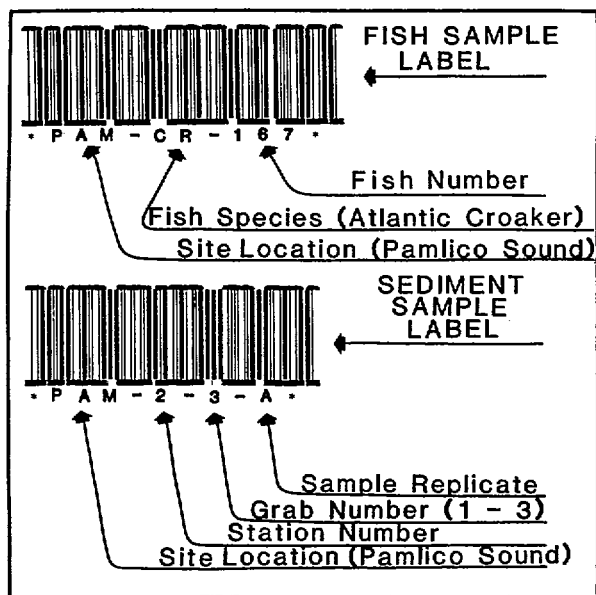


Fig. 2. Sample Barcode Labels

4. APPLICATIONS

The use of portable micro computers at sea and in the field during sampling operations is becoming routine. The availability of inexpensive computer equipment and versatile software has made computerized bar code labeling both feasible and practicable. Computer data display, entry and logging formats can be designed to suit individual requirements. Bar code labels can be printed to contain the same information as hand written labels, which makes the conversion to an automated labeling technique a relatively simple task.

The forte of the computerized bar code system to environmental monitoring, survey, and research is the ability to rapidly and reliably integrate large

amounts of sample labeling and other data into a near real-time, interactive data base and to have this data available to aid sample and data gathering efforts while still at sea or in the field (Fig. 3). In this way, information is made available quickly enough to monitor progress and modify activities as necessary. Preliminary sample and data reports can be produced aboard ship in tabular and graphic formats for early review. Upon return to the laboratory, the sample and ancillary data bases already exist and provide a base to which sample-analytical data is added. The laborious and often error-ridden transcription of field notes is avoided by integration of computerized systems into the earliest stages of sample and data gathering. The system is particularly advantageous where large numbers of samples or sample subsets (i.e., samples subdivided in the field and assigned to different analytical or archival purposes) must be tracked and eventually interrelated and/or related to other data sets.

For the Benthic Surveillance Project, the system allows sample labeling and length-weight data entry to proceed simultaneously with fishing effort. Length-frequency and weight-frequency distributions for several hundred individuals are generated and used to select individuals within a particular size range for inclusion in a sample. Sampling can proceed until the number of fish of the required size is obtained. Over-sampling that is normally required to ensure this number can be avoided because of rapid feedback from the computer, i.e., the normal delay between sampling and size classification of the fish is significantly reduced. At present, fish length and weight data are entered into the computer by keyboard. Eventually, electronic measuring boards and balances can be interfaced directly to the computer with a further savings of time.

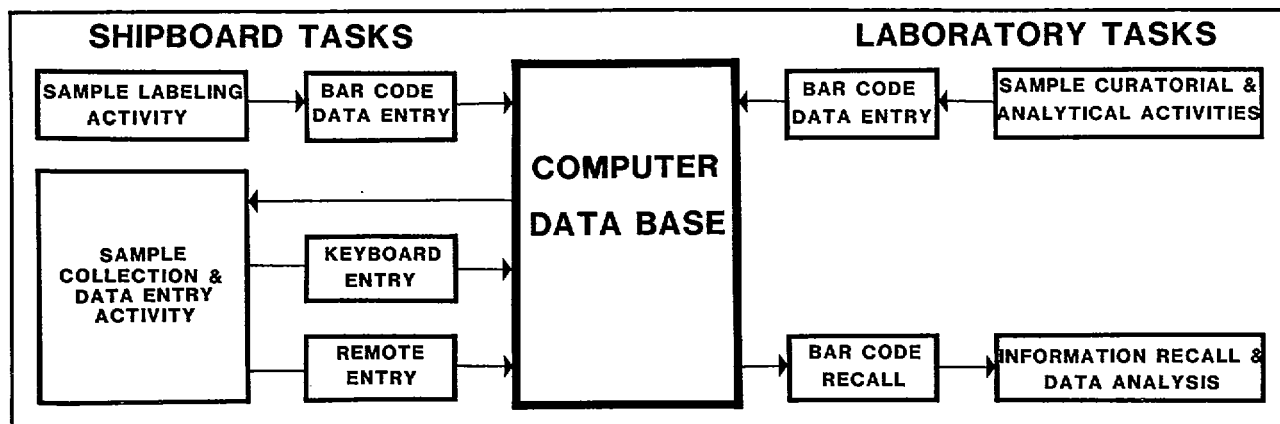


Fig. 3. System Flow Chart

The computerized bar code system is well suited to large curatorial collections, of which plankton samples are particularly good examples. Plankton samples may contain information pertinent to several research specialties and may be analyzed by several investigators over extended periods of time. The system will also facilitate the management of historical archives which are of increasing importance for dealing with questions of environmental management. Other samples and data sets that have characteristics appropriate to a computer bar code system may include sediment and water samples, particularly those where large numbers of samples and/or sample subdivisions are numerous.

5. SUMMARY

Described here is a cost effective and reliable method to label and keep track of large numbers of environmental samples. The availability of off-the-shelf micro computers and bar code equipment makes a bar code reading system for field and laboratory work a practical alternative to conventional labeling techniques. A system of this type can serve as a useful tool for managing diverse environmental samples. Capabilities of a computerized bar code labeling system are numerous. The system described can serve as a basis for developing similar systems configured around available micro computers to suit individual research needs.

6. BIBLIOGRAPHY

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