Codon CB-100 Distribution Management System

MANAGEMENT SUMMARY

Founded in 1967 as a consulting and software house, Codon began a study of distribution operations in 1969. This culminated in late 1972 with the delivery of the first CB-100 Distribution Management System, built around a DEC PDP-8 minicomputer. In the beginning, the Codon system was visualized as a remote processing point feeding information to a central computer facility. Thus, it was originally referred to as an intelligent terminal, and most of the currently installed 37 systems are operated this way. Since the CB-100's introduction, however, the capabilities of free-standing, multi-user data processing systems built around minicomputers have been recognized and marketed by many companies. The Codon system, although employed by some users for more than just distribution processing (remote batch processing, for example), retains its primary emphasis as a remote processing point for use in conjunction with a central facility.

The distribution function is not a simple one. It embraces order entry, warehouse inventory, credit checking, shipping, customer billing, and accounts receivable functions. Complicating the problem is the likelihood that one or more warehouses may be located at places different from the processing site. Even public warehouses can be involved. And there is the desirability of including freight cost calculations. Because both accounting information and physical items (the inventory) are involved, the data processing functions can be complex. Compounded as it often is by geographical dispersion and involvement of non-company personnel (public ware-

Warehouse inventory management is blended with customer order entry and accounting in this distribution management system. The CB-100 was an early entry in the use of multi-user minicomputer systems built around CRT's and disk storage.

CHARACTERISTICS

VENDOR: Codon Corporation, 11 De Angelo Drive, Bedford, Massachusetts 01730. Telephone (617) 275-2000.

MODEL: CB-100.

DATA FORMATS

The user of a Codon CB-100 system works entirely with the data formats established by his procedures and files. Turnkey software is normally provided. The internal representation of data and instructions is that of the DEC PDP-8; see Report M11-284-101.

MAIN STORAGE

TYPE: Core.

CYCLE TIME: 1.2 microseconds.

CAPACITY: 16K to 32K 12-bit words in increments of 8K words.

CHECKING: None.

STORAGE PROTECTION: None.

The Codon nameplate affixed to the DEC PDP-8 processor and DECpack disk drives does not in itself make this system unique; the software residing in the processor does. Codon has specialized in distribution management since 1969. The Infoton Vistar CRT terminal being used as a workstation is one of nine that can be attached to the system and operated simultaneously.

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houses), the distribution function is thus an appropriate candidate to be singled out as a separate data processing function.

The Codon CB-100 system attacks the problem by maintaining accounting and inventory information in master files on disk storage. Data is entered in inquiries made through CRT terminals. Entered data is processed by the minicomputer into forms, receipts, invoices, inventory lists, and accounts receivable, and is also used to update the master file. Up to nine operators can simultaneously utilize the system through the CRT stations.

Application software is typically developed by Codon for each customer. The customer may elect to implement additional functions not related to the distribution function or make enhancements to the original applications software. Programming is accomplished in DEAL, a macro-enhanced assembly language with distribution-oriented subroutines, or RPG.

Using the terminals, clerks can request customer order or stock status in response to sales inquiries, or initiate report printouts, or communicate with another distribution center, or dump part or all of the contents of a disk file onto magnetic tape if a tape drive is employed. Freight rate summaries, back orders and future shipping orders, replenishment orders and receipts, and customer order data are further examples of the kind of information that a clerk might enter into the system.

It is entirely possible, therefore, for the use of the CRT terminals to be intermittent rather than intensive. On the other hand, there may be a sufficient volume of data entry to justify hiring operators whose function is to key all day. In this situation, there could be a full-time system supervisor, but usually there is none.

A record can contain up to 127 characters. For longer records, two or more 127-character records can be linked. Although the necessary formats that organize incoming data are initially installed by the manufacturer, a format compiler is incorporated in the software so that new formats can be entered. Any format program in the library can be recalled in response to a code keyed by the clerk operating the terminal.

One of the strengths of the system is its ability to call up a data file at any time and modify all or part of it. Entry of new data is accomplished conversationally as an aid to inexperienced operators. An experienced operator can forego interactive entry, which consists of having the system call for different kinds of data as specified by the formats, by simply keying the data in accordance with a familiar format.

USER REACTION

Datapro talked with four users of the Codon CB-100 Distribution Management System. Altogether, a total of 11 installed systems were reported on, and two of the

CENTRAL PROCESSOR

The Codon CB-100 system is built around the DEC PDP-8 minicomputer. Because the user does not typically become involved with the internal details of the system, those details are not repeated here. Please see Report M11-384-101 for detailed information on the PDP-8 processor.

INPUT/OUTPUT CONTROL

The processor, memory, and peripheral devices are interconnected through the DEC Omnibus. CRT's and printers operate in a programmed I/O mode. The maximum total transfer rate in this mode is 134,000 words per second. The disk drives operate in a block transfer mode through the standard DMA facility that is an integral part of the Omnibus; maximum DMA transfer rate is 833,000 words per second. Typically, multiple low-speed peripheral operations and one disk transfer operation can be overlapped with processor execution.

CONFIGURATION RULES: The CB-100 system can accommodate up to nine CRT stations, up to eight disk drives, and multiple printers. In larger configurations, an expansion chassis option is required. The disk controller included with the basic system accommodates four drives; an additional controller capable of accommodating up to four more drives is optional. Each CRT station includes the necessary control logic. In addition, high and low-speed data communications interfaces are available.

MASS STORAGE

DSK5 DISK DRIVE: This unit is the DEC RK05 DECpack system. Each drive stores 1.6 million 12-bit words (3.2 million 6-bit characters) on a single, removable, front-loading, IBM 2315-style cartridge. There are 200 data tracks plus 3 spares on each surface. Data is recorded in 16 sectors of 256 words each per track. Head movement time is 10 milliseconds for a single-track move, 85 milliseconds for a maximum 200 track move, and 50 milliseconds average. Rotational delay averages 20 milliseconds. Data transfer rate is 120K words per second. The drives are manufactured by DEC.

INPUT/OUTPUT UNITS

See the Peripherals/Terminals table.

COMMUNICATIONS CONTROL

LOW-SPEED ASYNCHRONOUS: Permits interfacing a CB-100 system to the Western Union TWX network or the public telephone network. Transmission is asynchronous at 100 to 1200 bps. Complete software support is provided, including automatic dialing using the AC210 Autocall Adapter. This facility is primarily intended to communicate picking and shipping information to warehouses located remotely from the CB-100 site.

CM203S SYNCHRONOUS DATA COMMUNICATIONS CONTROLLER: Consists of a DEC synchronous data set controller, redundancy check option, and real-time clock. Transmission at up to 4800 bps is supported in a half- or full-duplex mode. Line protocol is IBM Binary Synchronous, permitting communications with a wide range of computer systems and terminals. In general, this facility is supported by software to transmit data stored on disk to a central facility during off-hours; on-line, interactive communication with a host processor is not supported.

SOFTWARE

The extensive software of the CB-100 is divided into an operating system, two language processors, a sort/merge

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PERIPHERALS/TERMINALS

MODEL	DESCRIPTION & SPEED	MANUFACTURER
PRINTERS		
CB105	Matrix printer, 132 columns, 64-character set; 165 cps	Centronics
CB107	Line printer, 132 columns, 64-character set; 300 lpm	Dataproducts
TERMINALS		
CB302	CRT display/keyboard, 1920 characters, 80 characters by 24 lines, 64-character set, 10-key numeric pad, scroll; 4800 bps	Infoton Vistar
CB104	LA36 DECwriter, keyboard/printer, 132 positions; 30 cps	DEC

users indicated that additional systems were either being installed or were on order. System sizes ranged from one display station up to eight display stations. The average system represented included about four CRT's and one or more printing terminals. Several of the systems rated were installed in foreign countries. The users had had from six months to three years of experience with the Codon systems. The CB-100 systems replaced a wide variety of approaches, including service bureaus, unit record equipment, manual methods, and an on-line CRT arrangement.

A summary of the users' ratings is given below.

	Excellent	Good	Fair	Poor	WA**
Ease of operation	3	1	0	0	3.8
Reliability of mainframe	3	1	0	0	3.8
Reliability of peripherals	1	2	1	0	3.0
Maintenance*	1	3	0	0	3.3
Technical support	2	1	1	0	3.3
Software	4	0	0	0	4.0
Ease of conversion	2	1	1	0	3.3
Overall satisfaction	2	2	0	0	3.5

* Maintenance was performed by DEC in all cases, including foreign countries.

**Weighted Average on a scale of 4.0 for Excellent.

The above ratings clearly indicate the very positive feelings of these users about their systems. Usually, they also mentioned that their initial installations were not nearly as smooth as the later ones. All of the users had their maintenance performed by DEC; they were generally satisfied with the DEC service, except in a few foreign locations with the non-DEC CRT station.

One user was using his system over 20 hours per day, 7 days per week, a tribute to its durability. Another, with two 8-terminal systems, was "amazed at the volume of work the system could produce." Typically, the users felt that while no experienced data processing person was required, a trained operator was needed to handle printer forms and other system-oriented functions.

Several users commented on the intricate procedures required to recover from error or down conditions. One user dumped his disks four times a day (requiring, however, only three minutes) to provide a restart capability.

utilities section, a program development system (PS/8), and applications software specialized for the distribution function and each customer's requirements.

OPERATING SYSTEM: Comprises the routines necessary to implement and govern all system operations. It includes the following elements: Re-entrant Multiprogramming Monitor, Utility Routines, Scheduler, Core Allocation Supervisor, Device Allocation Program, I/O Supervisor, Disk Handler, Application Interface Routines, and Disk Error Recovery Routines.

The monitor controls peripheral device utilization and forestalls clashes in their operations. It also provides program exits to protect file integrity and prevent operator/system error and ambiguous file accesses. A partition of core memory adequate to accommodate the largest possible overlay associated with the required application functions is allocated to each operator.

The only nonconversational functions are disk dumps and major sorting operations, which are normally performed on a once-daily or once-weekly basis. Individual files are sorted before printing to preclude interaction with other system operations. Daily transmissions, even when conducted concurrently with local keying, also do not disrupt other system operations.

Additional useful features of the operating system include:

- Direct File Access–CRT terminals can simultaneously access and modify any number of files and the records within these files. Up to 26 million characters of on-line file data are directly available.
- Security–Disk control software can detect access errors and recover valid data. Only one operator can modify the same record at the same time. If necessary, each operator can be assigned a set of passwords or a table of acceptable employee numbers that give access to the system and prevent unauthorized access. Each application program can contain certain provisions that protect individual files from illicit access or modification.
- Data Entry–Input is entered in a conversational mode so that the operator can check and correct data as it is entered. Value checks enable input data to be checked for content and magnitude. If a table lookup is required, the pertinent data is not only found but also displayed on the CRT screen for operator verification.
- Input Editing–The following edit checks can be performed on input entries: numeric-only fields, alpha-only fields, check digits, field boundary checks, mandatory entry and completion fields, range checks, zero balance, data emitting, right and left justification, data correction, and other, user-defined checks.

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The Codon system, like other turnkey systems Datapro has analyzed, requires careful attention from the user during the system design phase even though the user does not do the programming himself. The result, you might say, is only as good as the input specifications. Codon provides senior analysts with distribution expertise to assist the customer in preparation of the system specifications. Nonetheless, one Codon user put it very succinctly: "If you do your homework, you're OK."□

- Disk Files–File accessing is accomplished by a modified index-sequential method or by directly accessing a specified record number. Single or multiple sets of file keys can be used to facilitate accessing a master file of records. This method is said to reduce search time and also to reduce the need for a "house-keeping" cycle to once a week or even once a month.

LANGUAGES: Codon offers two language processors: RPG-8 (Report Program Generator) and DEAL (Distribution Extended Assembler Language). RPG-8 is a report program generator similar to IBM System/360 RPG; this language is utilized simply by filling in parameters on preprinted forms. Users with programming experience can employ DEAL to modify and/or add to their Codon installation as desired. DEAL includes DEC's PAL-8 assembler augmented with commands, data editing facilities, and processing operations relevant to the Distribution Management System.

SORT/MERGE: These special utilities are provided:

- Housekeeping–Checks file sizes, directories, and available filing space before initiating the sort; then sorts all disk files in one operation.
- Interactive Sort–Creates a temporary file in which records are sorted in accordance with various key fields for the convenience of the operator.
- In-Line Sort–Processes open orders and fillable back orders to create multiple output sequences in accordance with the user's needs.

APPLICATION SOFTWARE: Codon has developed a large array of basic programs to meet the requirements for a general distribution system. These typically serve as the basis for the custom software for each customer. The following paragraphs described a typical program set.

The *Order Entry* module provides automated assistance to the order entry clerk. Entry is performed in an interactive entry/response mode. Specific functions include initial input of customer order data, validation of input data, credit checking, pricing, adjustment of inventory levels, and preparation of picking and truck loading documents. Verification of shipments is accommodated.

The system and the operator work together. For example, the system "asks" for each item of information as it is required. When changes in orders are necessary, computerized assistance is provided. A separate *Order Change* module allows the operator to modify portions of an order without deleting or rewriting the entire order. The required changes are not only made in the open-order file, but a notation in the transaction file is also inserted and a complete audit trail of the change is therefore available.

The *Inquiry* module displays item prices, determines stock status, and displays in-process order records as well as customer credit information and order status at the operator's request.

Order Picking and Shipping products a sequenced picking list to aid in the selection of warehouse merchandise for movement to the shipping area. A variety of picking list formats is available, according to the demands of the application. From the weight entered for each item to be shipped, the correct weight for each order is calculated and entered on the bill of lading. In many cases the Codon system can automatically determine the correct number of cartons or packages.

The *Credit* module prints credit memos and makes necessary adjustments to accounts receivable files and/or warehouse inventory files.

Customer Billing is flexible to permit numerous decisions and alternatives. The proper invoice format is accessed, prices, taxes, and freight charges are calculated, and entered data is organized accordingly. Each item is called for by the system, and the operator can readily respond.

The *Receipts* module posts stock as it is received to the inventory file of the system. This module also informs the receiving clerk where the new stock is to be stored. Receipts are posted against open requisitions to check for delivery errors as well as to validate entries made by the receiving clerk. Audit totals insure correctness.

Back Orders are accumulated when received. Transmission to another location is made when the back order is for an item held by a regional or central warehouse. Whenever pending back orders cannot be filled automatically from newly received stock, the Back Order List program prints out the net stock quantity and the back orders. Overriding of the system when required is possible.

The *Accounts Receivable* option enables cash receipts to be posted to customer accounts. The computer helps in determining which invoice to credit, and it checks discounts, applies partial payments, and processes accounts based on credit memos and the like in accordance with specified procedures. The Cash Receipts Worksheet simplifies the posting of cash received to accounts receivable by assembling all necessary reference information on the CRT terminal screen. Open and partially paid invoices are displayed. Other reports, such as Credit Limit Exceeded and Accounts Receivable Aged Trial Balance, are available. Monthly customer statements are generated automatically by the system for all open accounts. Each statement shows all open invoices for the new month, as well as partial payments credited to date.

File Maintenance programs automatically check data validity and search for and prevent duplication of records when new records are entered in the system. These special programs are intended to prevent operator errors from impacting the files. For audit trail and error recovery purposes, transaction records are created for each modification.

PRICING

The Codon CB-100 system is offered for sale only. Maintenance is provided by DEC through its nationwide service organization. Leases can be arranged through a third party. DEC maintenance costs can be found in Report M11-384-101. The only non-DEC component in a Codon system is the CRT terminals, which DEC has agreed to maintain. The costs of a Codon system can be divided into two parts: the hardware, which includes a license for system software; and customized applications software. Hardware costs are outlined below. The typical cost for applications software can range from $40,000 to $200,000 but this cost applies only to the first system in a multi-system order. The hardware costs below include installation and training, but the customer must pay shipping costs.

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Under special request, other standard DEC peripherals such as magnetic tape drives can be included in a Codon system. The cost is usually 15 to 20 percent higher than the DEC price given in Report M11-384-101, and includes software, engineering, installation, and training support.

EQUIPMENT: The following typical systems include all controllers and adapters and a license for the Codon system software, but no allowance for applications software.

SMALL TWO-CRT SYSTEM: Includes PDP-8 processor with 16K words, two CRT display stations, two 3.2-million-character disk drives, a teletypwriter console, a CB105 165-cps printer, a CM203S Synchronous Data Communications Controller, and a license for the system software. Purchase price is $75,500.

MEDIUM FOUR-CRT SYSTEM: Includes PDP-8 processor with 24K words, four CRT display stations, four 3.2-million-character disk drives, a teletypewriter console, a CB105 165-cps printer, a CM203S Synchronous Data Communications Controller, an EXP401 Expander Chassis, and a license for the system software. Purchase price is $99,990.

LARGE SEVEN-CRT SYSTEM: Includes PDP-8 processor with 32K words, seven CRT display stations, an additional disk controller, six 3.2-million-character disk drives, a teletypewriter console, a CB107 300-lpm printer, a CM203S Synchronous Data Communications Controller, an EXP401 Expander Chassis, and a license fee for the system software. Purchase price is $134,170.■

EQUIPMENT PRICES

		Purchase Price
CB-100	Basic System; includes DEC PDP-8 processor with 16K words, one CRT display station, controller for four disk drives, two 3.2-million-character disk drives, teletypewriter console, and a license for the operating system and language processors	$62,000
MEMORY		
CBM02	8K-word memory module	3,000
MASS STORAGE		
CM1	4-drive controller (for 5th through 8th drives)	3,360
DSK5	3.2-million-character drive	6,120
PRINTERS		
CB105	165-cps matrix printer	6,740
CB107	300-lpm line printer	11,880
TERMINALS		
CB302	CRT display station	3,480
CB104	LA36 DECwriter	3,320
COMMUNICATIONS		
CM203A	Asynchronous Data Communications Controller	1,150
CM203S	Synchronous Data Communications Controller	3,280
AC210	Autocall Adapter	3,340
CABINETS		
EXP401	Expander chassis	2,290