On-Line Sales Recording System

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Introduction

THIS PAPER presents an equipment description of a pilot on-line Sales Recording System currently in operation for the Associated Merchandising Corporation as part of a research project. This pilot system comprises point-of-sale units connected to a central computer by means of an Input-Output Buffer Unit. The operating characteristics of this system are such that they may be extended to include, for example, inventory and production control, and the handling of transportation reservations.

Operation of the pilot unit which started in April, 1957, has continued with highly satisfactory results. The Sales Recording System has maintained an average "up-time" record of over 97 per cent for the past nine months.

Sales Recorder

The point-of-sale unit or Sales Recorder (Fig. 1) consists of a keyboard for manual input, in combination with a character display, and a procedure indicator. There is a punched tag reader for automatic input of the sales person number, customer number, and merchandise stock number. An output printer provides for a three-part sales check at the point of sale. The entire unit is packaged over a cash drawer and is contained within a vented aluminum housing, which opens completely for servicing.

The keyboard (Fig. 2), is of the type commonly referred to as a ten-key keyboard. Actually, it consists of fourteen keys—ten numeric and four control keys. The four control keys are: Enter, Nonmerchandise, Clear, and Total; they allow the operator to control the procedural input to the machine.

The keyboard is designed to provide both manual and electrical interlocks. When one key is depressed, another key cannot be depressed, and two keys cannot be depressed at the same time. The actual depression of the key is only for the first position of the key stroke. From that point on, the key is mechanically pulled down, and is held down until the Input-Output Buffer Unit has recognized the character being input as a legitimate one. When this routing is complete, the key is allowed to return to its normal position. Each time a numeric key is depressed, that number is shown in a lighted character display window of the point-of-sale unit. In this manner, a sales person can verify any item prior to striking the Enter key, which clears the display.

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Fig. 1—Sales Recorder.

Fig. 2—Sales Recorder controls and indicators.

The output of the keyboard is four bits with parity. These five bits, plus an additional control bit, are the information levels sent to the Input-Output Buffer. Operation of the keyboard can be at the sustained rate of six characters per second.

The procedure indicator provides a visual indication to the operator of where in the procedure the operator should be at any given time during input of information to the Input-Output Buffer. The indicator consists of a plastic engraved drum driven by a stepping switch. The drum advances one step each time the Enter key is depressed. Upon depression of the Nonmerchandise key, the drum advances to the nonmerchandise field. Upon depression of the Total key, the drum advances to its original start position.

The punched-tag reader was designed to accept the twenty-five column, Dennison tag, or abbreviation of it. When a sales person or customer number tag is read, the tag is returned after read-in, so that it may be retrieved by the operator. In the case of the merchandise tags, however, the tag is read and retained in the machine, which prevents littering the counter with merchandise tags. Since all of the tag information has been recorded on magnetic tape, the merchandise tags may be removed from a bin and discarded at the end of the day. The first character of any tag indicates which of the three types it is and if the wrong tag is inserted, the logic of the machine is such that the tag reader stops, and the Clear key must be depressed in order to retrieve the tag. The tags are read one step or character at a time, 7-1/2 characters per second. Again, as in the keyboard, the tag reader stops in a reading position and the output is verified as a valid binary number, prior to advancing to the next reading position. An electrical interlock between the tag reader and the keyboard prevents keyboard operation when a tag has been inserted in the reader. The actual reading of each character on the tag is accomplished by "sensing" the tag with five pins so connected through linkages as to actuate switches in the presence of holes.

When the Total key is depressed, the Sales Recorder is placed in the output mode causing the cash drawer to open and allowing the print-out of the sales check to begin. However, in a credit type sale, if the purchaser did not have a good credit rating, a Hold button will light, providing a bad credit indication to the operator, and preventing print-out. Print-out will proceed if the operator presses the Hold button.

The same mechanism that provides the character display for the keyboard is also the principle portion of the output printer. The output printer consists of ten numerical print wheels fabricated from nylon. These wheels are set up sequentially directly from the information sent by the Input-Output Buffer Unit. When a line of print has been set up, a print platen is released, the line is printed, and the paper advances to the next print position. The speed of this operation averages about six characters per second. An automatic overprint provides a visual indication on the check for credits or C.O.D. transactions.

The paper used consists of a three-part sprocket-fed preprinted form. The first copy is obtained through an ink ribbon impression and the back copies are carbonless paper, and require no ribbon for printing. Since the form is preprinted, the paper feed machanism is programmed in conjunction with the printer so as to print only in the correct blocks or spaces on the check and not in the preprinted portions.

The printer, keyboard, and tag reader are all separate

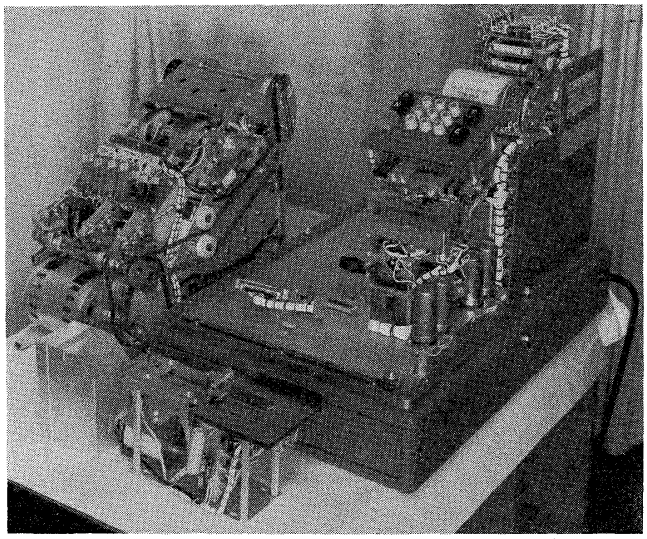

Fig. 3—Partially assembled unit with the Procedure Drum and keyboard in place and the tag reader and printer shown separately.

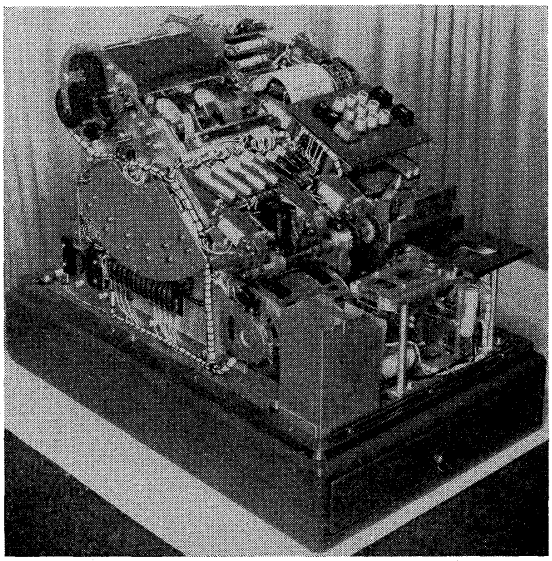

Fig. 4—Complete assembly with the cover removed.

units that plug into the base assembly. Fig. 3 gives an exploded view of the Sales Recorder while the complete assembled unit is shown in Fig. 4.

Buffer

The Buffer Unit is a multiplexing device which allows the transfer of data to and from as many as ten Sales Recorders. Working on a time-sharing basis, the buffer permits independent operation of each Sales Recorder. A block diagram of the Buffer Unit is shown in Fig. 5.

The communication between the Sales Recorder and the Buffer Unit consists of information flow within a closed loop.

At both receiving ends of the loop the character is checked for parity errors. If wrong parity is sensed, the character is rejected and an error displayed at the Sales Recorder. The keyboard of the Sales Recorder remains locked until the error is cleared. As mentioned earlier, the return of the correct character from the Buffer Unit to the Sales Recorder unlocks the keyboard so that another character may be entered. This double check, together with the relatively high power used in the transmission and the low impedance at both ends, makes the system very reliable from the point of view of the data exchanged, and insensitive to noise and crosstalk.

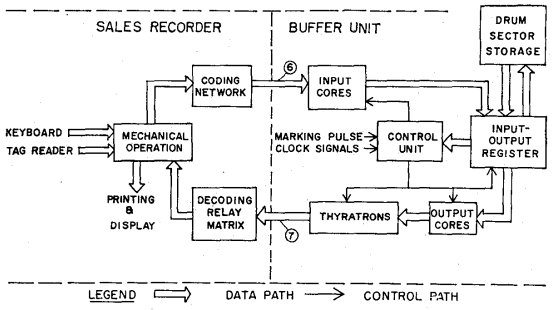

Fig. 5—Block diagram of the Buffer Unit.

The two information trunks are actually contained in a single cable that connects each Sales Recorder, via a junction box, to its designated input terminal at the Buffer Unit. To best describe the functioning of the Buffer Unit, its operation will be divided into two modes:

1) Input: receiving information from the Sales Recorder—or entering transaction data, and
2) Output: sending the processed information to the Sales Recorder—or the printing of the sales slip.

Let us consider the input mode. The 6-bit binary character in the form of voltage levels created by either depressing a key or reading a character from a tag in the tag reader is transmitted by cable directly to the input magnetic core bank. (See Fig. 5.) There is a bank of input cores associated with each Sales Recorder. The cores serve the dual function of noise suppression and gating.

Also associated with each Sales Recorder is a portion of a magnetic drum called a sector. That part of the drum containing all the sectors is designated as the Sector Channel. Each sector has a storage capacity of 360 5-bit characters. The sector is divided into preassigned fields corresponding to 1) the items listed on the Procedure Drum for input information, and 2) those items required for output information. These variable fields, once established for the desired application, are fixed in length. Thus, for instance, there is a three-character field for the sales person number. If insertion of a fourth digit is attempted, the Clear light at the Sales Recorder will light, indicating that the capacity of the field has been exceeded.

A special indexing track on the drum, called the Marking Pulse Track, provides the indexing mark within each sector to indicate the location of the character last operated on and the field starting position.

A magnetic core shift register in synchronism with the magnetic drum provides a read-out pulse that transfers the information from the input cores to the Input-Output Register at the time that the sector associated with the respective Sales Recorder is accessible. Since the arrival of the information from the Sales Recorder is asynchronous with respect to the read-out pulse, core logic is provided to assure that a complete character is actually placed in the Input-Output Register. Once in this Register, the information is checked for parity, and if an error is sensed an error control flip-flop is set.

If a numeric character is present, it is written on the sector at the location specified by the marking pulse. However, if the character in the register is one of the six operational commands, the matrix in the control unit is activated, so that the specified command level is generated. These command levels enable their related logic to perform the required function. In either event, a parity error prevents the processing of the character in the register.

The information transferred at the start of the sector cycle remains in the Input-Output Register for a time interval equivalent to a sector period, approximately 4.1 msec. All operations pertaining to the character received are executed within this period. Therefore, it is the Input-Output Register that is being time shared, allowing the sequential sampling of information in each input core bank.

Clock signals are provided so that synchronous timing with the magnetic drum occurs.

Just prior to clearing the Input-Output Register, near the end of the sector period, the contents are transferred to the output core bank. If the error control flip-flop was set, the Input-Output Register is cleared before the contents are transferred, so that the output core bank contains all zeros. Shortly thereafter, the information is read out of the cores to fire their associated thyratrons, thus forming the return character which activates the decoding relay matrix in the Sales Recorder. This in turn terminates the transmission of the character to the Buffer Unit, and

also extinguishes the thyratrons by removing their plate voltage. As was the case for the input cores, there is a bank of output cores and thyratrons associated for each Sales Recorder.

The information levels transmitted by the Sales Recorder remains present for several complete auxiliary memory cycles, about 130 msec, at which time an error indication is made, unless the correct character echo is returned earlier. Since all zeros are returned to the Sales Recorder when parity error is detected, the information transfer is not interrupted. Therefore, a second or third chance is afforded to correctly process the transmitted character, and thereby minimize the possibility of transient errors stopping the operation.

Let us now consider the output mode where information is being printed on the sales slip. In the output mode, the information to be transferred to the Sales Recorder originates from the sector storage. However, a character is only transmitted when a request for information is made by the Sales Recorder, and then only one character is transferred per request. The buffer, in processing this request, will allow a character in sequence, as indicated by the marking pulse, to be transferred from the respective sector to the input-output register. Once in this register, it can be read into the output cores and the thyratrons fired in much the same manner as is done during the input mode.

The central computer processes a transaction only if the input of data from a Sales Recorder has terminated. This is signified by a total symbol entered at the beginning of the respective sector when the total key at the Sales Recorder is depressed. Before the buffer can respond to the Sales Recorder's request for a character, the processing of its associated sector by the computer must be completed. After the central computer has signaled that this processing is completed, it has no further control over the respective sector.

The seventh line in the output trunk furnishes the overprint level to the Sales Recorder. Another thyratron per Sales Recorder is provided and operated by a special control flip-flop. This control storage is activated by a program controlled character coming from the sector storage.

Each sector may be in a different operational state at a given time independent of one another, and thus there is no interference or interruption of communication between a Sales Recorder and its associated sector storage.

Recorder Central

The central computer, referred to as Recorder Central, is a general-purpose internally programmed digital device with a fixed order code. As shown in Fig. 6, it comprises a magnetic drum, an arithmetic unit, a control unit including a clock and control pulse generator, a small high-speed magnetic core memory, and an operator console to provide program and operator control. The magnetic drum contains, in addition to the sector channel, a random access stock and credit reference file, the program storage, the work space for transaction processing, and the necessary timing tracks. The small high-speed memory of twenty-character capacity is used for all operations, except transfers within the drum.

The computer is a one-address, variable word, numeric machine. An instruction word consists of an order code of two characters, and an address area consisting of four characters. The order code was specially designed to facilitate file processing as well as rapid calculation. The order code contains instructions for communication between a Sales Recorder sector and the computer, arithmetic computations, decision and control operations, file processing, and console input and output via paper tape and monitor printer.

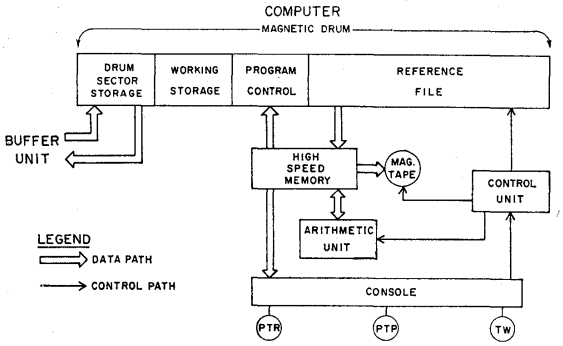

Fig. 6—Block diagram of the Recorder Central.

Upon recognition of the Total symbol by the computer, the entire contents of that sector are transferred to the working storage. The sequence of words and their positions within the sector remain the same. Thus, transaction processing requires a minimum of editing and rearrangement for output printing.

The input data in the working storage is analyzed to determine how the transaction is to be processed. If the transaction requires the verification of a customer's credit, the customer's charge number is processed against a credit exception file. All stock numbers are passed against the stock reference file to determine price and city, state and federal tax information. These data are obtained for all merchandise items sold in the transaction. Prices are extended, subtotal and total calculated, and required information listed for printing on the sales slip, after which the contents of the working storage are written out to the transaction record magnetic tape. After receiving a check signal from the tape station, the information in the working storage is then transferred to the respective Sales Recorder sector and the Input-Output Buffer notified that transaction processing is completed.

To determine the beginning and end of the variable sized items on the drum processed by the Recorder Central, item markers are used. The working storage can be changed in

layout to represent any kind of sales check or business form corresponding to the Sales Recorder sector layout. The ability to vary the reference storage message sizes to conform to variable word requirements allows great efficiency to the use of the drum.

Access to the file storage is hastened by avoiding long indexing searches. Messages within the file may be either extracted, deleted, changed, or added, by separate orders. Variable sized criteria may be used with these instructions to extract desired information. Thus, one may be interested in all swim suits, in all bikini swim suits, in all bikini swim suits with blue polka dots, by adjusting the criterion accordingly.

To gain access to the desired data of a message, a mathematical transformation on the criterion of the message is used. This allows minimum delay in locating the messages and thus speeds up over-all transaction processing. More important, however, by avoiding the use of indexing routines, messages can be entered into the reference storage or extracted from it without the requirement of prior sorting and collating. Thus, the problems of file maintenance are considerably simplified and external processing is appreciably reduced.

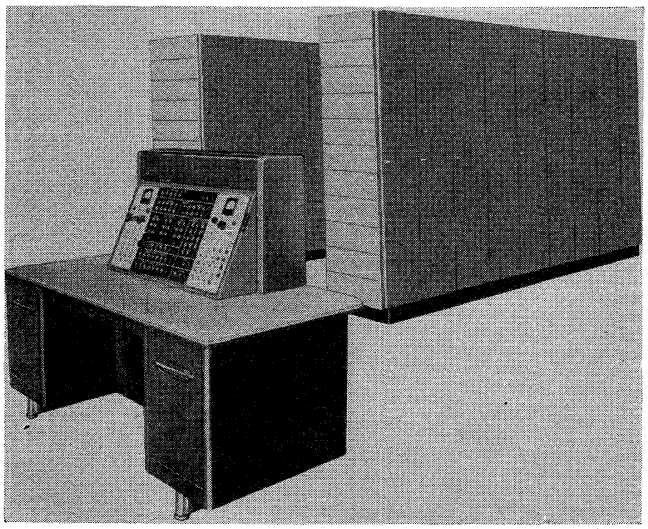

Fig. 7—Recorder Central and Input-Output Buffer Racks with console and power supply.

The control console may be used to monitor system operation or to provide means for manual control of the Recorder Central. A view of the Recorder Central is provided in Fig. 7. All control flip-flop indicators in the machine are displayed as an aid in maintenance and program debugging. All areas of the computer may be interrogated from the console. Information can be introduced either manually or by means of paper tape. A monitor printer is provided for printing the contents of the high-speed memory or any portion of the auxiliary memory when desired. Marginal checking facilities are also controlled from the console.

All transaction processing operations are carried out automatically. If information concerning daily transactions is required at any time by the Electronic Data Processing System the current transaction record magnetic tape can be remotely disconnected, and a new tape connected, by the Sales Recording System.

The Recorder Central contains many built-in checking features. Redundancy checking is used throughout the equipment to determine errors in transmission of characters and to isolate their sources. Arithmetic operations are repeated and results compared. Orders are checked before they are carried out. These, among others, are designed to insure against incorrect processing. However, in a system used for on-line processing the ability to maintain continuous operation is of paramount importance. Thus, the Recorder Central is designed to attempt to overcome any error a fixed number of times before it will stop operation. This will discriminate between transient errors and those due to catastrophic breakdown. In the latter case, a complete set of machine status indicators is available at the console, specifying exact portions of an order in which failure had occurred for ease and rapidity of maintenance. Plug-in type module construction is used to facilitate troubleshooting, preventive maintenance, and replacement in case of failure.

Conclusion

The Sales Recording System represents a great step forward in providing the means for data integration within a department store. The Associated Merchandising Corporation's research installation has demonstrated beyond a doubt that on-line Sales Recording systems are a reality. Here, for the first time, a variety of transaction types, as broad as the store desires, may be processed directly from a point-of-sale unit, with complete computation performed by a fast, accurate, and versatile high-speed computer, including an automatically printed sales slip.

But more than this, the point-of-sale unit can be used to either interrogate the reference file and thereby gain immediate access to any desired information, or actually enter new reference information, directly from its remote location.

It is important to note that this information need *not* be in any ordered form. Furthermore, a magnetic tape record, made for each transaction entered, provides a direct and reliable means of furnishing the information to an Electronic Data Processing System for data handling. The Electronic Data Processing System can have access to the magnetic tape at any suitable time without interrupting transaction processing by Recorder Central.

Acknowledgment

The authors wish to acknowledge the contributions of Albert Burstein, Edward Damerau, Robert Grapes, Andrew Ling, and Felipe Tanco in preparing this paper.

Discussion

J. T. Wallace (Eastman Kodak Co.): Is the Dennison tag reader available separately and what is the general means of reading the tag?

Answer: Yes, it is. The reading is accomplished by pins going through the holes and consequently making switches.

N. J. Dean (Ramo-Wooldridge Corp): What is the capacity, speed, and form—tape, drum, etc—of the random access reference file?

Answer: The random access reference file which is a portion of the drum has a capacity of approximately 72,000 characters. The speed is approximately 1500 rpm with a character rate of slightly less than 100 kc.

Question: How many characters in a complete transaction? If more than one, is the entire message buffered before presentation to the computer?

Answer: There could be up to 360 characters. That is the full capacity of a sector, there being 10 sectors for the sector storage.

The normal transaction will have a smaller percentage and therefore the sector capacity was laid out so that you could process a maximum of five merchandise transactions and five nonmerchandise type transactions per sale.

An entire message is retained in the sector until the "Total" indication has been given. At this time, the complete sector is transferred ino the "Working Storage."

Mr. Dunham: Do the marking pulses and clock signals originate from the magnetic drum?

Answer: Yes.

Question: Will this point-of-sale unit include customer billing?

Answer: Ultimately it could, by providing all the necessary information to an Electronic Data Processing System.

Question: How do you plan to handle the sales slip; namely, is a copy to be returned to the customer—a generally accepted billing practice?

Answer: One copy of the sales slip is given to the customer at the time of purchase. The other two are retained by the store; one to be included with the monthly statement for charge sales, and the other for record purposes.

Question: I would like an idea of the general size and cost of a complete system for a medium size department store.

Will one computer handle any number of sales recorders? How many pieces of intermediate equipment are required?

What provisions would be made for leaving an alternate means of recording sales in the event of computer failure for even a short time during the day?

Answer: For cost figures our sales department should be contacted.

The number of Sales Recorders that may be handled by a single computer is a function of the computer handling rate as well as the random access rate to the reference file.

A paper tape punch could be used as a stand-by unit to capture the required information for future data processing, while the sale may be handled by normal sales book method.

Question: What is the expected cost on each point-of-sales recorder?

Answer: For cost figures our sales department should be contacted.

Question: Do you intend to use telephone lines to connect a remote point-of-sales recorder to files and computer?

Answer: Long-distance hookup, that is, beyond the confines of a store, has not been considered as yet.

Question: How many point-of-sales recorders can be attached to your system?

Answer: The system is a pilot system, and therefore provision for only ten Sales Recorders was made.

Question: What is the maximum number of input-output units you can couple to the described system?

Answer: For this pilot system, thirty Sales Recorders were set as the maximum, and still maintain an average transaction rate of one a minute with an average queueing rate of one second for the transaction processing.

Question: What provisions are made for multiplexing or sequencing between the many point-of-sale units and the central computer?

Answer: Each Sales Recorder has a sector allocated to it. When the sector comes under the read heads, the associated Sales Recorder will receive information if it's in the output mode or furnish information if it's in the input mode.

Question: Can a department store economically justify the use of these Sales Recorders?

Answer: This is a question for the individual department store to answer.

Question: How much time is required to process a transaction at the point of sale? Did you find that this time requirement was in any way objectionable to the customer?

Answer: The transaction time varies with the data to be entered, of course. However for average length transactions a rate of less than one minute per transaction may be sustained. This was found to be in no way objectionable to the customer.

Question: If the point-of-sales unit can enter new reference information, as on credit, can a customer operate one point-of-sales unit in the absence of the salesman and thus improve his credit rating prior to making a large purchase?

Answer: No. Although special coding is provided to allow entry of data from the Sales Recorder, it requires a knowledge of the code (nonmerchandise code) and a special sales person number. Adequate programming checks are provided to accomplish this.