University of Mississippi
eGrove

Haskins and Sells Publications | Deloitte Collection

1958

Recent developments in data processing

Paul W. Pinkerton

Follow this and additional works at: https://egrove.olemiss.edu/dl_hs

Part of the Accounting Commons, and the Taxation Commons

Recommended Citation
Haskins & Sells Selected Papers, 1958, p. 359-372

This Article is brought to you for free and open access by the Deloitte Collection at eGrove. It has been accepted for inclusion in Haskins and Sells Publications by an authorized administrator of eGrove. For more information, please contact egrove@olemiss.edu.

Recent Developments In Data Processing

By Paul W. Pinkerton
Partner, New York Office

Presented before the Delaware Accountants Association, Wilmington—April 1958

WHENEVER I do that, or see it done, I think of the two good friends who had been engaged in good natured kidding about each other's religion for many years. Finally they agreed that as intelligent men they should at least attend service at each other's church. On the next Sunday they attended Mass together at the Catholic's church. They sat in the back, and all during the service the Catholic explained in whispers the significance of the various parts of the ceremony. The Sunday after that, they attended the Baptist church, where the Protestant worshipped. Again they sat in the back and the Protestant explained in whispers the significance of the different parts of the service. When the lights in the sanctuary were turned off, the minister stepped up to the pulpit and took off his watch, just as I did, and placed it before him on the rostrum. The Protestant said nothing so the Catholic leaned over and whispered, "What does that mean?" The Protestant whispered back, "That doesn't mean a damn thing."

GROWTH OF BUSINESS DATA PROCESSING

In the last few years we have witnessed a tremendous increase in mechanization of the office. Many factors have contributed to this increase. We have all seen or heard the figures representing the growth in the number of clerical employees, both in absolute terms and relative to the number of factory workers. It is popular to blame government for part of this increase and to attribute the rest to management's need for a paper substitute for direct observation and to the lag in improvements in office machinery. It is easy to overlook the startling growth in service industries, such as insurance and banking, the advances in management techniques that require clerical activity in the interest of additional profits, and the need for accounting for the sharply expanded volume of credit, both personal and commercial.

The increase in clerical costs has occurred over many years. What was the spark that ignited the sudden interest in mechanization? Perhaps it was the application of electronics to the processing of data that has focused attention on the problem which has been growing for so long? Executives once content to leave such matters to office managers, chief clerks, and others directly responsible are now becoming aware of the office operations and are insisting that something be done in their own companies, or at least they are watching intently to see what is being done.

ELECTRONIC EQUIPMENT

Developments relating to business data processing have been coming rapidly in recent years. The most talked-of advance is electronic data-processing equipment. Five or six years ago we heard some talk about electronic brains, and some groups were seriously considering how electronics might be applied to commercial problems. Progressive companies were utilizing every newly developed punched-card machine and were pressing for more. But the electronic computer, which had performed wonders in the fields of science, engineering, and logistics, was not yet thought of as an accepted office tool. Four years ago it was thought that there might be 50 companies large enough to use a large-scale electronic data-processing system, such as the Univac. There are now at least 250 large-scale systems in operation, and the rate of deliveries to users is increasing. The medium-scale equipment is being put to use even faster, as might be expected. Over 1,000 of *one* medium-scale punched-card electronic system have been delivered.

INTEGRATED DATA PROCESSING

Another development that may be of even greater significance than electronic data-processing equipment, especially in smaller and medium-sized organizations, is integrated data processing. While the concept of IDP does not necessarily depend on certain types of equipment, the desire to integrate the processing of data has resulted in the development of considerable new equipment and in increased utilization of some old equipment. These developments in turn have focused attention on the possibilities of further integration. *Integrated* data processing and *electronic* data processing are closely related, in that EDP is a highly developed application of IDP.

MOTIVATING FORCES

Accountants are interested in these new developments in data processing for many reasons. Basic, of course, is the need to take full advantage of equipment that will make accounting and record-keeping more efficient. Also, the adoption of radical types of new equipment and the accompanying changes in procedure and organization create a demand for careful consideration of their internal-control aspects. And to the internal auditor and the public accountant comes the problem of applying auditing principles in developing new techniques for the verification of financial statements and transactions.

But these are more or less routine matters. More intriguing than increased efficiency in record-keeping is the prospect of obtaining substantial improvement in the effectiveness of management. A new management tool has come into being. Noteworthy progress in business planning and control is being achieved. Stimulated by the possibilities of an electronic system, methods are being found to better evaluate future trends and conditions. The application of this new equipment in the area of planning and control is not outside the realm of the accountant. We are all aware of the expanding rôle of the accountant as an essential member of the management team through the controllership concept, and the expanding rôle of the CPA as an advisor to management. The accountant who is playing this expanding rôle is in a logical position to take the lead in the fullest utilization by management of its new tools, and thus in carrying accounting further along the road from *record-keeping* to *profit-making.*

NONELECTRONIC APPLICATIONS

Let us see how these new developments are being used. I should like to look first at integrated data processing not employing electronic data-processing equipment, then come back to EDP.

A typical application of IDP ties together several operations related to shipping and billing of bulk chemicals. Upon receipt of the customer's order at a sales office, a punched tape containing the customer's name and address, shipping instructions and other fixed data is removed from a file and inserted in the tape feed of a typewriter which automatically types the heading of a shipping order. A punched tape, for each item ordered, containing unit price, standard unit cost, description, and various codes is next inserted in the typewriter. The typist enters the quantity of each item ordered by means of the keyboard—the only manual typing necessary, other than date and customer order number.

The completed shipping order is mailed to the plant. At the same time that the order is typed, the typewriter produces, as a by-product, a punched tape containing all the information typed. This tape is mailed to a central billing office, where it is converted automatically to punched cards. Upon receipt, from the plant, of a copy of the shipping order showing the exact weight and strength of material shipped, this information is marked on the product cards in the billing office. A mark-sensing reproducer punches these data into the cards. These product cards are then fed into a calculator which extends the item amount, taking into consideration the quantity, strength, and unit price. The item cost is also extended. The heading and product cards are then fed to a punched-card line printer for the automatic preparation of invoices. A total card, used for accounts-receivable accounting, is automatically produced on a summary punch during the preparation of invoices. The product cards are used for sales analysis, for inventory accounting, and for cost data.

In this entire processing the only information recorded manually relates to quantities ordered and shipped.

This example illustrates how the aim of IDP is accomplished largely through the use of punched tapes and punched cards that interconnect equipment by providing for automatic sensing or "reading" of recorded data, thus *avoiding* the manual entry of data into mechanical processing devices.

In our fascination with new things, it is easy to overlook the fact that in punched-card equipment we have had such a means for many years, and it has been very effectively used. What, then, is new about integrated data processing, besides the name? For one thing, new machines have been developed that produce, or can read, the paper tape used for so long in wire communication. In addition, there have been new developments in punched-card machines. But I believe the most important thing is the reason back of these new developments—and that is the increased attention focused on the processing of data. Part of this attention has come as a result of the study of electronic data-processing systems. By contrast with the operating speed of electronic equipment, the preparation of data for input seemed to be at a snail's pace. But we have also had increased attention on the problem apart from electronic equipment, mostly by a few large companies, as part of a scientific study of the needs of data processing.

Since we already had machines that could sense data automatically, the need was seen as one of making the *initial* recording as automatic as possible, and it is in this area that most of the progress has been made. One writer defines IDP as *capturing a business transaction in one operation as it occurs the first time and in such a form that the transaction can be processed automatically . . . the automation of source data.*

But writing the *source document* in a form that can be sensed by machines is not sufficient for integration. *Internal files* of various kinds should also be so expressed, since the processing of transactions usually requires the use of some information from these internal files in order to complete the source document. For example, the purchase order from the customer in my example might not contain standing shipping instructions, adequate products codes and descriptions, or sales prices. It obviously would not include cost information. Such cases are the rule rather than the exception.

The advantages of integrating the various operating steps are primarily *cost reduction, speed,* and *accuracy.* Speed and accuracy are of course important factors in improving customer service.

Various types of equipment are used in integrated systems—typewriters, calculators, accounting machines, punched-card equipment, and electronic devices and systems. Interconnection of equipment requires media acceptable to the machines in the system. The ultimate will be reached when machines are capable of sensing *printed* or *written* letters or figures at reasonable cost, and considerable progress is being made towards this goal. I believe, however, that the use of *codes* for letters and figures will be more common than character sensing. The codes may be expressed in the form of holes (as in punched cards or punched tape), magnetic spots, or spots that may be sensed photo-electrically.

ELECTRONIC DATA-PROCESSING SYSTEMS

The most far-reaching development in the evolution of machines for integrating the processing of data is the electronic data-processing system, and I shall devote the remainder of this talk to electronic equipment. With punched cards and punched tape, we had media through which machines could communicate with one another to avoid the repeated copying of informaion and its manual entry into a machine through a keyboard. But even with integrated data processing we have (1) the physical handling of media between machines, and (2) the requirement that *exceptions* to the routine be separated for special handling. Electronic data processing eliminates these disadvantages to a considerable extent and provides other advantages.

Some have said that the office has lagged behind the factory in the use of machinery, and this is probably true. The prime aim of *factory* mechanization, however, was to replace the *muscle power* of the human. There is no such need in the office. The second aim of machinery was to transfer *skill* from the worker to the machine. This also was of more value in the factory, because of the greater possibility of standardization, reducing the need for judgment.

But in the areas of mental effort not requiring judgment, electronic equipment has much to offer in permitting the transfer of skill to the machine, reducing mental drudgery. It is, of course, unnecessary to say that these electronic machines do not think. How then do they eliminate mental drudgery? First, of course, they perform calculations at terrific speed. A large part of clerical activity consists of fairly simple decisions, based on observation. These decisions, in a large number of instances, if not most, require a choice between only two alternatives. And the decision is very often based on the size of numbers. The principle of the electronic machine as to this element is not complex. Since it can compute, it can subtract one number from another to determine if they are equal or, if not, which is larger. The result of the comparison automatically sets up circuits that determine further processing. As a simple example, take a social security tax calculation. The machine compares the previous gross pay with $4,200. If it is *greater* or *equal,* it proceeds without computing a tax. If *less,* a tax must be computed.

This ability to make elementary logical decisions is one of the principal characteristics of electronic data-processing machines. This ability, coupled with the internal storage of a program of instructions as well as data, gives the machines wide flexibility.

Blair Smith, of IBM, one of the foremost analysts in this field, has contrasted electronic machines and human beings by saying that humans are much slower and less reliable, but on the other hand are more flexible and can be produced by inexperienced labor.

When it was recognized, not too long ago, that electronics offered the ability to relieve the office clerk of routine mental activity, two possible approaches became evident. The first was in keeping with the usual pattern in office equipment. This approach resulted in the *general-purpose* system, capable of performing any assigned task. It is necessary only to introduce the required program into the machine—a simple operation, once the program has been designed. The same system can perform such diversified functions as payroll and paycheck preparation, inventory accounting, production scheduling, and sales analysis—as well as complicated mathematical problems.

SPECIAL-PURPOSE ELECTRONIC SYSTEMS

The second approach, not commonly used in the design of office machinery, results in so-called *special-purpose machines,* better described as *limited-application equipment.* As is quite common in *factory* operations, a machine is designed to perform only one or a very few functions.

Let me describe an electronic data-processing system called the *Magnetronic Savings Account System* designed by The Teleregister Corporation. I believe three of these systems are being built. The first one is to be installed at a local banking institution within a couple of months.

Suppose the system is already installed and accessible for inspection; let us see how it operates. Each teller has a keyset, which might make you think of a 10-key adding machine. It is similar to the Teleregister keysets that you may have seen at American Airlines or other ticket counters. A depositor can be served at any window. The teller "keys in" the account number, and the account balance is instantaneously displayed on the keyset. Then the amount of the deposit is keyed in and the deposit bar pressed. The amount of the deposit and the new balance are automatically posted to the passbook. A light on the keyset is turned on automatically if a previous deposit had been made without the passbook, which must now be posted. Another light is turned on if there is unposted interest. In these instances the passbook is brought up to date by inserting it in the keyset and pressing a *print deposit only* bar. This is done before a deposit or withdrawal is posted.

The procedure is slightly more complex for a withdrawal. When the account number is keyed in, a series of lights indicates the approximate amount of checks previously deposited that have not yet cleared, and the number of days remaining before such amount can be withdrawn. A *hold* condition is indicated by a light, and the transaction is referred to a special teller. Assuming no unusual condition, the amount of the withdrawal is keyed in and the withdrawal bar is pressed. The amount and new balance are automatically posted to the passbook—unless the withdrawal exceeds the balance, in which case a *reject* light goes on.

Where does all this information come from? It is all stored in code in the form of magnetized spots on the surface of a rapidly revolving cyclinder, called a magnetic drum. This drum is attached by wires to the keysets. The keying in of the account number sets up circuits to the appropriate place on the drum, and the information appears in a split second on the keyset. Deposits and withdrawals are recorded automatically on another section of the drum, and the new balances are determined by means of an arithmetic unit. The drum holds information on 170,000 accounts.

The system is not tied up except, first, to bring the balance and conditions to the keyset, and then again when the posting bar is pressed. The other tellers therefore are not held up, although at a busy time there might be a delay of as much as three or four seconds.

At the end of the day the transactions of each teller are summarized for balancing, and the balances on the drum are then updated. An historical printed record is made of all transactions by means of a high-speed electric typewriter.

Interest is computed automatically and entered on dividend dates.

The system also will include magnetic tape handling equipment for use in processing mortgage accounts, and school savings, Christmas Club and Vacation Club accounts, using the same drum and arithmetic units. The balances of these accounts are recorded on magnetic tape, since immediate access is not required.

The tasks for which *special*-purpose systems have been designed, to the best of my knowledge, are all characterized by the need for almost instantaneous access to large amounts of information, together with the ability to update the information as transactions occur. You have probably all read of the *Reservisor* systems, also built by Teleregister, which keep up-to-the-second inventories of unsold airline or railroad space and flight information. A similar system in use by a manufacturer of seasonal footwear, who produces about 100,000 items daily, provides instantaneous reports on inventory against committed orders to facilitate production planning. The best they had been able to do formerly resulted in a five-day posting delay.

GENERAL-PURPOSE ELECTRONIC SYSTEMS

The capabilities of the *general*-purpose electronic system are based on the following principal characteristics:

- Complete intercommunication among all units of the system, under central automatic control
- Almost unlimited capacity to make *preplanned* decisions in the course of the processing operations
- Large storage capacity for data and for filing an elaborate coded program of instructions which the system follows automatically
- Calculating capacity
- Speed of manipulation of data

Chrysler Corporation was one of the early users of large-scale general purpose equipment. MoPar, the parts distributing division, used EDP initially for five basic applications, all interrelated. They are inventory control, invoicing, determination of cost of sales, accounts receivable, and sales analysis. The last four are fairly routine, but the advantages of electronic equipment in control of an inventory of this kind are much greater than clerical economy. Substantial reductions in inventory, with resulting benefits, are anticipated. Inventory records were formerly posted by bookkeeping machines, and the review of the stock-status records was made two to three months after the transactions occurred. Inventory records are now processed daily and reflect transactions of the preceding day.

Because of the internal speed of the machine, information is read in entirely from magnetic tape. Three types of information are read in—each from a separate tape. One is the master file, containing a considerable amount of data as to each item in stock at any warehouse. Sales for the preceding day are on a second tape, prepared as a by-product of the invoicing routine. And other transactions, such as purchases, receipts, transfers, are on the third, prepared by converting punched cards. As a result of processing, the master file tape is updated and two tapes are prepared for offline printing of reports for necessary action. One prepares a distribution report to allocate to the various warehouses material due from suppliers and manufacturing divisions. The other prepares a stock-status report, but only on an exception basis—that is, where some action is required. The stock-status report contains all information necessary for four types of action—procurement, transfer of stock between warehouses, expediting receipt, or disposition of surplus.

Other uses of EDP go from one end of the scale to the other. A recent survey found that among general manufacturing companies the most common application was payroll. Production and inventory scheduling followed, and then cost accounting and budgeting. In fourth place came engineering and research applications.

Even the chickens can be thankful to EDP—if they take a real interest in their profitability. As you know, poultry feed has to be manufactured with definite percentages of protein, fat, fibre, ash, and so on, obtained from such grains as corn, oats, and barley, or from soybean-oil meal. Two major feed companies are reported to use electronic computors to determine, in ten minutes each day, the best feeds to use for each formula to meet the requirements at the lowest cost, based on the day's closing grain prices.

The basic components of any EDP system are *input* and *output* units, *storage* devices, a *control* unit and the *processing* unit. So far as results are concerned, the differences between one system and another relate to *speed, storage capacity,* and *types of input* and *output* units. All are alike in terms of general logic. It might be helpful to think of a data-processing system as similar in some respects to an automatic machine tool. A raw casting is fed into the machine where it is positioned and machined automatically. The finished piece is dropped into a bin and the next piece automatically fed into position. In the data-processing system the raw information is fed in and processed, and the resulting information is put out. One similarity to the machine tool is that only related information material is processed at one time, after it is sorted out. We wouldn't have payroll and sales information entered indiscriminately. The data-processing system does, however, examine *each item* of information and processes it according to its characteristics or peculiarities.

Because of the *speeds* at which the machines can operate, it is desirable that the information be fed at high speed, and also that the output be recorded at high speed in order to keep the processing unit occupied. This is accomplished by recording the information, in coded form, on magnetizable tape. The most common magnetic tape is about one-half inch wide and about 2,000 feet long—quite similar to that used in home tape recorders. By passing the tape over a reading or recording device at high speed, data are transferred to or from the storage unit at speeds of several thousand characters a second. Punched cards or punched tape may also be used for input and output, and output may also be printed by line-at-a-time printers. A printer demonstrated recently prints full-size reports at 5,000 lines per minute.

After data for the electronic system are prepared by recording them in coded form, no further human intervention is necessary except to put the tape reels or cards at the machine and carry away the final results. As a matter of fact, the largest part of the input to the system generally does not have to be recorded manually, since it is already prepared for the machine as a result of previous operation of the system. As we saw in the Chrysler example, opening inventory balances would be recorded on magnetic tape as the output of the previous inventory operation and would be automatically reintroduced to the system.

INTERNAL OPERATION

It would be foolhardy for me to attempt to explain, even with gestures, how the system operates internally. From a practical standpoint it is not necessary for us to know. I will agree, however, that to believe some of the fantastic things we hear about these machines takes a lot of faith. We all remember the old-fashioned faith that people had in the Bible as a literal guide to every-day decisions. I heard of a young man who finished college with no clear idea of what to do with himself. As he had been taught, he looked in the Bible for guidance. Closing his eyes, he opened the Book at random, placed his finger on the page, opened his eyes, and read, "And Judas went and hanged himself." Not being very sure of this answer he tried again. He closed his eyes, opened the Book again, placed his finger, opened his eyes, and read, "Go, and do thou likewise."

Input and output units are under the complete control of the stored program. A very simple sequence of operations might be to read one record from the *master* file and one record from a *transaction* file, *process* the transaction to update the master file record, and write out the *master* file record onto a new tape. Any desired information may be recorded on a second output tape. Then the cycle would begin again. The number of tape units and other input and output units would depend on the particular application.

SYSTEMS AVAILABLE

There are not many different electronic systems available for business data processing. I would be hard pressed to name a *dozen*. These systems have more similarities than differences. All will carry out approximately the same assignments. The principal differences are *speed* and *cost*. The magnetic drum systems are substantially slower internally than systems using magnetic cores. Over-all speed for an application is affected by several other factors. One is the number of input and output units that may be attached at one time, and the speed of these units. Internal storage capacity is important. Mention of other features would serve only to confuse, but it should be apparent that a comparison of two systems can be made only in relation to a specific application. There is no one *best* system.

COST

Most electronic systems can be either rented or purchased. The cost of a system will depend on several factors, including the number and capacity of storage units and input and output units. Printers are fairly expensive. I know of one complete electronic system that will rent for over $1 million a year, including payment for overtime use. The rental also covers maintenance. The purchase price of this equipment would be about $3 million. A smaller complement of this same system might rent for less than half a million a year.

A smaller, slower system *not* using magnetic tapes might cost $50,000 per year, or $100,000 per year *with* magnetic tapes, for one-shift use.

Initial costs for installation and air-conditioning for a large system could easily exceed $200,000.

MASTER FILES

Most data processing utilizes master files of some kind, such as stock records, customers' ledgers, and personnel files. Maintaining these files up to the minute is not ordinarily necessary. It is more efficient under conventional methods to accumulate the transactions for posting, and with electronic equipment this is even more true. The processing of master files through an electronic system is usually the most time-consuming operation, so it is desirable to reduce the number of times the master file must be processed.

OTHER SYSTEMS

In some instances it is necessary or desirable to have quick access to up-to-date balances or other information. To accomplish this it is necessary (1) that transactions be posted immediately and (2) that the updated information be available quickly. In such instances the use of magnetic tapes is too slow, and magnetic drums or other storage devices with shorter access times are used. The storage capacity needed in such instances is substantially greater than is available in most electronic data-processing systems. To meet this need, *one* general-purpose system, the Univac File-Computer, has been designed with basic magnetic drum storage capacity of 180,000 characters, expandable to 1,800,000 characters. Most other systems have a capacity of only 10,000 to 40,000 characters. In this system, transactions may be posted from magnetic tape or other automatic input. They may also be entered directly from a large number of keyboards so that balances can be kept current as transactions occur, as might be desired with a fast-moving inventory. At the same time information as to balances is instantly available.

A *second* system, IBM's RAMAC 305, is built around a 5,000,000-character memory, consisting of a series of magnetic disks, much slower than magnetic drums. Input is by means of punched cards only, and output may be punched into cards or printed a character at a time. Magnetic tape is not used.

Two other systems provide *optional* large-volume storage devices, in addition to conventional storage devices, to meet this need where it exists. The highest capacity of one system is 24,000,000 digits, and of the other 200,000,000 digits, but the time required for access to stored information is much longer than with other magnetic cores or drums.

Of only limited interest to accountants are the electronic computers designed not for business data processing but for scientific or engineering calculating. The two largest commercially available systems are Sperry Rand's Univac Scientific and IBM's Type 704. Some of these systems are being used for accounting purposes, but such use is incidental to the technical use for which the equipment was acquired.

NEED FOR A REALISTIC APPROACH

A few minutes ago I made a brief reference to the program used by the machine, and mentioned that it was a simple operation to introduce this program into the machine, after the program has been designed. I do not want to leave you with the wrong impression. The *design* of the program is not easy. It might be likened to writing a procedure manual in almost infinite detail, covering every conceivable type of transaction and variation, preceded by the design of the system itself. A program of *several thousand* steps is not unusual, and many programs would usually be required for one application. The necessary preparatory time is customarily measured in man-years, and a programming effort of thirty or forty man-years for a large-scale system would not be surprising. This preparatory cost represents in itself a major investment.

I should like to close with a few personal observations. A year or two ago anyone able to take a detached view of the situation might have felt a certain lack of realism. We thought we heard the opening shots of the office revolution. From all sides came promises of startling savings in clerical costs. Some were so enthusiastic that they didn't stop to count the costs; the advantages to management were so great that cost counting was a waste of time. Some were deploring the use of this lofty equipment for such prosaic tasks as payrolls, implying that nothing less than the management of a company was worthy of assignment to the electronic brains. There were even a few waiting hopefully for electronics to fall flat on its face.

We now see signs of a more realistic approach. Some who entered the field early have gone through trying periods, and some are out of the woods. Substantial improvements have been achieved, even though savings have generally been less than expected. It is no longer fashionable to look down one's nose at applications of electronic equipment to routine record-keeping. There have been improvements in production scheduling and inventory control. There have been some examples of "frontier" applications in connection with linear programming and Monte Carlo techniques. A few major organizational changes have been made to permit better utilization of large-scale equipment, but most companies are moving slowly in changing existing patterns. There have been a few fiascos as a result of inadequate planning, and these are receiving much more attention than the more numerous examples of solid achievement.

In the early days, meetings on electronic equipment were sprinkled liberally with individuals wearing white ducks, tennis shoes, and goatees. Because of this factor, those attending conferences were advised to take a refresher course in psycho-ceramics. I don't know whether you are familiar with this course—it deals with the subject of cracked pots.

Those attending conferences today are more likely to be business men, perhaps not so eccentric.

It is still too early to see precisely where we are going. Few large-scale systems are yet being fully utilized. Only two large-scale systems and two medium-scale systems have been delivered in any quantity. I would expect to find more tape-operated electronic systems delivered in the next year than have been installed up to this time.

But it doesn't seem too much of a risk, even for a conservative accountant, to say that data processing by electronics is here to stay.