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Accounting Trends — Data Processing by Electronics

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You have seen during the last year or two a tremendous acceleration in the trend toward extensive mechanization of accounting and record-keeping activities. Developments in this area have led some of the more poetically-minded to talk of an office revolution having a significance equaling that of the industrial revolution of the 18th century. Even the most prosaic analysis indicates that startling advances are in being. It is well for us, as accountants, to keep abreast of developments and their effect on our work. This we are doing. The journals of the accounting societies, such as the Accounting Review, The Journal of Accountancy, The Controller, The Internal Auditor, and the N. A. C. A. Bulletins, are carrying an increasing number of excellent articles dealing with electronics, integrated data processing, and the like. The Controllership Foundation has recently published a 175-page descriptive reference guide to literature in the field of electronics as it relates to the office. The inclusion of this topic in the agenda of this Conference is further evidence that we are aware of our obligations and opportunities.

What are these obligations and opportunities? First, of course, we have the obligation to take full advantage of equipment which will make accounting and record keeping more efficient - to slow or reverse the trend toward higher costs resulting from the needs of business and government for more and better information and for earlier availability of information. The adoption of radical types of new equipment, and the accompanying changes in procedures, create a demand for careful consideration of their internal control aspects. 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. In recognition of this last, Mr. Arthur Foye, as president of the American Institute of Accountants, last year appointed a committee to study and advise on the effects of electronic data-processing equipment on auditing procedures.

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 is coming into being. Noteworthy progress in business planning may be achieved. Stimulated by the possibilities of an electronic system, methods may be found to better evaluate future trends and conditions, and to better appraise the probable effects of contemplated actions.

Is the application of this new equipment in the area of management controls outside of the realm of the accountant? Not at all. We are all aware of two important accounting trends which are closely related to each other - the expanding role of the accountant as an essential member of the management team through the controllership concept, and the expanding role of the certified public accountant as an advisor to management. The accountant who is playing this expanding role is in a logical position to 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.

Widened horizons are desirable on the part of the accountant in another respect. One machine or system will do not only accounting work, but also record keeping and calculating for production scheduling and control, inventory control, research and engineering, and so on. This will require a crossing of departmental lines in order to serve the company as a whole, and the accountant should keep this in mind.

Some are probably asking what conceivable interest your small companies or clients can have in electronic data-processing equipment, which must be very expensive. It is expensive, and even though there may be developments which will make electronic equipment available to more users, it will remain beyond the reach of the vast majority of companies. This does not mean necessarily that these companies will not be able to obtain the benefits of such machines. For one thing, service bureaus will be established at various principal cities which will handle, on a fee basis, data processing for companies which have insufficient volume to warrant having their own equipment. Another approach which will probably receive increased interest is the pooling of equipment by a group of companies. The companies might come from one field such as life insurance or stock brokerage, or they might be entirely unrelated.

One possible effect of electronic equipment on the smaller com-

pany is indirect, but not unimportant. The enthusiasm which electronic data processing has generated results largely from the potential monetary benefits. It is conceivable that these benefits may give to the larger company a competitive advantage which would create a sizeable problem for the smaller company. This situation may hasten the tendency toward mergers of smaller units. This may apply more to service industries, such as insurance, than to manufacturing industries where data processing involves a proportionately smaller part of total operating costs.

What are these new concepts of mechanization which have aroused so much enthusiasm? There are two, quite distinct but providing considerable mutual support. The use of electronics for data processing has received the greatest attention. It has considerable glamour. We are fascinated by machines whose speeds are measured in millionths of a second, and which can perform thousands of operations without human intervention. The other, referred to as integrated data processing, involves what has been called the "common language" approach. The aim of both electronic data processing and integrated data processing is the reduction of human effort, of one kind or another.

Electronics will undoubtedly be used in many types of office equipment besides the computers or data-processing machines. National Cash Register Company recently demonstrated an accounting machine embodying some surprising features. The posting of a ledger card (such as accounts receivable) automatically places magnetic spots on the back of the card indicating the balance. The account number is also coded in magnetic spots. When the ledger card is inserted in the machine for a subsequent posting a device automatically positions the card at the first vacant line, picks up the old balance by sensing the spots, and records the new balance computed by the machine. Incidentally, the machine locks if an attempt is made to post to an incorrect ledger card. A trial balance is taken by inserting the cards in the machine, where the balances are sensed and accumulated.

Other devices using electronic components should be expected over the next few years.

As the term "common language" implies, the method is to record data or transactions in such a manner that the record can be "read" by various machines, without requiring human eyes. The aim is to eliminate repeated recordings, by human beings, of the same information. A variety of new devices have been developed, such as attachments to

adding machines, desk calculators, bookkeeping machines, cash registers, and typewriters. These make possible the preparation of original documents and the simultaneous production of perforated tapes or cards for use in automatic processing. Advanced techniques provide for the automatic transmission of data in cards or tapes over long distances. Since there is at present no universal common language, devices are available for converting from tapes to cards, from one kind of tape to another, and so on.

The reading of punched cards by machines which list the information, prepare documents, make calculations, accumulate totals, etc., is familiar to all of you. A more limited array of machines controlled by punched tape is now available. These machines include the electric typewriter and an imprinter which produces address plates, as well as the tape-to-punched-card converter. In addition, the punched tape or cards may be used for the input of data to an electronic data-processing system, or may be converted automatically into the faster plastic or metal magnetic tape.

Let me describe briefly an application of integrated data processing presently in operation, involving the preparation of shipping orders and invoices for bulk chemicals. Upon receipt of the customer's order at a sales office, a perforated tape containing, in punched-hole code, the customer's name and address, shipping instructions and other 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 containing unit price, unit cost, description, and various codes for each item ordered 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, except for date and customer order number. The completed shipping order is sent to the plant. At the same time that the order is typed the typewriter produces as a by-product a perforated tape containing all the information which is 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 machine which senses these marks converts them to holes in the cards. These cards are then fed into an electronic calculator which extends the item amount on the product cards, considering 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. 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 quantities shipped.

One more brief example may indicate the wide variety of applications of the integrated data-processing concept. A combination cash register and point-of-sale recorder is available which is proving attractive to department stores and other retail stores. This machine is capable of automatically reading Kimball or Dennison prepunched merchandise tags. In addition to a receipt for the customer, a punched tape containing all details of the transaction is prepared. This tape is used for sales and inventory accounting, by conversion to punched cards or by direct use in an electronic data-processing system. Incidentally, an extension of the use of these machines to mechanized physical inventory-taking is suggested. By wheeling the machine through the rows of garments and registering each hang-ticket on the tape, a very rapid inventory might be obtained, both as to units and price.

Thus the principal purpose of integrated data processing is the elimination of repeated recording by human beings, to save time and to decrease the possibility of error.

Integrated data processing does not necessarily involve any electronic equipment. The two developments in data processing - electronics and integration - have been parallel and are closely related, however. I believe that small and medium-sized business, and possibly also large companies, may benefit more from the application of the "common language" concept than from the use of electronic equipment.

Turning to electronics, the concept is more complex, as is the equipment.

Prior to the electronic computers (or data-processing systems, as the business counterparts are often called) machines and devices used in the office were all tools of the clerks. Each machine was designed to carry out only a limited number of operations under the direct control of a clerk. The work must be passed from machine to machine and from clerk to clerk, so that the time for a job is subject to the speed and ability of the worker. With the introduction of the electronic system, it is possible for an entire procedure, starting with the original data, to be carried through with no intermediate handling of any kind.

What do we mean by "electronics"? One of my associates, Virgil Blank, has written this: "The science of electronics treats of the emission, behavior, and effects of the electron, the most fundamental particle of matter. It is the particle that constitutes the current flow in a vacuum tube, which is the heart of the electronic circuit. This current flow is the energy of an electronic system just as the motion of wheels, shafts, and levers is the energy of a mechanical system. Instead of being harnassed to the limited speed of noisy moving parts straining against friction and inertia, pulses of energy move silently through the electronic system, processing data at the speed of light rather than at the speed of the wheel. Replacing bulky mechanical parts capable of limited tasks, compact electronic hardware can be combined into a modern accounting machine comprising an interconnected system with a potential for automatic record keeping on a scale never before considered possible."

The secret of the speed is thus the elimination of moving parts. But this speed has a greater significance than speed alone. Dr. Howard Aiken, of Harvard University, puts it this way: "In the past, engineers have been concerned primarily with four fundamental problems. The first of these has been the production of power, power being that by which men augment their own muscles; the production of tools, these being devices with which men have adapted their hands to their work; the production of instruments, these being devices by which men have adapted their sense of perception to their surroundings; and finally, through the use of power, tools, and instruments, the production of consumer goods . . . But note that all of these activities have to do with the elimination of the physical drudgery to which our race is heir. Assume, however, as we enter the field of data processing, that we are now entering upon that activity in which we hope to eliminate the mental drudgery with which our race is associated."

From the viewpoint of the employer, electronic machines are an extension of the basic principle underlying the rise of manufacturing industries, the transfer of skill from the worker to the machine. This same extension of principle is the basis of factory automation, of which we are hearing so much. Electronic data processing is the office counterpart of automation in the factory.

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, for two reasons. First, office operations are subject, in much greater degree, to conditions imposed by outsiders; consider the variety of forms of vendors' invoices, for example. Second, the office worker is required to exercise more discretion or judgment.

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 do perform calculations - add, subtract, multiply, divide. But 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, involve only a choice of 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 evident. 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 which 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.

The same principle is used to sort - to arrange data in numerical or alphabetical sequence. Also, the processing of a transaction according to its type is easily arranged by means of numerical or alphabetical codes which are used by the machine as the basis for selecting the processing routine.

This ability to make elementary logical decisions is one of the major 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. A more sophisticated ability results from the fact that the machine is able to perform calculations on its own instructions, thus amending them according to the characteristics of the data being processed.

From a social viewpoint, the transfer of mental drudgery from man to machine is desirable. From a sound business viewpoint, however, we would not seek mechanization if it were not advantageous to do so on a basis of cost reduction or improved profitability. Machines

must be better than humans for the particular task.

Blair Smith, of IBM, 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, together with tremendous speed, 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. One system can perform such diversified functions as payroll and paycheck preparation, inventory accounting, production scheduling, and sales analysis - as well as complicated mathematical problems.

The second approach, not ordinarily used in the design of office machinery, results in special-purpose machines. As is quite common in factory operations, a machine is designed and built to perform only one function. One example is the Reservisor, built for American Airlines by The Teleregister Corporation, which is used only for maintaining up-to-the-second records of unsold plane space. Another is the Speed Tally built for John Plain & Company by Remington Rand for maintaining perpetual inventories of fast-moving mail order merchandise on a current basis.

Special-purpose as well as general-purpose machines provide means for introducing data, processing it automatically, and recording the results. In either system the input and output units may operate entirely under the control of the system itself, without human intervention. The basic difference is therefore one of flexibility. The program followed by the special-purpose machine is fixed in the design. Such a machine would be expected to be available at lower cost, and would be appropriate in instances where flexibility is not a factor.

There are relatively few manufacturers of general-purpose machines for business use, only nine that I know of:

First, the well-known manufacturers of office machines:

International Business Machines Corporation, which makes two systems of various sizes

Remington Rand Division of Sperry Rand Corporation, which also makes a large-scale and a smaller-scale system

Underwood Corporation
National Cash Register Company
Monroe Calculating Machine Company
Marchant Calculating Machine Company

Second, newcomers in the business-machines field, but old hands at electronics:

Radio Corporation of America
Datamatic Corporation, an offshoot of Minneapolis-Honeywell and Raytheon
ElectroData Corporation

Basically these machines all do the same work. The principal differences are in speed and cost. There are also other differences, such as capacity for storage of data and instructions, number and type of input and output devices and auxiliary equipment, and automatic checking features. Comparisons can be made only on the basis of careful studies related to specific applications. I would like to give you some idea of equipment costs. A fairly complete large-scale system might exceed $2,000,000 in purchase price or $600,000 in annual rental. It is not likely that any complete system could be obtained for much less than $200,000 in purchase price. It is not possible to give exact prices, as that depends on the amount of equipment and special devices. In any event, the cost is not small.

This leads to a consideration of limitations of electronic equipment. It is difficult to study the machines without becoming enthusiastic about their possibilities. But limitations and disadvantages must be balanced against the advantages.

One of the most obvious limitations is the cost. The number of companies which can use a $200,000 piece of equipment is much larger than was thought possible five years ago, but it is still quite small. Is the cost going to come down? It may, but I don't think I'd bet on it. In addition to the costs of the equipment, there are large costs of investigation and preparation. Franklin Life Insurance Company estimates that the preparation of their programs for using their Univac will require in excess of 20,000 man-hours of work. Full utilization of the tremendous speed of this equipment can be made only after a thorough systems analysis. Systems work is largely the establishing of standard procedures for repeated work to make jobs routine - to eliminate the need for reconsideration of all factors each time a transaction is repeated. Until recently exceptional or unusual transactions could be

handled only to a limited extent. With electronic equipment it is possible - and desirable - to standardize the treatment of the exceptional. To accomplish this the exceptions must be anticipated, and here lies part of the reason for programming difficulties and cost.

Closely related to the amount of cost is the matter of substituting a fixed cost for perhaps a higher variable cost. A substantial slump in business may throw the advantage against the machine, but the high cost would probably continue, even if the equipment is acquired under lease, because of the difficulty of returning to a system requiring large numbers of clerks.

Quite a bit of concern has been expressed over the effect that the installation of an electronic system would have on people - the employees. This is a subject which can not be given justice in a few words. It's the old story of any technological improvements. We can expect general good, coupled with some dislocations. Reductions in total personnel in any company should be gradual and can be accomplished through the normal attrition of retirements and other separations. But some individuals will be transferred to new positions, and some others will be unable, for one reason or another, to fill other jobs satisfactorily. The necessity of maintaining employee morale will add some cost to the transition.

There may be some problems at a level higher than that of the clerks. The most effective use of large-scale machines will tend toward consolidation of operations, thus possibly creating resistance and dissatisfaction at a supervisory or executive level.

Another limitation which is being given serious thought is the necessity for relying on one piece of equipment, which is of course subject to failure. With respect to payrolls, for example, the possibility that the machine may be out of service for any extended period needs thorough study. Experience thus far has indicated unusual reliability, however. In the first place, the machines have almost no moving parts, which limits the possibility of mechanical failure. As to electronic or electrical elements, it is possible to anticipate failure. Regular daily tests are carried out to detect any components which show signs of deterioration, and these are replaced immediately. And the machines have been designed so that troubles may be located quickly.

One of the most obvious limitations of systems involving storage of information on magnetic tape is the absence of a visible record. Access to this stored information on a random basis may prove too slow

to answer inquiries from vendors, customers - and auditors. To take care of this the machine may be called upon periodically to print out all the information on the tapes to provide an understandable visual record. The lack of a visible record may also have its advantages. Today's businessman is often bogged down by too much paper. The electronic system can be programmed to produce for his attention only the exceptions - the very bad and the very good.

Another element of inflexibility results from the length of time required for programming. Consider the reaction of the company's president when he asks for some special information in a hurry and is told it will take five men three weeks to get ready. Of course he isn't likely to ask very often after that.

Decentralization of responsibility has been an important factor in the growth of many of our industrial giants. These electronic systems tend toward geographical centralization, by reason of their costs. This has presented some problems, and will continue to retard the adoption of electronic equipment in some companies. What is needed is cheap and fast communications. Data for an electronic system and the results of processing can be transmitted automatically and at high speed over telegraph or telephone wires, and thus can be made available at any distance from the centralized equipment to serve decentralized management.

Two other limitations relate to experience - shortage of experienced personnel, and inadequate experience with electronic systems. Both will be alleviated in time, but there are problems at present.

All this points up the need for careful study before acquiring equipment - and before deciding not to acquire equipment. In many instances the cost and other limitations will prevent acquisition. Just as not all are presently able to use punched-card or other mechanical systems, it is obvious that not all will be able to use electronic equipment. But it should be comforting to the executives of any company to know that they have investigated the possibilities and are satisfied that the present methods are the most satisfactory.

In this paper I have hit only the high spots of some aspects of the trend toward greater mechanization. For those who want to follow through, I suggest as a starting point the excellent reference guide published by Controllership Foundation. This guide refers to articles on integrated data processing, as well as on electronics.

A recognition of accounting trends and a study of their effects

on our work are essential in fitting accountants to continue to provide a widening scope of service to management. The trend toward substantially increased mechanization of record keeping and data processing presents a challenge to accountants to step up to our responsibilities by helping to take full advantage of these tools for better management.