AUSTRALIAN POST OFFICE

CERTIFICATE COURSE IN ADMINISTRATION

PART 9

A.D.P. & Methods

BOOK 2 – A.D.P.

Australian Post Office

Certificate Course In Administration

Part 9

Book 2

A.D.P.

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CHAPTER 1 - AN INTRODUCTION TO DATA PROCESSING

THE NATURE OF DATA PROCESSING

What is Data?

We may define data as basic facts which are created as the result of some business activity and that this data will form the input to some system of processing for analysis of the data. This analysis may be merely a summarisation of the data by categories. For instance, it is interesting to know the total sales of postage stamps but a breakdown of this by the sales value of each stamp in the range could indicate an excess of printing of one type and perhaps a shortage in another. A study of this information reveals possible deficiencies in the orders to the printing office. It is realised that "data" is plural but this Branch has adopted, as standard, its use with a singular verb.

What is Information?

From the above then we may define information as the result of some processing system after the data has been received and processed to a point where it becomes useful to the people receiving the information by helping them to make judgements or decisions to better perform and control the tasks which are part of the responsibility of their jobs.

It should be realised that information which is the result of one part of a processing system may be the basic data used as input to another part of the system.

In the above example we may take the situation a step further. The postmaster analyses his stamp sales to advise his head office of his replenishment requirements, but the head office will take his and other replenishment orders to develop a total order. This total order may then be analyzed to determine "fast" and "slow" selling stamps to bias the actual order placed on the printer. This sales "trend" would be of great significance in placing the initial orders for a new issue.

What is Data Processing?

Since the beginning of time man has observed things and noted them and stored them away in his brain for future reference. As he gained more facts or knowledge he started to deduce certain other facts from those he already knew. These facts may be called raw data. The ancient Greeks and Romans handled data in their business, government and personal affairs. Goods were bought and sold, taxes were paid, money was borrowed, workers were paid for their services. All these activities required data.

Even in the home we probably plan a budget and allow so much of our income for each of several expenditure items such as food, power and lighting, and clothes.

We can see then that the term data processing describes any process in which a collection of facts, which we call data, is processed in some pre-determined manner to provide a desired result.

We may see then that the term data processing is a general one, and although only introduced into general vocabulary since the introduction of computers, the activities are basically the same as have been carried on for many years. Previously, data processing activities have been called by their specific application, e.g. invoicing, sales analysis, inventory control, mainly because the work was divided or segregated and different people were in charge of the various and separate operating systems. From the three activities indicated above it becomes obvious that, say, three copies of certain data were required as one copy had to go to the people in charge of invoicing to bill the customer, a second to the sales analysis people to better plan the range and volume of future products, and a third to inventory control to maintain supplies of components for current products.

As we have stated that the final product is a desired result then we knew in advance the type of information we wanted. It also infers that we also had devised the method of processing to be undertaken to achieve this result, and hence this dictates the raw data that was required to be processed. There is also the implication that, having stated a desired result, we knew the purpose for which this information was created, i.e. it is to be put to some useful work.

THE NEED FOR DATA PROCESSING

Development of Modern Data Processing

Many years ago all business was conducted on a strictly cash basis, just as the super-markets of today. Thus a person could run a one man business. He spent his money in buying materials, took them home and made a product from them. This he sold for cash and provided that he had as much money as when he started he was satisfied with his work.

However, as the quality of his workmanship became known, he received more orders for goods and now requires to keep track of who ordered what and when the goods are to be completed. He finds that by buying more material in larger quantities he can get it cheaper. But he hasn't sufficient money to pay for it. However, on the strength of his probable income from the finished goods, he arranges to be supplied with materials on credit. Thus the materials vendor needs to keep his record of materials sold on credit in order to follow-up the payments due.

The manufacturer finds that the customer cannot pay the whole sum at once and therefore sells to him on credit and must keep records regarding the transactions. It becomes increasingly obvious then that he must keep records of the data of his business transactions to remain solvent. These records become his data of the finances of his business.

But he is also involved in the making of goods so he must maintain records of what materials are required for any of his product lines. He must also have records of the materials he has currently in stock in order to calculate the additional material to be purchased to fulfil his orders. Whilst this is generally known as inventory control nevertheless it is data of his business activities and he must maintain records of it.

A customer may require an article not produced by the manufacturer before. The manufacturer will analyse the data already in his possession and will calculate the probable requirements of materials. When the job is completed he will record the actual requirements for future orders that may come in. He will very likely also check his "probable" requirements calculations with the "actual" figures to enable him to better estimate future probable requirements for additions to his range of products.

It is obvious then that records need to be kept and that the data recorded is accurate. This applies no matter at what level the business transaction might be. Even the family group must maintain some sort of budget otherwise over-spending could create serious financial difficulties.

These records could contain historical data of past planning and achievements, current planning and achievements on future planning already formulated. The data contained should be in sufficient detail of value and/or classification as is required by the data processing system to provide the amount of information in the detail required. We could make a broad classification of the type of data that a business organisation may wish to keep.

~~Customers~~. Suppliers

Kinds and quantities of goods sold. Price of the goods sold. Information on shipping of the goods. Maintenance of records of customers who do not pay cash. Maintenance of records of subsequent collections of amounts due.

~~Suppliers~~. Customers

Kinds and quantities of goods purchased. Cost of the goods purchased. Receipt of the goods ordered. Payments made to suppliers.

These two are very similar as of course a company A regards another company B as a supplier whilst B regards A as a customer.

Payrolls.

Names of employees, Earnings of the employees. Any other information such as deductions, insurance, tax and pensions.

Operations of the business.

Income received from products. Cost of raw materials to make products. Overhead costs of running business. Profits or losses made. Growth of the business.

Management of an organisation require this information in order to answer questions that arise. How much profit did we make this year? How does the profit compare with last year? Are our costs of doing business too high? Is our business growing at a satisfactory rate? Can we afford to buy new buildings and equipment? Should we expand our business operations?

The Information Explosion

By 1800, it is estimated, the sum of human knowledge was doubling every fifty years. Then, in the 1830's came the full impact of the industrial revolution. It accomplished more than just the substitution of machines for human hands; the industrial revolution also gave birth to the information explosion. Information began to accumulate rapidly not only because the new machines were generating information, but also because man, freed to a large extent from the burden of manual work, was able to generate more information himself.

By 1950, the sum of human knowledge was doubling every ten years, and there were predictions that knowledge would continue to expandat such a rate that by 1970 it would be doubling every five years. Noting the trends, American scientists during the sixties warned of the problems that this mass and flow of information would produce. Dr. Vannevar Bush, a widely respected engineer and mathematician, cautioned that science might soon be strangled by its own product. By 1963, in the natural sciences alone, 600,000 technical documents were being published yearly, and it was clear that there would be a continuing acceleration in the amount of published scientific matter.

The effects of the information explosion were experienced in other areas of the economy. In medicine, for example, the dean of the medical school at the University of California in Los Angeles declared that more medical research had been published since World War II than in all prior human history. An executive of an aircraft company revealed that just the paper required for the design drawings of a jet plane outweighed the plane itself.

As knowledge accumulates, it becomes increasingly difficult for anyone to have access to all the information available in even a highly specialised field. Accordingly, the techniques of processing, filing, storage, and retrieval assume added significance in man's efforts to avoid the waste of duplicating work that someone else has already done.

PROCESSING DATA

Who Does Data Processing?

It is often though that only people in an office process data. This is not correct as the following typical activities illustrate.

* A bank teller records deposits and withdrawals.
* The travelling salesman records and reports information regarding orders he has received to his head office.
* A factory machinist records the number of parts produced and the time taken to manufacture them.
* A checker in a supermarket registers the price of each article and totals them for customer payment.
* An airline clerk takes a booking and writes and issues a ticket to a passenger.

How Data Processing is done

The Creation of Data

As a result of various types of transactions and related business activity there are several operations which create new data or affect the flow or organisation of data in a business. The size of the business does not make any difference other than the methods of processing which are used from business to business.

* Purchasing. A business is carrying out its function by producing a commodity. To make this commodity raw materials have to be purchased. The larger the business other things also have to be purchased. These may not enter into the product directly but are required as aids to production. These are tools, office supplies, delivery trucks, janitor services, and may even go to amenities for employees such as a canteen.

* Receiving. An order is placed one day for the purchase of raw materials but the goods will not be delivered until later. Records are maintained to ensure that the quantity ordered has been received and that the quality of the goods is up to the standard laid down.

* Inventory. The good or materials received are now part of the stock in the store and now enter the books of the business as inventory. There is a continuous movement of stock as issues are made to production groups and more goods are received from suppliers and therefore a system is required to maintain the inventory in order to ensure sufficient material in hand to meet production requirements.

  The method used may vary. In a small grocery for instance it may be that further supplies are ordered when only six of that item are left in stock. If the volume of movement is too large it may be impractical to do it this way. A periodic counting of the stock may be required and is called "taking inventory". The actual stock is checked against the theoretical stock as indicated by the records. Discrepancies will probably be revealed that are accounted for by errors in data provided or possibly pilfering from stores. Whatever the result taking inventory gives a fresh starting point for the next period of business activity.

* Production. This is the act of making the product which is to be sold. It should be realised that this may be an actual physical item such as a car, desk, or postage stamp, but could also be a service such as window cleaning or a telephone service.

* Selling. The completed goods must be sold to customers. Frequently, with physical items, they are made first and then efforts made to find customers to buy them. With services it is usual to "sell" the service to a customer and then "produce" it.

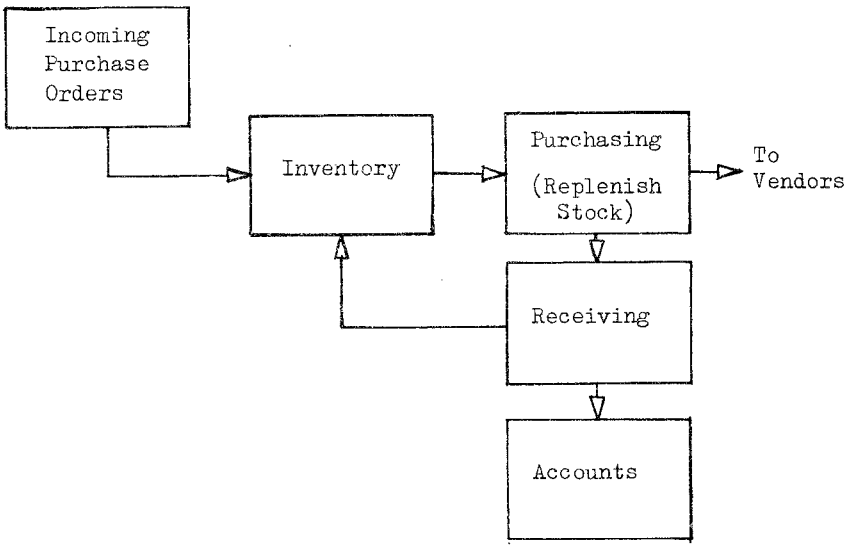
* Delivery. Having made the product in the factory, it must be delivered to the customer. Sometimes, if the commodity is small enough, delivery may be made at the same time as selling. This occurs in small articles such as bread and clothes from the retail stores. If a volume of the commodity is required delivery will be at a later date as time is required to make and/or pack the goods for shipment.

* Billing. Goods having been delivered to a customer it is necessary to notify him that he now owes money by sending him a bill. Usually billing of a customer follows delivery of the goods or service but at times billing and payment may be made in advance of delivery. An example of this is the initial rental charge for a telephone service. In fact, ensuring telephone bills are a mixture as they are made up of charges for calls made in the previous period and rental for the ensuing period.

* Receivables. This is the activity of the customer paying his bill. It also involves the issuing of reminders to delinquent customers who have still not paid their bill after a reasonable period of time has elapsed.

* Payables. This is the act of the business paying the bills it owes to others. This consists of bills from suppliers of materials used as components in the product and associated aid equipment, and also the paychecks of its employees engaged in the production of the product range.

From the above outlines of the various activities it is obvious that no one activity can be entirely divorced from another within a business. The diagram below illustrated the inter-action between sections of a business.



The Manipulation of Data

Data is handled or processed several basic ways

* Recording. This is the actual writing or placing of data on paper or some other media. Recording takes place at any time during any of the following types of data manipulation. If the data is used for more than one purpose copies of the data may be made for storing in different places. Typical of this is an order to be sent out which is made out in several copies so that purchasing, receiving and payables each have a copy for their particular function.

* Classifying. This means identifying the data. An invoice identifies the article sold as well as the quantity and price details. The data must be recorded with some identification or classification otherwise the data is meaningless and cannot be used for any purpose. An invoice would have to be identifiable in order to know whether it rightfully belongs in the payables or receivables area of activity.

Within some major classification there may be further divisions. For instance purchasing would probably maintain records in major categories of materials, e.g. tools, machinery, office equipment, etc. Then the classification of office stationery may be subgrouped by type such as fixtures like filing cabinets and expendable materials such as paper and pencils. The data may then be filed in alphabetic order of the name of the supplier.

To conserve writing effort codes are sometimes used. These codes may be abbreviations of the entities they represent or merely single digits or letters. In a personnel file for instance M or F may be used to represent male or female and M or S indicating married or single. Thus MM could be interpreted as Male - Married and FS as Female - Single.

* Calculating. This is also called computing. It is rare that some arithmetic process is not required. The process required could be a very complicated one or a simple one merely to total up the number of sales. It should be realised that figures play a big part in everyday business activities.

* Sorting. Having set up a system of classification then any data that is recorded will have to be sorted so that it may be placed in its proper category. Or sorting may be necessary to ensure information goes to the right destination.

For example, a payroll file may be kept in alphabetic order of employee name, but the pay envelopes or cheques will have to be sorted by, say, department, to ensure correct destination of the pay.

The type of sorting to be done is dictated by the requirements of the processing undertaken.

* Summarising. After data has been sorted it is usual to summarise the data into a more concise and understandable form as it is desirable to know totals of entities. Whilst it is important to calculate how much each employee is to be paid, the total salary amount by department must be known in order to keep account of part of the overhead in running the various departments. Furthermore, the grand total must be known in order to make the necessary withdrawal from the bank.

Similarly, a total of orders received must be known in order to evaluate the raw material required and the manpower and/or machinery required to produce the total quantity orders.

* Communicating. Data that is idle is of no value. It must be passed from person to person or department to department. Billing cannot take place for instance unless advice is received from shipping that they have despatched goods to the customer.

The communicating may be done in several ways such as messenger, interoffice conveyor belt, pneumatic tube, mail, telephone, or telegraph.

* Storing. Data may not be required for immediate use and therefore must be stored. A letter for instance would be filed for future reference. Invoices for a customer are filed until a billing process is commenced at the end of the month.

This latter activity is one of the major problems of modern business as the huge volumes experienced these days in some large businesses require large areas of storage space.

Storing of data could occur at any stage of processing. Data would have been stored in readiness for processing, in temporary storage during processing (as between phases in the processing activity), and would be stored after processing to be available for some use.

It should be realised that these types of operations may take place in any sequence entirely dependent on the requirements of the operating system.

Basic Elements of a Data Processing System

A prime aim of any data processing system is to provide management with information to facilitate its task of Decision making. There are many factors which can affect the achievement of this aim some of which are indicated below.

* Different managements have varying requirements of information which may be more or less specific to their own unique problems, and the level of detail of information supplied will vary.

* Management exists at all levels of administration from top management, middle management, down to section supervision. The types of problems in each of these levels will call for differing detailed information depending on the use to which it is to be put.

* Every data processing system should have contained in it certain basic elements. These are:

Input - a carefully planned procedure for providing accurate data as quickly as possible.

Storage - Ample facilities for holding all the master data of the system.

Control - to ensure that the system works at peak effort and any errors are corrected quickly and accurately, and re-presented for processing.

Operation - the carefully planned steps of the processing.

Output - information derived from processing the data.

Other aims also are to achieve -

Cost reduction,

Reduce effort,

Improve legibility of records, and

Easier control by supervision.

Management and supervisory personnel of all ranks want information about the activities under their control and responsibility. However, the information must be accurate and the information must be made available in time to be of some use. Thus speed and accuracy are the two major criteria.

* Accuracy. This is dependent to some extent on the processing method but mainly the accuracy of the original raw data.

* Speed. Unless the information is obtainable within prescribed time limits any decision or judgment made may not be sufficiently effective, if at all. For example, it is useless to obtain a railway timetable only to read that the last train would already have departed.

  Human frailties are such that under a heavy volume of work tiredness can set in giving rise to a diminution of both speed and accuracy. Even further, the volume of data required to be processed may be so huge, and the amount of time available for processing be so limited as to make it impossible for humans to carry out the work by themselves.

  Thus some assistance is needed to maintain this accuracy and more especially speed, in order to meet time limits stipulated in the processing methods. To meet the demands, some mechanical contrivance is needed to assist man. The advantages of such a device are readily apparent as once set in motion it will repeat the same process over and over again without deviation thus giving rise to accuracy. By making the device perform faster speed is achieved.

As the main pressure of work is involved with the large volume of data to be processed, the need for, and interest in the development of more effective and efficient processing methods has been mainly in the realm of the large scale organisations.

The main problems which have created this pressure for research have been :

* The development of huge and continually increasing volumes of paper work and the resultant need for large staffs to maintain the necessary records and perform the required processing.

* As business increases there is a tendency to decentralise the activities of an organisation setting up regional offices in keeping with geographical criteria. This puts a further burden on the main office of the organisation of keeping in touch with the activities in hand on a timely basis for effective control. The emphasis on need for improvements in communication has become increasingly obvious.

As a result of these two very important considerations the following trends have developed :

* Use of office machines. This involved the use of typewriters and then later the mechanical desk calculator developing into the electric desk calculator, and accounting machines to the present day computers to reduce the manual handling of data.

* The introduction of the concept of integration. This is the linking together of various data processing activities to reduce and possibly eliminate redundancies of data collection, processing and record-keeping. Integration has been applied to equipment configurations with the aim of reducing manual handling of data. It has also been applied in administrative system by the re-organisation of organisation structures to achieve a more efficient use of basic records.

INTRODUCTION

We have seen that data processing is a term used to describe any process of collecting facts (data) and processing them in some way to produce the desired results (information). In the modern business world, the facts are usually stored and maintained as a group of records making up a file. The file is processed in some way (for example, by summarising, checking, updating from new information, etc.) in order to provide, as output, meaningful information which will be used in the conduct of the business.

When this processing is carried out on a computer, it is usually known as "Automatic Data Processing" (A. D. P.) or "Electronic Data Processing" (E. D. P.).

The former term has been adopted as standard in this Department.

This term implies that once the data processing system is started, it will continue until completion of the particular job in hand without further intervention of humans. If the work to be carried out on a computer is going to be done automatically then there are certain attributes the machine must possess in order to be able to carry out its function.

These are :

* Reading. Equipment which can "read" data that is to be processed.

* Program. It must contain within itself a set of instructions (program) to be carried out to achieve the processing required.

* Main Store. Data to be stored temporarily such as intermediate calculations. Data that has been "read" in as well as results that are to be "written" out. The program itself must be in memory.

* Secondary Store. There must be storage media of some type to contain master file data that is to be updated.

* Writing. Equipment which can "write" the results of the processing.

* Arithmetic. Equipment which is capable of carrying out any calculations required.

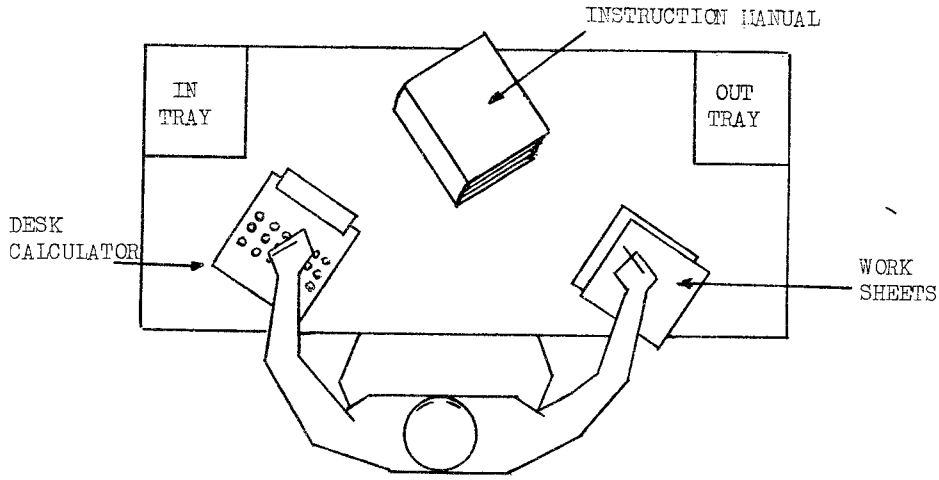
WHAT IS A COMPUTER?

An electronic data processing system consists not of a single item of equipment but of an integrated group of different pieces of equipment which together perform these data processing operations.

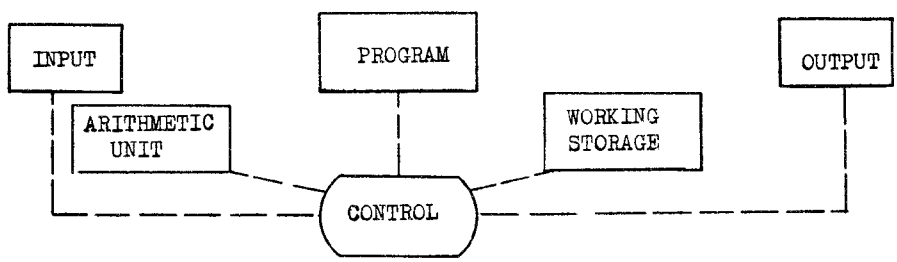
It is easier to understand the part the computer plays in data processing if we consider first a very simple manual system - that of an accounting machinist operating a desk calculator to perform a simple, routine job.

In carrying out this job, she always follows a set procedure, which consists of a number of related operations, the order and nature of which are explicitly laid down in the Instruction Manual.

The sequence begins when she receives some data in a standard form in way of the IN tray. She moves selected data to the work sheet: that is, she stores the data for later use. She next takes specific items from the work sheet and feeds them into the desk calculator for arithmetical processing. The results are then returned to the work sheet for further processing.

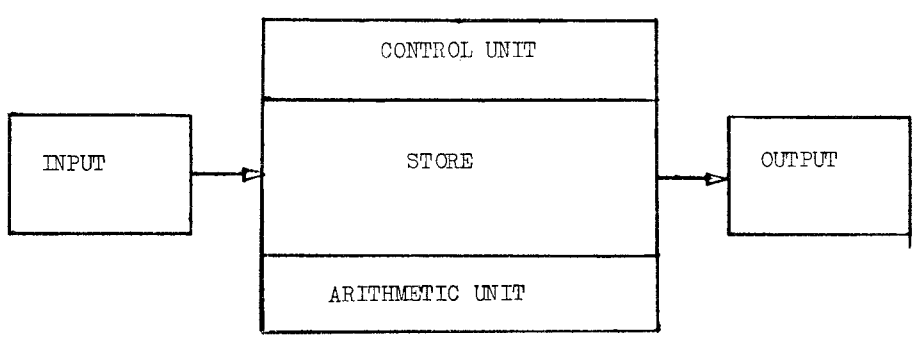


When all the necessary steps are completed, new data have been created and this end product is placed in the OUT tray. The process may be represented schematically as follows :



The previous diagram also serves as a crude representation of the main components of a computer. Data is taken into the computer by an input device and placed in a special "store" (sometimes called the memory). Arithmetic operations are performed by an arithmetic unit, and data is transferred to this unit from the storewhen the operations are to be performe d. The results are then returned to the store. The end product is obtained from the computer via an output device. All of these operations are controlled by the control unit, which interprets and obeys the program.

A computer is usually organised so that the store, arithmetic unit and control unit are contained within one physical cabinet called the "Central Processor" or C. P. We may represent the functional areas of a computer as follows :

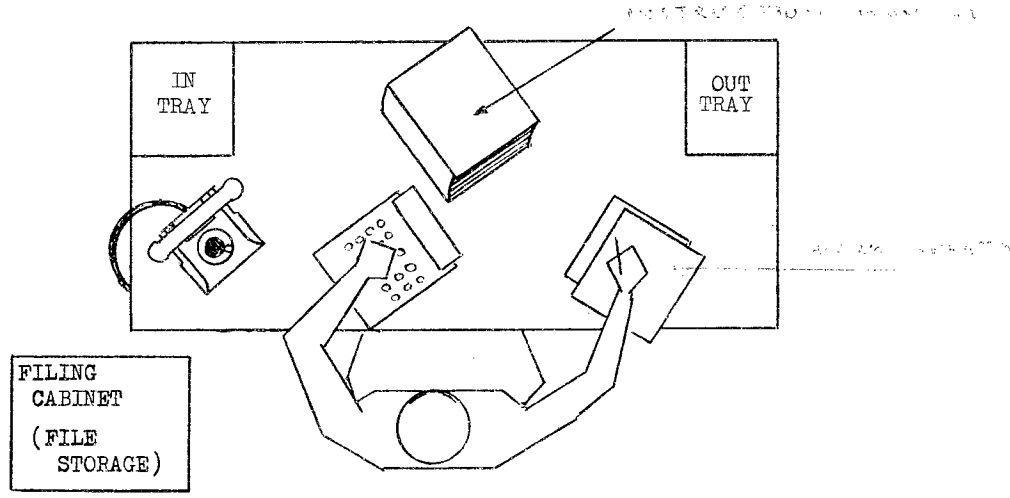


* The Instruction Manual ("Program") must have been prepared in complete detail and be quite explicit. It should assume no knowledge or ability on the part of the operator, apart from the ability to read, understand and follow the instructions.

* The Operator does no calculations other than by using the desk calculator, even for the most elementary arithmetic.

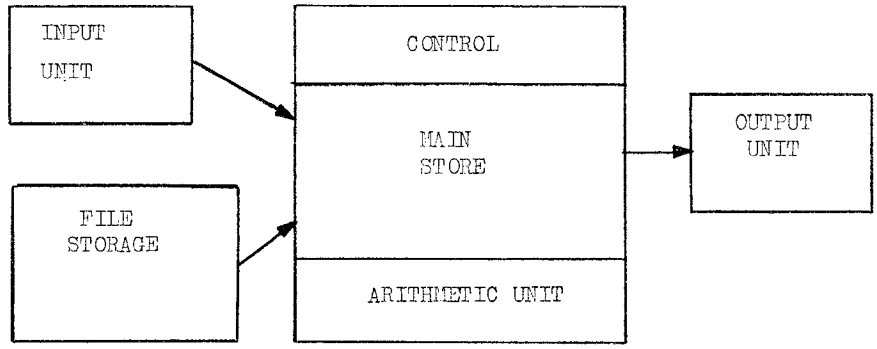
* The operator has no initiative or imagination, and follows the sequence of instruction implicitly.

It is possible to expand our original illustration to show additional features of the computer. Let us add a telephone, and a filing cabinet, to our manual system :



The job now becomes a little more complicated, although the entire procedure is still laid down in explicit detail in the Instruction Manual. Besides performing the calculations mentioned before, the operator also updates a ledger by entering the results of some calculations into appropriate columns. The ledger is kept in the filing cabinet, and accessed by the operator when it is needed.

A computer may also have certain file storage devices attached to it in order to have accessible large amounts of data, which can be updated as required. These devices thus serve to increase the storage capacity of the computer, and are sometimes known as "back-up" storage.



To return to the clerical analogy, the operator may, in the course of updating the ledger, be interrupted by the telephone ringing. When this happens, she leaves the job she is doing to attend to the telephone call. It may be that the caller requires some information from the ledger. The operator will find the information, acting in accord with certain pre-defined procedures (again in the instruction manual), and pass it to the caller. When the call is concluded, the operator will resume processing the normal ledger work, re-commencing at the exact point at which she left off when the interruption occurred. (She may have been required to note this point down somewhere, in case she forgot it while handling the phone call.)

Many computers are also able to handle interruptions like this. The normal job may be left to answer a query coming in from a distant point, and then,when the query is answered, the processing is resumed by the control section of the Central Processor, which will automatically "remember" the place it is up to, before answering the query.

A further illustration may be drawn from the manual system concerning the use of languages. If the operator happens to be bi-lingual, and prefers to do all her thinking in, say, Chinese, it will not affect the system at all, as long as the input and output are in English. If she is the only person to use the ledger, this also might be kept in Chinese, with no adverse effect upon the system.

Similarly, the computer does not work ("think") in English. It uses its own language, which is suited to the speedy operation of its electronic circuitry. However, because it produces its output in a form we can readily read and understand, we do not care!

Logical Units of the Central Processor

The Central Processor is the computing centre of the computer system and is made up of 3 logical units which are the Control Unit, Memory, and Arithmetic Unit.

The Control Unit

This is the hub of the whole system and directs the step-by-step operation of the entire system, including the input and output equipment. It is itself controlled to a large extent by the program, a set of detailed instructions which are entered into the machine as input and stored in memory. The primary function of the control unit is to select instructions from memory, interpret them, and direct their execution.

Memory

This is the storage device of the system. Both the data to be processed and the instructions governing the processing are "filed" in memory in such a way that they are easily accessible as they are needed. New data resulting from processing may be kept in memory until it is used again in further processing, or until it is delivered to an output device. In most instances, the larger part of memory storage is taken up by instructions. The reason behind this is that the data to be processed by a program may be brought into memory in batches, each batch being processed and delivered to an output device before the next batch is brought in. However, all instructions necessary for processing the data must be immediately available to the computer. This means they must be stored together in memory.

Arithmetic Unit

Any arithmetic process indicated by the instructions in the program are performed by this unit. It can add, subtract, multiply and divide. It also can perform logic operations such as testing and comparing two values for a high, low or equal status. The ability of making comparisons is the basis of the computers so-called ability to make decisions. For instance, the program can instruct the computer to bypass certain subsequent instructions if, while processing the data, it comes to an item which does not meet certain conditions. For example, a payroll program may be directed to bypass the overtime pay sequence of instructions if the number of hours worked were 40 or less.

Data Representation and Recording

When humans communicate with each other they use a language of the numbers 0-9 and the letters A to Z. Presenting information to a computer is somewhat similar to communicating with another person by letter. The information to be conveyed has to be reduced to a set of symbols that can be understood by both parties. The symbols used in communicating with a computer are recorded in special ways upon some suitable medium, so that the computer can receive them interpret them, process them, and finally produce the results in some form suitable for our use.

Some of the media used to communicate with a computer are :

punched cards,
punched paper tape,
magnetic tape,
magnetic ink characters (on cheques), and
optically recognisable characters (on forms).

Each medium has its own code or set of symbols which will be recognised by the computer as representing data.

Not only must there be a way of presenting data to a computer but there must also be a method of representing data within a computer. The computer may hold the data in a variety of physical devices: for example, electric relays, vacumn tubes, transistors and magnetic cores. The simplest method, in computers, of representing data is by the presence or absence of electronic signals, thus there would be only two states, "on" and "off". It could be likened to the on-off condition of an electric bulb. This simply means that the components (transistors, magnetic cores, etc.) can indicate only two possible states or conditions. This two-statecondition is known as binary mode.

The binary mode has always been attractive to the digital computer design engineer because bi-stable components are relatively cheap and simple to devise and incorporate in hardware designs. Discrimination between two States, is easier and more convenient than, say, discrimination between ten States especially as it can be reduced to the task of detecting the presence or absence of some feature.

We may represent the two conditions with the digits 0 to 1. The zero represents "off" and the 1 represents "on".

In our day by day arithmetic we use the ten digit symbols 0-9 and because there are ten conditions it is known as decimal arithmetic. When avalue has reached 9 the addition of 1 starts us again at zero with a 1 carry to the next position to the left. In binary arithmetic the highest digit is a 1 and the addition of 1 to it reverts it back to zero with a one carry.

Decimal Notation

Each digit position in a number is ten times the value of the digit position on its right. Thus in the five digit number below the 1 on the left is ten times the value of the 1 on the right

Position value	10000	1000	100	10	1
Digits	6	4	1	1	5

Binary Notation

Because the base of this number is only two, each digit position is only twice the value of the position on its right. The binary number 10110 shown below has a value of 16+4+2 = 22 as we understand it in decimal mode

Position value	32	16	8	4	2	1
Digits	0	1	0	1	1	0

The memory of the computer is made up of a great many magnetisable cores shaped like doughnuts with wires passing through the "hole". These cores, may be magnetised in either of two directions. Thus a group of these may be used to represent characters as we known them.

Decimal	Binary
Ø	ØØØØ
1	ØØØ1
2	ØØ1Ø
3	ØØ11
4	Ø1ØØ
5	Ø1Ø1
6	Ø11Ø
7	Ø111
8	1ØØØ
9	1ØØ1

A group of four bits (Binary digITS) can be used to represent the ten decimal digits.

Other Systems of Notation

There are several other numbering systems used, some of which are very convenient for representing binary digits in a shorthand manner. One of these is the octal system which has a base of 8 (digits 0 to 7). One octal digit can be used to represent 3 bits. In the example above (010110) the bits are grouped in threes starting from the right hand side thus 010 110.

The digits 0-7 can be expressed in binary as follows :

0	000
1	001
2	010
3	011
4	100
5	101
6	110
7	111

Thus the grouping above may be indicated by a 2 (010) and 6 (110).

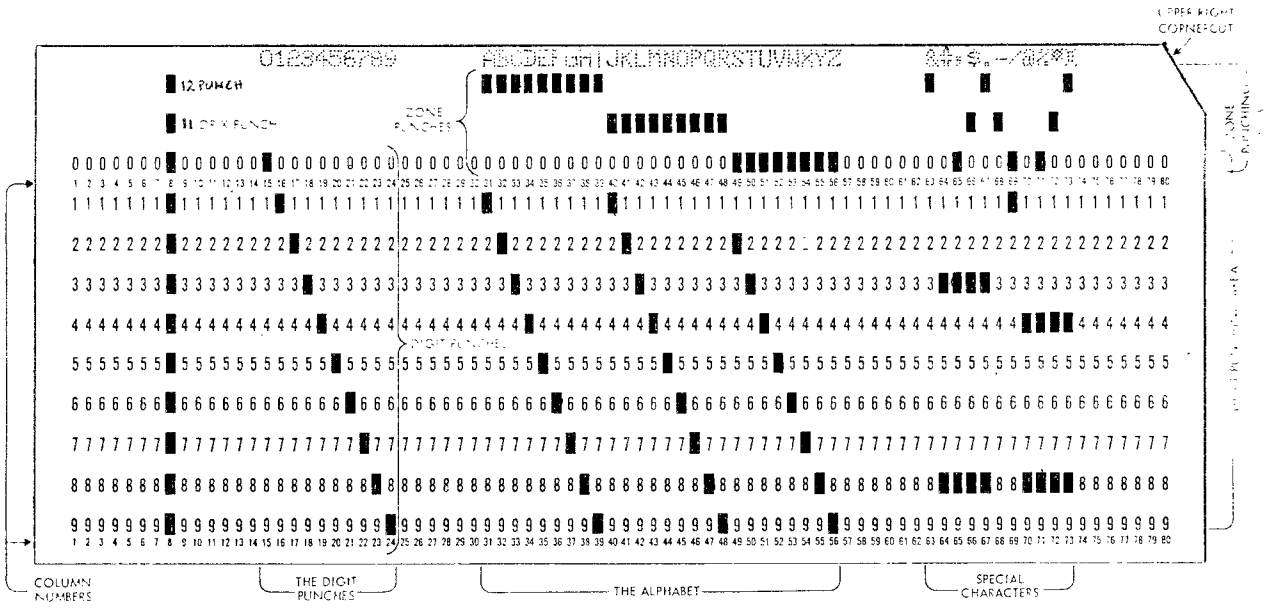
The decimal number 22 can therefore be represented as 010110 in binary notation which in turn can be represented as 26 in octal notation.

Punched Cards

This is one of the common media used to feed data into a computer and sometimes used to receive data from the computer. The data is recorded in the card as holes punched in specific places on a specially designed card.

A standard punched card measures approximately $7\frac{3}{8}$" x $3\frac{1}{4}$" and is divided into 8Ø columns and 12 rows. The columns are numbered from 1 to 8Ø (from left to right) and the twelve rows are designated R (or 12), X (or 11), Ø - 9 (from top to bottom).

Rows R, X, Ø comprise the "zone" area of the card; rows Ø - 9 comprise the "numeric" area. Note that row Ø is considered to be both zone and numeric.



The coding position of a punched card.

Each vertical column on the card can hold one character of data, thus the card has a maximum capacity of 80 characters of information. Data is punched into the card using a card-punch. The hole code system is a fairly simple one. A single hole is punched for digits 0 to 9 in the relevant vertical position in the column. A two-hole combination is used for the letters of the alphabet, being a combination of one of the zone punches and one of the digits 1 to 9. For special characters such as full stop and comma a three-hole combination is used.

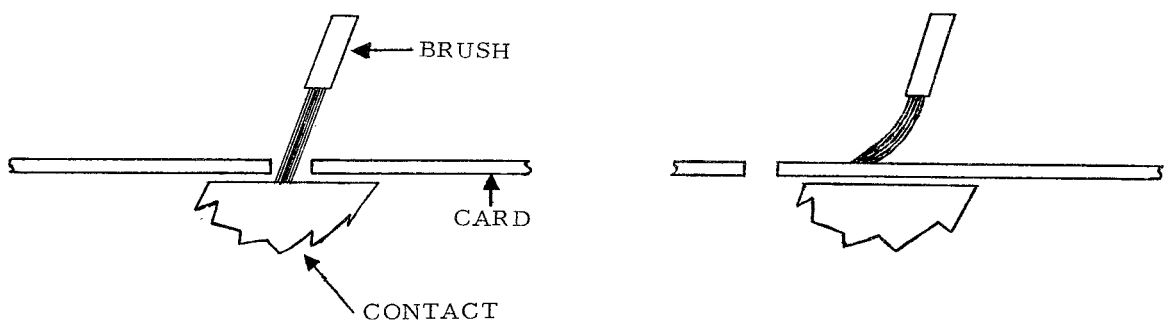
The placement of data in a card has to be carefully planned, as the computer program which directs the reading of a card must be written in a manner that will correctly interpret the data. The card must be divided into areas called fields, each consisting of one or more columns set aside for punching one type of information. The size of the field must be set after determining the largest or longest piece of information to appear in the field. In an invoice card for example columns 1 to 5 may be set aside for customer number field, columns 6 to 25 for the customers name field, and so on. Notice that the decision has been made that a customer number is never more than 5 figures long and that the name field can cope with names up to 20 characters in length. The group of fields relating to one transactions is called a record.

Data encoded in a card usually consists of the data regarding one item or unit of transaction. Thus if an invoice contains details of six items purchased a separate card is punched for each line - item. Hence the punched card is known as a unit record.

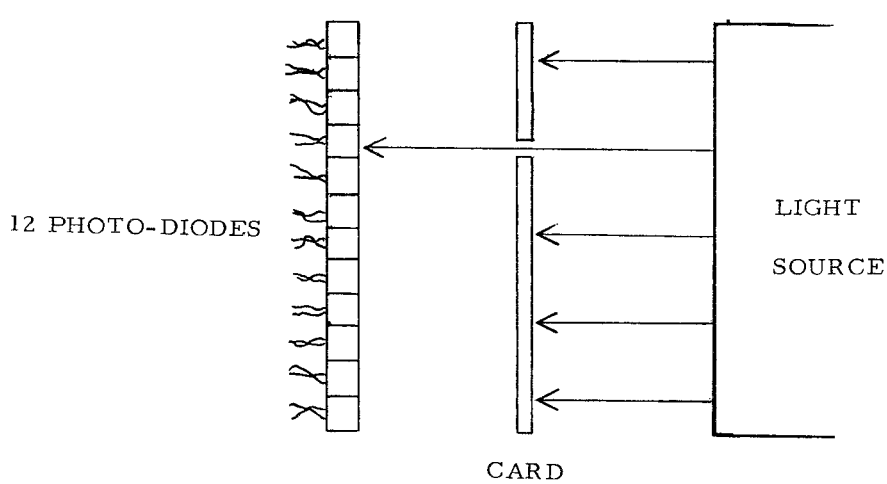
The cards are read photo-electrically or electro-mechanically. In the latter case, twelve small sensing brushes touch the card as it goes through the reader, one for each row on the card. When a hole is punched in the card, the brush touches a contact through the hole, and an electric circuit is completed. When there is no hold, no circuit is made.

(a) HOLE

(b) NO HOLE

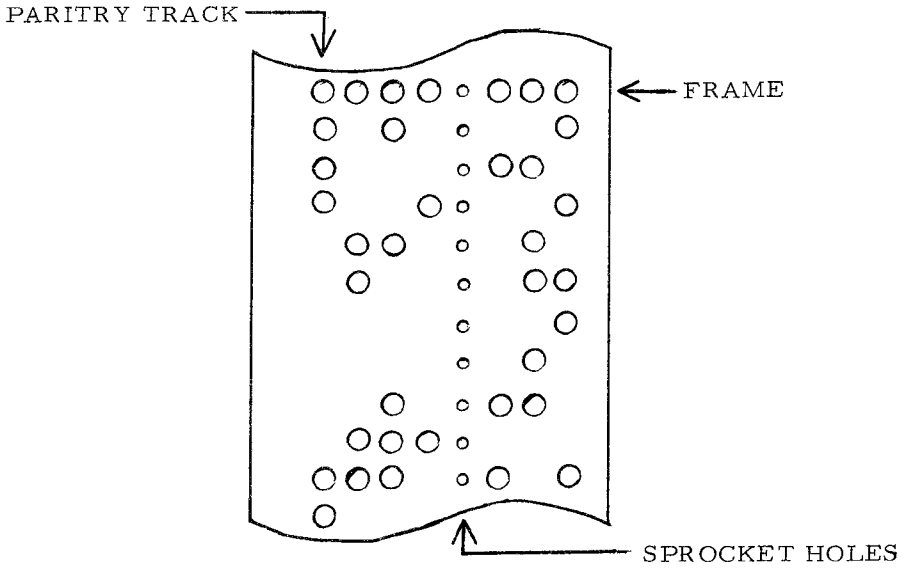


In the photo-electric reader, a beam of light takes the place of the brush. When it shines through the hole, it strikes a photo-diode (a light sensitive electronic device) which registers the presence of the hole.



Paper Tape

This is another media commonly used as input to a computer system. The paper tape most commonly used for business data processing is about one inch wide and about 1,000 feet long, mounted on a reel. The recording system is a coding of punched holes in various combinations across the width of the tape. Each position across the width of the tape is called a frame. There are usually 10 frames or characters along one inch of tape. Paper tape may be referred to as 5, 6, 7 or 8-channel tape depending upon the maximum number of channels (hole positions) which may be punched in one frame, or width of tape. Each character is represented by one frame: a hole punched in a particular channel represents a binary one; the absence of a punch represents a binary zero.



Of the seven channels used for each frame, channels 1-6 contain the character representation. Channel 7 contains a checking or parity bit.

The paper tape is punched in ODD parity; this means that the number of holes punched in any frame must be odd. If the character is represented by an even number of holes in channels 1-6, an extra hole is punched in channel 7 to make the number of holes odd. If the character is represented by an odd number of holes in channels 1-6 no hole is punched in channel 7.

In reading the punched paper tape the number of holes in each frame is counted. If this number is found to be even, a parity error has occurred and some indication of this is made in a predetermined manner.

The paper is normally supplied without holes, the sprocket holes being punched at the same time as the character frames.

Because the reel of tape is long, record after record is punched into the tape i.e. the reel of tape contains the data equivalent to many punch cards. Hence, although several records may be punched, each transaction is recorded separately. When cards are read, the card reader passes the physical card through the machine and the 80 columns of data are stored in the computer memory. As paper tape is continuous a special hole punch code is used to signal beginning of a record and the computer program is written to detect this special punching in order to process a record at a time.

COMPARISON OF PUNCHED CARDS AND PAPER TAPE

Punched cards have the following advantages :

* Flexible in its applications,
  e.g. may be used as a mail returnable document.
* Easy to sort mechanically.
* Easy to locate a particular record.
* Easy to amend a particular record.
* Data may be interpreted along the top.

They have the following limitations :

* Sensitive to humidity and temperature.
  Under certain conditions they warp and become unreadable.
* Subject to mutilation, such as folding, binding, tearing and crimping of the edges.
* Bulky to store.
* Restricted to 80 columns per card.
* Mechanical limitations in the reader mean a slow input speed.
* If a deck is dropped, the cards may have to be resorted into order.

Paper Tape offers the following advantages :

* Cheaper than cards.
* Mechanisms for punching and reading are also cheaper.
* Less storage space required.
* No loss of sequence possible.
* Long records possible.

It has the following limitations :

* More difficult to locate and correct characters.
* Subject to mutilation.
* Very slow input speeds.

Other Methods

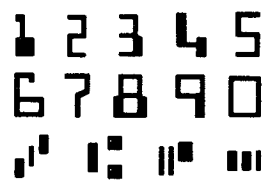
Machines have been designed to scan characters imprinted on documents. These are known as Magnetic Ink Character Recognition (M. I. C. R.) and Optical Character Recognition (O. C. R.).

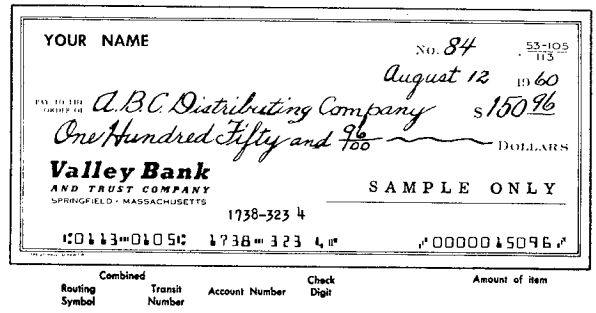
Magnetic Ink Character Recognition (M. I. C. R.)

This method of input is largely confined to cheque reading, sorting and tabulating. The characters are printed across the bottom of the cheque in a special ink which can be magnetized.

When the document is to be read, the reader first magnetizes the ink, and then interprets the magnetic fields set up for each character. The system adopted in Australia is called the EI 3B font, and consists of the 10 digits (0-9) and 4 special characters. The characters can be read visually if desired.

Example :





Optical Character Recognition (O. C. R.) -

This method is based on the use of a bright light source with a lens system to detect, in terms of electrical impulses, the pattern of the printed character to be read. This pattern is matched against a master character pattern to identify the number or letter. Some readers can only read numbers or characters printed in a special type. This restricts the input to source documents which have been printed on adding machines, cash registers and accounting machines equipped with the special type font.

Data Transcription

Before any data may be processed it must be converted into a machine readable form such as punched cards or paper tape.

Punched Cards Machines

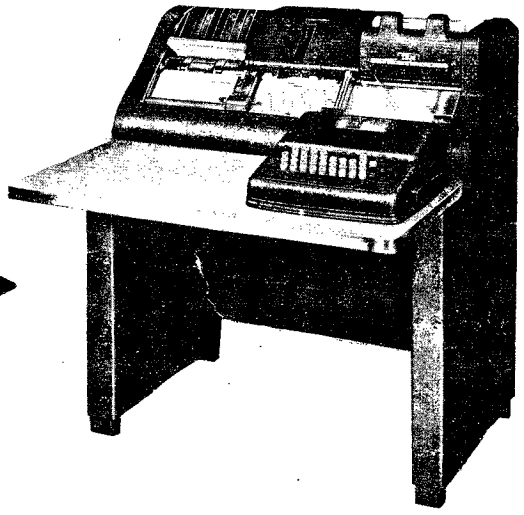
The Card Punch, has a keyboard similar in layout to a typewriter (Refer Fig. 1.) The operator reads the data to be punched from a hand-written or typed document and depresses the relevant keys on the machine. The corresponding hole-code is punched in the card column. The card represents a particular business record, and, as such, has a pre-determined design format. This card design determines what is to be recorded on the card and in which specific columns of the card. Each particular card format will vary from the others.

J W Smith Pty. Ltd.
100 Collins St.
Brigham.

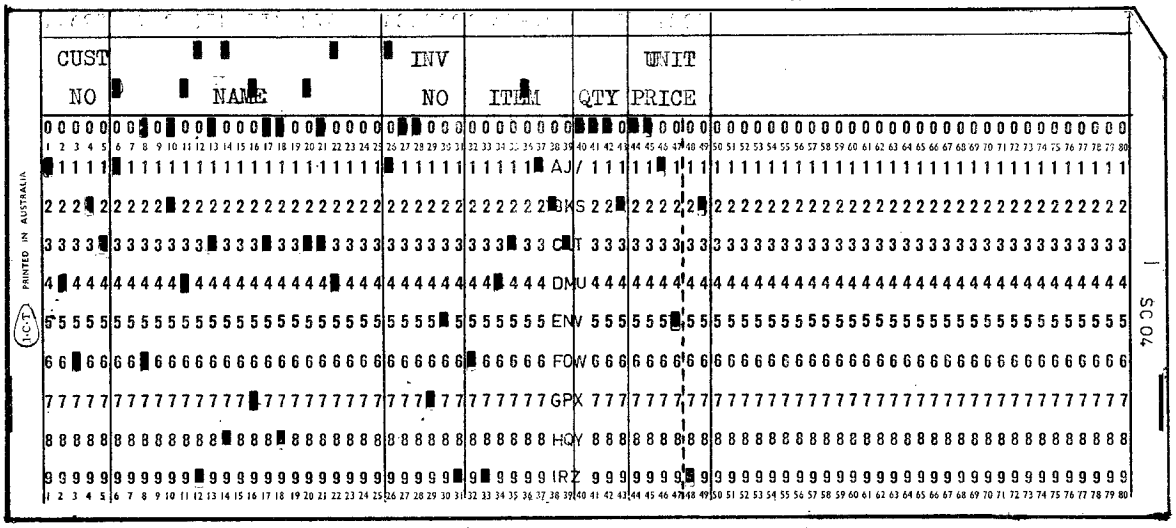
CUST. NO.
14623

INVOICE NO.
A 00759

ITEM.	QTY.	PRICE.
6943-123	2	15·92
7415-246	15	·05
2612-419	3	2·44



CARD-PUNCH. Information is transcribed to cards.



PUNCHED CARD. Contains information in machine readable form.

Fig. 1

To aid the operator there is a program control feature on the machine which can relieve the load of keypunching. It can automatically control the duplication of data from card to card such as invoice date, and bypass or skip columns of the card in which no data is to be punched. The program is changed for each format of card that the operator is to punch.

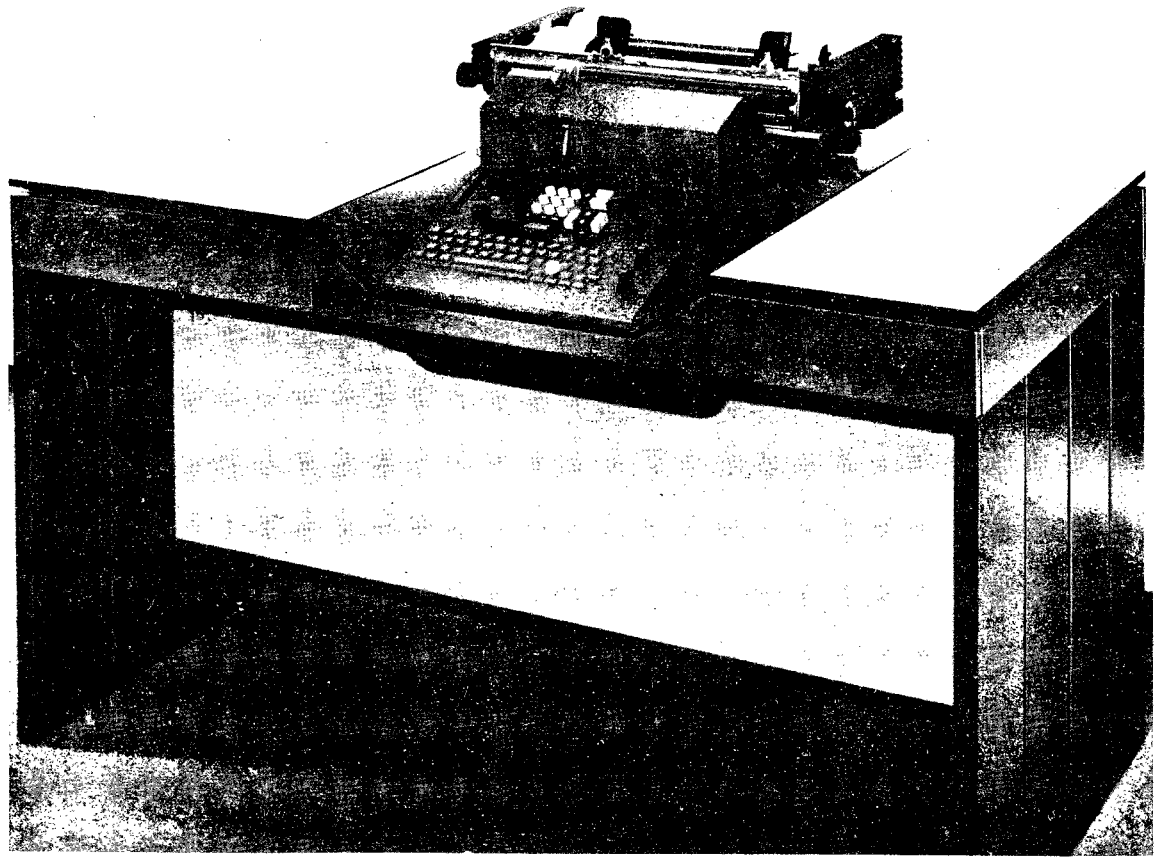
For verification of accuracy of both operator and machine, the cards are passed through a similar machine called a card verifier. This machine is similar to the punch and the operator performs the same steps as the punch operator. The machine however matches the keys depressed with its "reading" of the holes in the card. Any disparity is signalled to the operator.

Paper Tape Machines

There are several types of paper tape units used in the A. D. P. Branch.

The Flexowriter (Fig. 2) is basically a typewriter mechanism with a paper tape punch and paper tape reader incorporated. As data is typed it appears on the paper as in normal typewriter operation but the relevant hole-code is also punched into paper tape.

The typed copy affords a guide to the operator as to her accuracy. If she detects a typing error she may type a special character which punches a delete code into the tape. This can be recognised by the computer program to ignore the incorrect data.

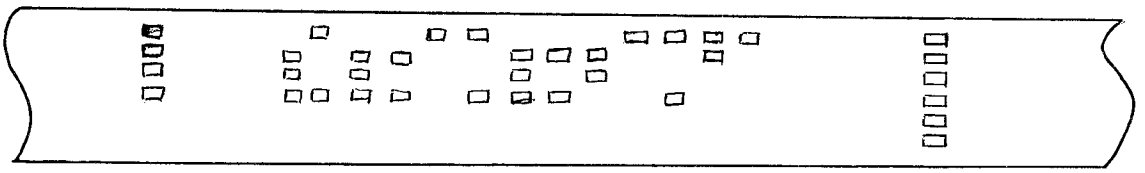


An OLIVETTI AUDIT machine. The paper tape mechanism is contained in the cabinet
Fig. 3.

To check the validity of the tape that has been punched, it may be removed from the punch mechanism and inserted in the reader mechanism. Depressing a designated key causes automatic reading of the tape and data read is typed on the sheet of paper in the typewriter mechanism affording a visual check of the data punched in the paper tape.

Another unit used is the Olivetti Audit machine (Fig. 3) which has mechanism built in to perform calculations. A program used in connection with each particular record format controls the activities that take place. The data to be punched into tape is entered on the keyboard and the program controls punching in the tape and addition of the data in a register. The data is entered again on the keyboard but the program now suppresses punching and causes subtraction from the register. On completion a zero balance in the register denotes accuracy. A proof sheet is also printed as the keys are depressed as a visual guide to the operator and also provides a copy of the data that has been punched.

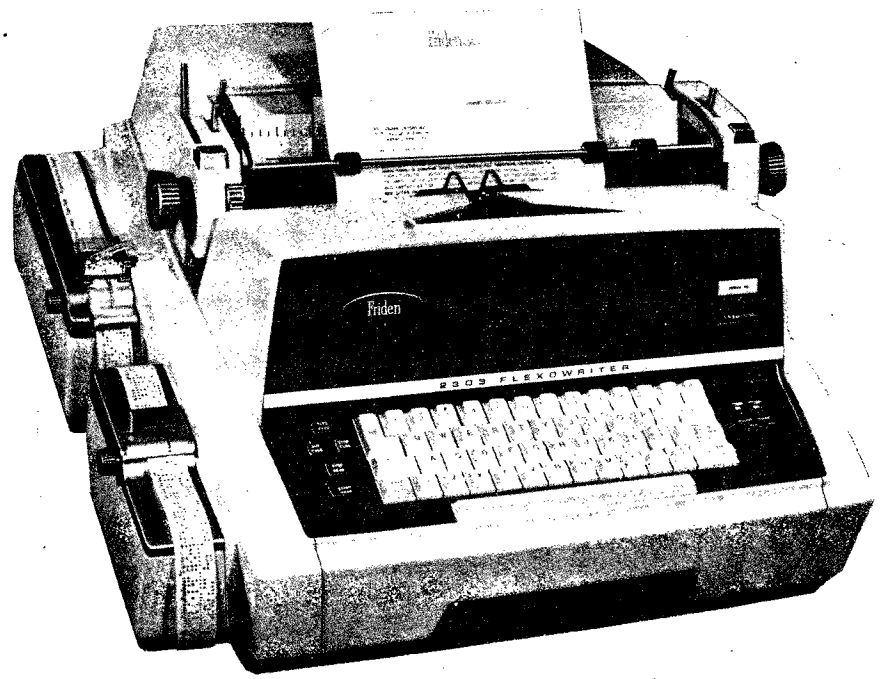
The paper tape produced by Olivetti machines is somewhat different to the round-hole tapes outlined above. This six-channel tape is 13/16" in width, and is punched with rectangular holes. It does not use sprocket holes.



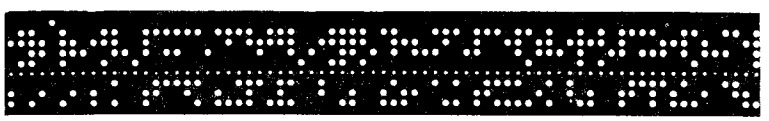
This type of paper tape is frequently used for input of data to the P. M. G.'s main computer configuration at North Sydney.

This is the common language which lets man converse with computers, motivate control automatic machines, document data without constant retyping and risk of errors.

Hand-written or typed documents.



FLEXOWRITER. Information is transcribed to paper-tape.



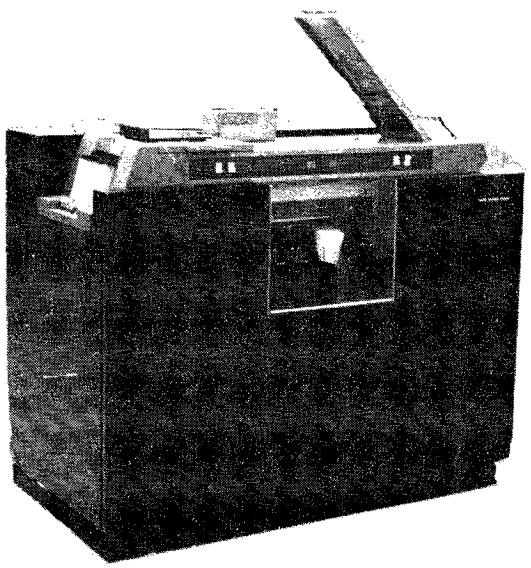
THIS IS THE 'COMMON LANGUAGE' WHICH LETS MAN CONVERSE WITH COMPUTERS

PAPER-TAPE. Contains information in machine readable form.

Fig. 2

A Honeywell 1800 Computer Configuration similar to the one installed in our Sydney Date Processing Centre.

Card Readers and Punches



A combined Card Reader-Card Punch

The units located in our Sydney Data Processing Centre are a card reader and card punch combined in the one cabinet. However each operates independently of the other unit. To ensure accuracy each card in the reader is "read" twice by two reading stations. Any disparity in the two readings signals an error which can be detected by the computer program. The cards are passed through the machine to stackers. Under program control the card may be directed to different stackers thus permitting segregation of error cards.

Speed of reading cards varies with the particular unit but the Sydney unit has a maximum speed of 800 cards per minute. The punch unit has a maximum operating speed of 250 cards per minute.

Magnetic Tape

We have seen that cards and paper tape may be used to feed data into a computer system, but the master file of data must also be stored on some machine readable media. One of these is magnetic tape which is similar to that used on a home tape recorder but is of superior quality.

Magnetic tape is generally either $\frac{1}{2}$" or $\frac{3}{4}$" in width and consists of a MYLAR (polyester film) strip coated with a special oxide which can be magnetized. The H1800 uses $\frac{3}{4}$" tapes. The recording portion of a full reel of tape is 2400 feet ($\pm$ 50 feet) in length. The Honeywell Series 200 Computer uses $\frac{1}{2}$" tapes.

Computer Equipment

A computer consists of a group of machines of various types some of which are data input devices, others are output devices, whilst a third group are input and/or output devices, and others contain main stores and control circuitry.

The Central Processor

This unit contains the storage or memory banks of the computer and the necessary electronic control circuitry to co-ordinate the activities of the other units in the systems.

The main storage unit of most modern computers generally consists of magnetic core storage. A magnetic core is a tiny doughnut shaped ring of material. Each of these cores stores one binary digit (bit). The important characteristics of magnetic cores are their compact size and the magnetic property of the material. These are arranged in groups to enable the computer to store information. There are 3 main ways in which this grouping is carried out.

Word Machines

In a word machine, the groups are comparatively large, with each group being designated a "word". The size of the word varies from machine to machine. Typical sizes are 12, 18, 24, 36, 48 or 60 bits. The H-1800 is a 48 bit word machine.

Character Machines

Here, the grouping is 6 bits to hold data. Each 6-bit character holds one piece of information: that is, one character from the computer's character set. The Honeyweel Series 200 Computers are of this type.

Byte Machines

Groups of 8 bits, called bytes, are the units of storage in these machines.

Information can be placed into, held in or read from computer storage as needed. The types of information which will be contained in the computer storage are :

* instructions to direct the computer;
* data on which the instructions operate; and
* reference data such as constants, tables etc.

Storage is divided into separate locations, each of which has an address, in much the same way as a set of post office boxes is arranged in a post office. The size of each location depends upon the type of computer system; it may be a character, a word or a complete record. As has been mentioned previously, each location in the H-800 and H1800 is a 48 bit word. Obviously in order to operate upon an item of data, it is necessary to know the address of the location containing the item.

Storage can be classified in two ways :

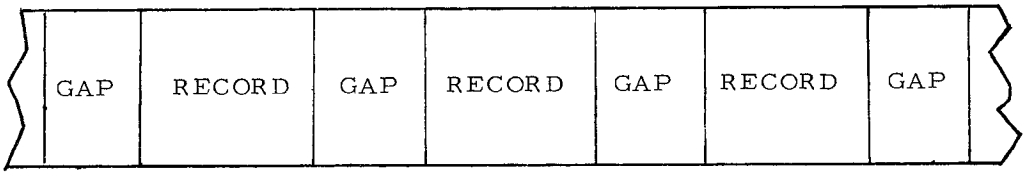
* main or primary storage; and
* auxiliary or secondary storage.

It is relatively common to find that a computer contains a main magnetic core storage of limited size (say 4, 000 words, or 16, 000 characters) and an auxiliary disc or drum storage capable of holding hundreds of thousands or even millions of characters. Usually this auxiliary storage is not directly available to the control or input/output devices and therefore all information to and from auxiliary storage must pass through the main storage unit.

Like paper tape, magnetic tape is divided lengthwise into channels. In these channels data is recorded in the form of magnetised spots. Each combination of spots corresponds to a letter or digit.

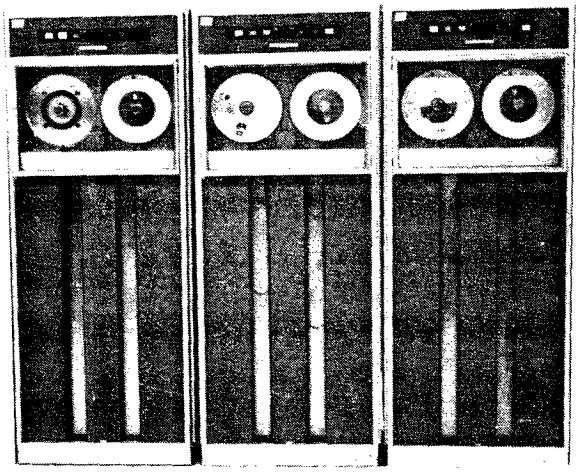
The data is written on magnetic tape in records with a gap separating them and the information is read or written one record at a time. A record basically consists of a number of data words and may be of any length, although normally a maximum record size will be specified for ease of programming and control.

The operation of the tape drives for both $\frac{1}{2}$" and $\frac{3}{4}$" tapes is as follows: magnetic tape may be read forward or backward; writing is achieved in a forward direction only. Data are read or written when tape passes under the magnetic read-write head; this is the only object which makes contact with the recording surface of the tape. Tape motion is achieved by applying vacuum through one of two capstans (one for forward motion; the other for reverse) which are continually rotating at constant speed. Tape slack is vacuum controlled in vertical chambers.



Information is written in longitudinal channels and one array of bits across the tape is called a frame, and as many as 800 frames can be packed into one inch of tape. A reel of tape therefore can hold from 15 to 20 million characters of information. For very large files multiple reels are used. It is not unusual to have large master files encompassing 20 or more reels of tape.

There is a fixed starting and finishing point on the tape reel. This ensures that data is always written and later read from the same starting position on the tape, and finishes on the same position. This also allows for a portion of tape at either end to be free for threading onto the tape reels. These starting and finishing points are detectable by the drive mechanisms.



MAGNETIC TAPE DRIVES

When a file consists of two or more reels of magnetic tape, two tape drive units are used alternately. The computer program can detect the end of a tape and cause instructions to be altered in order to read or write tape on the alternate unit.

The only method of processing tape is to commence at the beginning of the file and read each record on the file in sequence to the end of the file. This is known as Sequential Processing. It is standard practice therefore to have the records arranged in some predetermined sequence. This also means that transaction records on another tape must be arranged in the same order. When transactions are processed against a master file, this is called updating i.e. bring up to date. The old master file is read from one or more drives and a new master is written on other reels on other drives.

2 Magnetic Disk Storage consists of a number of thin metal disks, coated on both sides with magnetic recording material, spinning about a central vertical shaft. Data are recorded as magnetised spots, as on magnetic tape.

3 Each surface of each disk has a number of concentric recording tracks; also each surface is divided into equally sized sections known sectors. The number of records in a magnetic disk storage device depends upon :

4 * the number of disks;

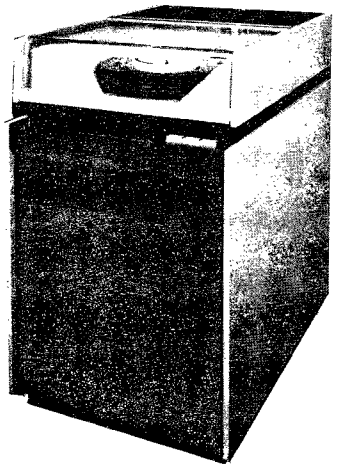
* the number of tracks on each disk; and

* the number of sectors on each disk.

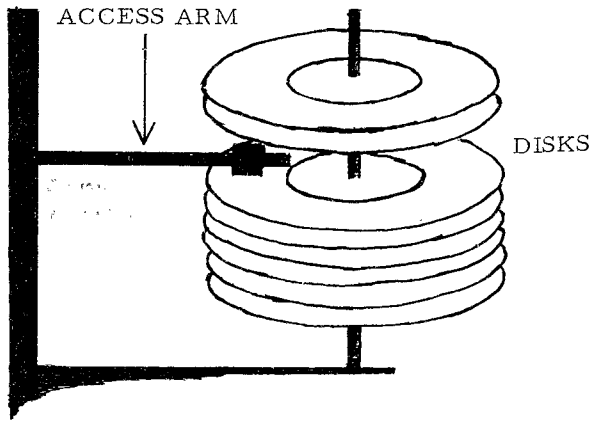
The access arm has a lateral motion and has attached to it several read-write heads one for each disk surface. Movement of the access arm can position the read-write heads in order to read data from a particular sector on a particular track on a particular disk surface. Each sector therefore has an "address" made up of identification of disk surface, track, and sector.

1. Magnetic Disks

A common feature in modern computers is that disk storage may be provided in removable self-contained packs, giving virtually unlimited storage capacity.



Magnetic Disk Drive and removable disk pack



Schematic diagram of disks and access arm.

5 The main feature of magnetic disk storage is that any location anywhere in the disk device can be accessed in approximately the same time as any other location.

There are two main forms of access to the file. One is Sequential Processing in which records are read or written in sequence of address and the process is therefore to all intents and purposes the same as magnetic tape. The other form is Random Access Processing. In this form some method is used to relate the identity of the record (the fields used to normally classify its sequence in the file) to a disk address. Thus the file data is not stored in address sequence. When transactions are processed the same method is used to find the master record as was originally used to store it. The advantage of this system is that it is only necessary to process those master records that are to be affected and no reading of master records takes places for those with no transaction record.

Another dissimilarity is that the updated record may be written back onto the same disk in the place from which it was read. This obviously replaces the previous information that was there so that at any time the record reflects the latest situation. A typical application would be inventory control where the stock-in-hand field reflects the latest condition as stock orders are applied to it. It is still possible of course to read data from one disk pack on one drive and write the new record on another disk pack on another drive.

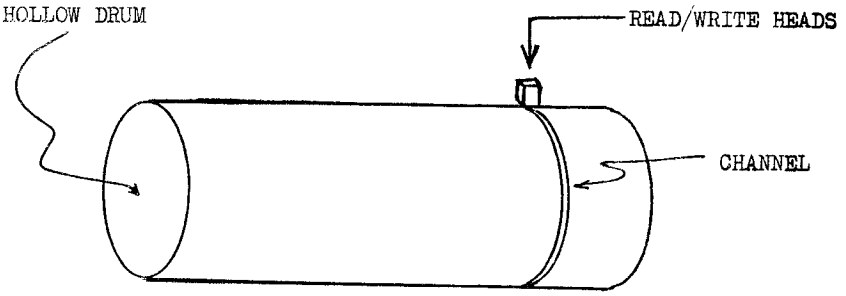
Magnetic Drum

The drum is a relatively old kind of storage device. The computer drum is made of a metallic substance, machined to close tolerance and coated with an oxide. The drum is continually rotated at a constant speed in proximity to read, write and erase heads.

Random access to information stored on a drum incurs a waiting time on the average of half a revolution, except where there are several sets of reading heads spaced around the drum circumference when the random access time is less.

There are two ways to store data on a drum memory. A serial method is used when speed is not essential. One of the tracks is selected and a data or instruction word is written on the track one bit at a time until the entire word is stored on a single position of a single track. This method is commonly used when the drum is referenced on a single word basis with subsequent references to be taken from other operations of the drum.

The second method is the parallel method which is commonly used when data is referenced in larger blocks. With this recording method there are enough tracks on the drum for every bit of a data word. if 12-bit words are used each bit will be stored on a separate track. In this case the time to locate the word may be long but the transfer time is quite short.

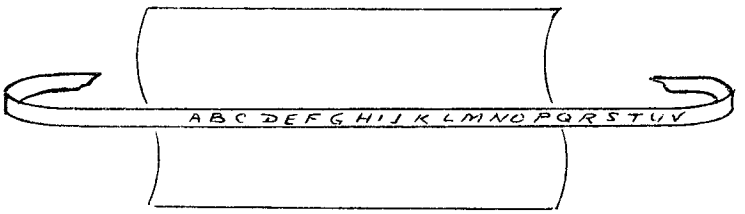


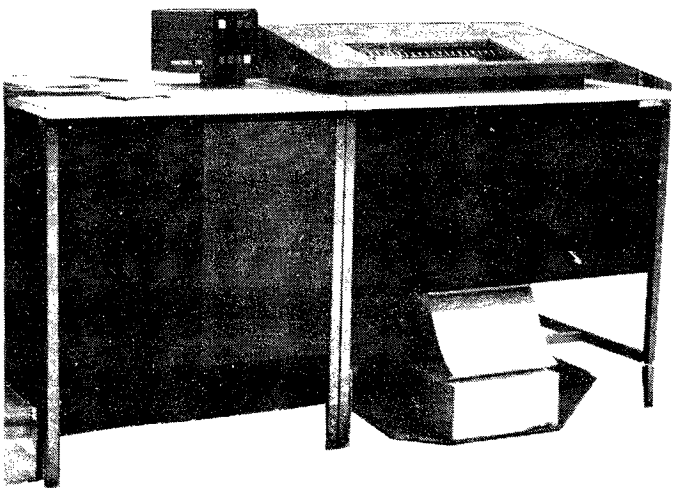
High Speed Line Printer

Printer listings form the final output of most computer programs. Continuous stationery is mechanically fed through the printer under the control of the program, and characters are printed upon the paper by one of several means.

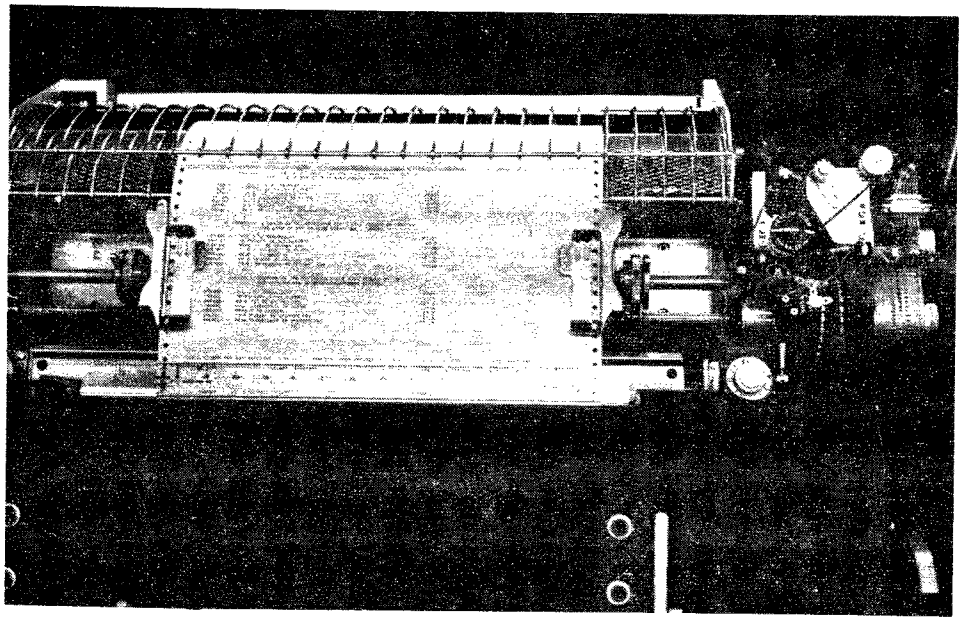
Bar Printers use a group of type bars, one for each print position in the line, each bar contains every character in the set. The line is setup by raising each bar until the desired character is opposite the printing position, and then printing the whole line at once.

Chain printers have the characters in the set mounted on an endless chain which rotates continuously across the paper. Letters are printed as the appropriate characters pass the desired positions.



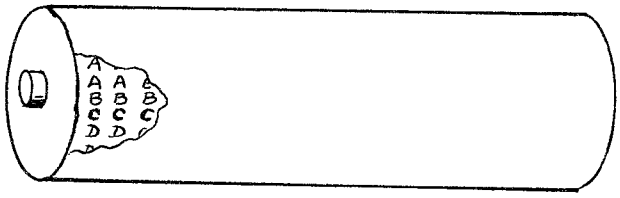


A High-speed Line Printer.

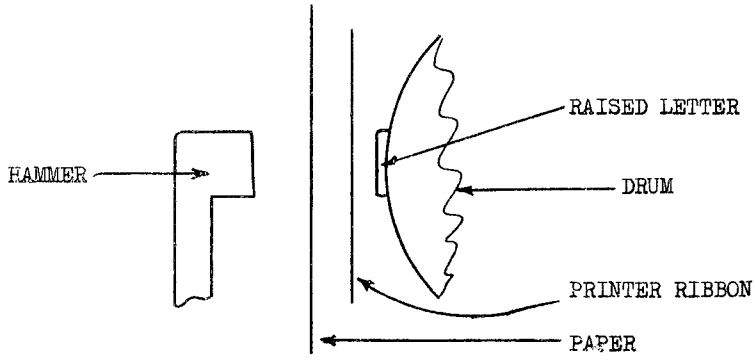


A report being printed on the high speed printer.

Drum ("on the fly") printers consist of a continually rotating drum which contains all the characters around the drum in every printing position.



As the drum rotates past the paper, the drum may position where all the "A"s, say, are to be printed in the line. Hammers are moved electrically to force the paper against both a carbon ribbon and the drum to print the A's. The drum rotates on, and all the "B"s are printed, and so on until the line is completed.

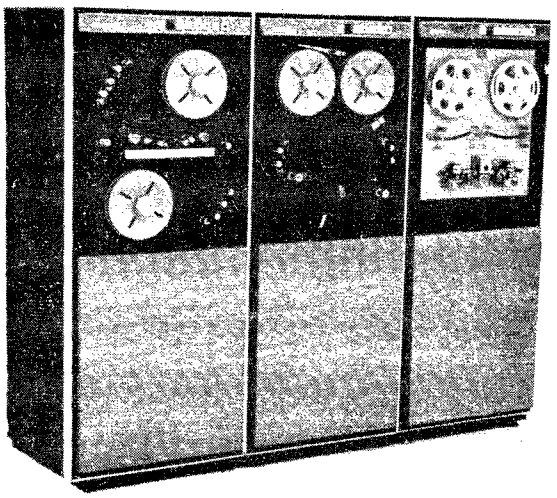


Carbon sheets can be interleaved with paper to produce multiple copies. This is the most common form of high speed line printer used today.

Electrostatic Printers use an electrostatic charge principle, similar to the Zerox office copier to produce the printed image. These printers offer the fastest printing speed, but are very expensive and cannot produce carbon copies.

Paper Tape Readers and Punch

Paper Tape readers vary in speeds according to model up to about 1000 frames per second while the punches are relatively slow at about 110 frames per second. The computer program reads the frames one at a time building up the data until a record is stored in memory. The installation in Sydney has two paper tape readers and a paper tape punch as in the illustration. The first unit is a reader and the second is a punch. The third is a reader for the special paper tape produced from Olivetti Audit machines.



WHAT IS A SYSTEM?

This could be defined as an organisation of manpower, machines and methods under a set of predefined procedures (or rules) to accomplish definite goals. The system may be large or small and involve the whole of an organisation or only part of it.

It is, of course, the final result of an effort of analysis of requirements of the system, planning and designing of the system and implementation with necessary inter-action between these various activities to achieve a practical solution of providing the information desired.

HOW THE SYSTEM IS DEVELOPED

As already indicated there are several stages in building up to a finally accepted system which must meet the needs of the management groups, sometimes called user departments, while operating within the confines of the computer system.

Feasibility Study

This is an examination of the business by management to determine the practicality and profitability of installing a computer system. With big business organisations it is usually bypassed as the answer is a foregone conclusion of "Yes". The sheer volume of work is such that it becomes necessary to utilise a computer.

In smaller organisations, however, the study must be approached seriously as there is considerable expenditure involved in setting up and maintaining the system. It may be found that a computer installation on site is not justifiable, but to buy "time" at a computer service bureau is. In some instances, the study reveals methods of improving the manual system sufficiently to nullify the need for a computer system, until a further build-up of work volume justifies it.

Definition of Problem Area

This is the task of setting down the boundaries within which the computer system is to operate. A study must be made of the problem area to determine in broad principle the purpose of its existence, what it sets out to produce, i.e., its information requirements or required output, and hence the input data and the controls which are to govern the processing.

The computer contains electronic circuitry to carry out the functions of reading and writing data, moving data from one part of memory to another and for performing arithmetic. It has a set of instructions which activate these circuits as required.

The specifications laid down with respect as to what data is to be processed, what data is to be used in specified calculations, what decisions are to be made and the relevant action taken must all be translated into a step by step group of instructions which is called the program.

The detail must be specific as the computer can make no inferences. For example, we may say to a child "May I ask your age?" and expect to get an answer of, say, "Nine". However the computer can only give a direct answer of Yes or No to the original direct question. Thus, if the answer were "Yes", the further direction question of "How old are you?" may be asked.

Again it cannot be asked directly if a certain number has a value of 2 or 3. It must be asked if the number is a two and if the answer is "no" proceed to ask if it is three.

The program, therefore, consists of a complete sequence of computer instructions and any associated constants, etc., required to enable the computer to perform a single task. It could be regarded as a job description for a computer to follow step by step.

If a few steps were missed out a human could possibly detect this and take the necessary remedial steps. A computer, however, is merely a high speed machine that will do only what it is told regardless of the right or wrong of the step.

Therefore, all specifications must be in the greatest of detail and every decision or exception stated together with the necessary solutions. Only if these are fully stated and correct can the computer carry out its task accurately.

The programmer writes his instructions on a sheet of paper, in a prescribed manner and within the confines of a strict set of rules. We use the technical term "language" to describe this writing but when the expression "computer language" is used it should not be confused with or thought to be similar in make-up to ordinary languages such as English, French, German, etc.

The machine only understands its own "language" which is in binary code. It is unpractical for the programmer to write his instructions in machine code and so he uses ordinary letters and numbers in his instructions but following the rigid rules laid down for the computer language he is using.

The group of instructions or program is punched into cards (or sometimes paper tape) and this is processed by a special program supplied with the computer which reads the letters and numbers and translates them into machine language, according to the rules stipulated for writing the program. The technical term "compilation" is used to describe the process. This machine language program is stored on magnetic tape (or disk) and is then available at any time and may be used repeatedly for loading into the memory of the computer which is activated to execute the program thus carrying out the allotted task.

Program Testing

Before the program is used productively, it must be thoroughly checked as to its performing the intended task and doing it accurately. For this the programmer must prepare a comprehensive set of test data which will searchingly explore the accuracy of the program, not only the normal condition cases of data but every type of exception also that has been catered for in the program.

It is usual also to use actual data supplied by the user group to doubly check the program and to reveal the presence of any condition that has not been catered for in the program. This could be a result of omission from the original specifications or a change since the specifications were drawn up.

Parallel Running

For a period of time, which may vary from days to months, the computer system may be operated in parallel with the manual system. This is done to ensure continuation of normal output and to check the computer system output. It also allows a period for user department personnel to become familiar with handling the computer system output. Frequently the changeover is gradual, with only a section of the work applied at a time to ensure a smooth transfer to computer operations.

Production Running

Systems are passed to Production running when the A. D. P. Section and the user department are both satisfied that the programs are achieving the specifications laid down.

With this broad area defined, work proceeds with the analysis of this area in detail and the design of the system to carry out the work. It should be realised that there is considerable interaction between analysis and design because what is to be done will greatly affect how it is to be done, and limitations that may be imposed will have an effect on what will finally be done.

Systems Analysis

This is concerned with the critical analysis of the data processing operations and their redesign. The entire business may be the subject of the analysis or only a section of it as determined by the definition of the problem area.

In the first stages of the analysis, the work consists of learning what is done by the existing system of personnel, equipment and operating conditions. To this must be then added what is wanted to be done by management but which has not been done because it was impractical up to this time. This, in fact, points out why the investigation process has been undertaken. Management is dissatisfied with the present system because of late, insufficient or inaccurate information or placing an excessive burden on operating personnel to collect, process and distribute data, all rising to excessive cost of operating. Other reasons also could be the introduction of a new range of products, a change in policy, or increased competition requiring a revision of the current operating system.

Facts to be brough to light in this analysis are such things as the output required; what is its format? Is there a timing deadline? What volumes of output? Any peak loading periods?

Following this therefore is the study of the manipulation of data to achieve this output. What master files are required? How big are they? Frequency of processing the files. Volume of transactions to be processed against the files. How are the master files built up?

This obviously leads to a survey of where does data originate? What forms are used? Who adds additional data? What controls or limits are imposed? What are the exception conditions and the method of handling rejections and subsequent corrections being re-introduced?

It may be seen that this fact-finding involves a huge amount of detailed investigation to finally ascertain the real information requirements and the limitations that may be imposed.

Usually, experts experienced in this type of work are used to carry out the investigation, but it could be possible, in a small job that is contained in a small area, for the analysis to be undertaken by personnel within that area. Their results could then be passed to data processing experts to design a computer based processing system to carry out the work.

Systems Design

The personnel carrying out this function are experts who have a sound knowledge and experience of computer equipment of various types. They must understand the capabilities and also the limitations of the equipment.

With this knowledge and the specifications laid down by the analyst, he can then lay out a configuration of computer equipment to best suit the carrying out of the work. Any limitations that may be imposed by equipment would be reflected in a feed-back that may require some modification to be made to the information requirements laid down.

If the system specified is to be run on an already existing computer configuration the requirements may have to be tailored to fit the available equipment. An alternative may be to extend the configuration with more equipment or replace existing equipment with more suitable versions.

An important aspect of the design of the system is the consideration given to the human participants of the system. No system is entirely automatic as someone must provide the initial data, others have to deal with exceptions of a type requiring judgement and to represent the corrected data. Time must be spent in laying out specific procedures to be followd by people in these areas to ensure an efficient overall system.

Programming

The computer is not able to perform any activity at all unless provided with a program to carry out a specific task. A separate program is required to carry out each of the tasks assigned to the computer. To understand this we must first understand what a program is.

Just as a clerk needs his instruction manual to direct his activities, a computer requires instructions to control its activities.

Maintenance Programming

As time passes, changes will occur in criteria limits or changes in policy may be made which will require amendments to the computer program or reflect these changes.

The alteration will require that the amended program as written be represented to the special program for translation into machine language (i.e., re-compiled) and this new machine language program then replaces the previous version and it must be retested for accuracy and presented for approval.

WHAT IS A PROGRAMMER?

The previous text has given some indication of the work involved in setting up a computer based operating system. Little has been said of the A. D. P. Branch personnel involved. The term used to describe the people involved is "Programmer" and this appears as part of the job designations. There are several major areas of activity and these are systems analysis, systems design and programming. Another important activity is the operation of the computer installation. There are also some involved in specialised activities.

All these people require specialised knowledge of computers and must undergo training to this end. Because of its specialised nature the A. D. P. Branch has its own training sub-section. The major course is a 12 months full-time course and members are designated as Programmer-in-Training.

On successful completion of the course they are assigned to programming and other tasks including systems analysis and systems design.

WHAT APPLICATIONS ARE SUITABLE FOR COMPUTER PROCESSING?

We must first discover the attributes of a computer system, its capabilities and also its limitations. There are a number of differences evident between a man doing a job and a computer doing the same job. These could be summarised under the following headings :

Speed of Operation

The computer works at speeds far in excess of the capabilities of any man. Reading and writing data on magnetic tape for instance is calculated in thousandths of seconds, while moving data from one location to another in magnetic core memory is of the order of millionths of a second. A large powerful computer may be able to perform 500,000 or more instructions in a second.

Accuracy

Because of a complex system of built-in accuracy checks, the computer can be regarded as an extremely accurate device. Deficiencies in the output of a computer are almost invariably due to incorrect input or input which requires special processing which was not catered for in the design of the system. This point should be clearly understood - the computer will always do exactly what it is told to do. It has no way of knowing if this is right or wrong, from the point of view of the desired results. If a part of its circuitry fails, it usually halts and provides some indication of what has gone wrong.

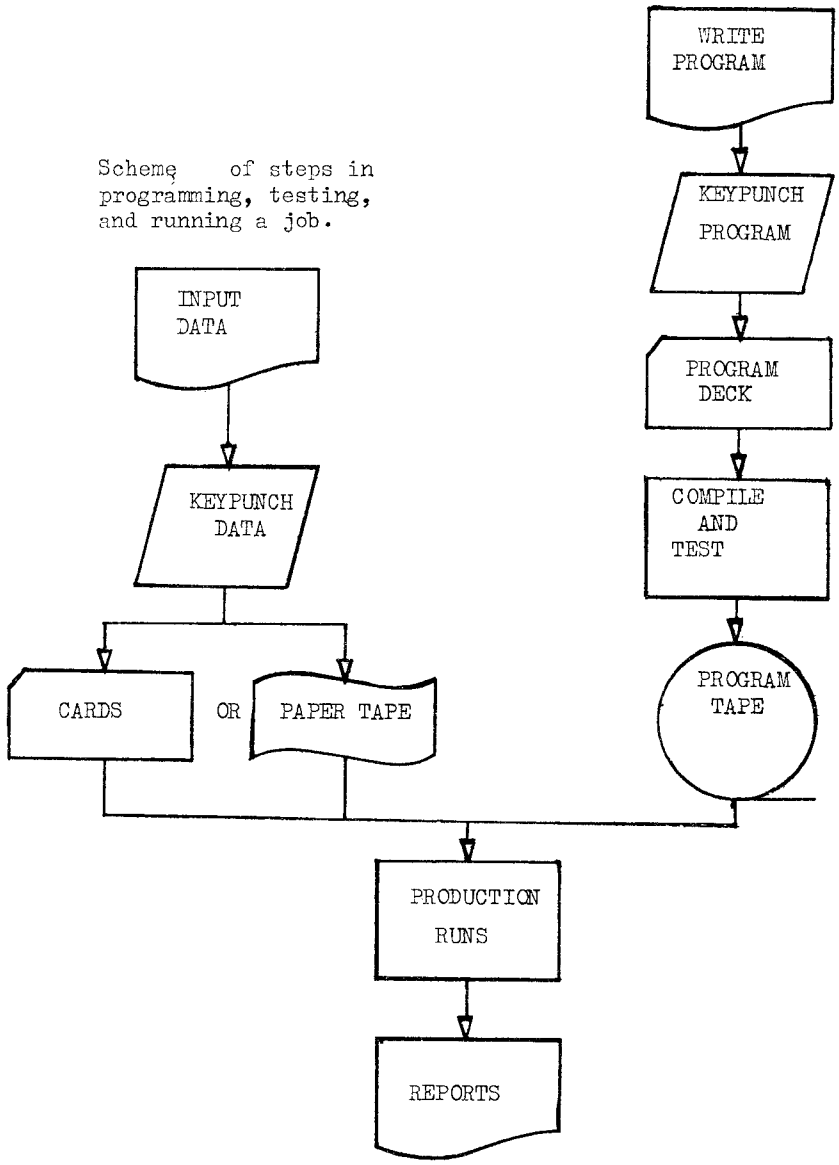
Flexibility

A computer can readily process job after job, no matter how different one job is from its predecessor. It does not require time to learn to do a new job. It will immediately begin following the instructions provided for it.

Versatility

Many computers can do more than one job at a time. For example, it might carry out the preparation of a payroll complete with printed cheques and at the same time answer queries from a number of remote points on stocks of spare parts held in the organisation, together with copying a file of cards onto a magnetic tape.

Scheme of steps in programming, testing, and running a job.



Compactness of Data

The manner in which data is recorded and stored on magnetic tape or disc means that huge master files may be stored in a relatively small space as compared to paper documents in steel filing cabinets. The sheer volume of data in large organisations like the Post Office or insurance offices creates a situation where it becomes impractical, if not impossible, to handle the data manually.

It becomes evident then that the type of work most suitable for a computer oriented system is one involving routine calculations and repetitive checking or updating of records where there is a large volume of data to be handled. Typical are payroll inventory, sales analysis, insurance, production control and billing.

The speed of a computer makes possible the processing of the data in a short while thus producing up-to-date information as soon as possible.

The early use of computers in business was to take over the routine activities of office work but management generally has now realised that the computer can be a powerful tool in aiding control of a business. For instance, the computer can handle an inventory control system and provide reports on stock movements and balances. However it can also provide, using suitably written programs, sales analyses in various categories. The computer has no ability to make a judgement; it merely produces information but the manager can use his judgement and infer other information. He can ascertain by the sales analysis reports which products are good "sellers" and which are poor and thus direct a better utilisation of the finance and equipment of the business.

TYPES OF SYSTEMS

A computer based system may be implemented in several ways and these methods all have their use. Before a business adopts any one method all consideration should be given to the long term view of the system and its implementation.

Isolated jobs

This method involves the building up of a computer system for sections of the business activity with no inter-action by computer programs between the various systems. In such a context a system is implemented for inventory control, say, and another, quite separately, for manufacturing. There is no output from the first which automatically becomes input to the second. Thus the inventory system may produce reports showing stock movements but this information is manually processed and then entered into the manufacturing system.

This type of system usually results in a design that is far from the optimum from the point of view of information processing. The amount of planning required for each of these isolated systems may not be as great as planning the system as a whole, but further costs could rise if a system re-design is later required.

Total Integrated Systems

This approach requires great expenditure of labour in planning and implementing the system, as it looks at the total information requirements of an organisation and the inter-action of data between sections of the organisation. Because it is a review of the whole data processing system of the organisation it takes considerable time and personnel to achieve success.

Implementation of the project is difficult as all facets of the system must be co-ordinated and set-up simultaneously.

A Total Integrated System Introduced in Stages

In this type of system there is planning of the whole system in a broad level to analyse the interactivity of sections of the organisation. The design and implementation of the system is done in stages. This permits a gradual building to a total integrated system without recourse to major replanning of sections of the system which serve all activities. Since implementation is carried out in stages there is an opportunity for a gradual changeover to a computer based operation while maintaining maximum utilisation of equipment and manpower.

Assignment No. 1 (ADP)

1. Describe, by comparison with a manual system, the functional units of a computer system. That is, Input, Output, Control Unit, Store, and Arithmetic Unit.

2. What is the purpose of a computer program?

3. Explain how data is represented in:-

   (a) Punched Cards
   (b) Punched Paper Tape
   (c) M.I.C.R. characters

   and indicate the main uses of each.

CHAPTER 3 - OPERATION OF AN A. D. P. SYSTEM

INTRODUCTION

In any system there are certain basic processes and in a computer based system these still apply although carried out in a specialised manner. The main areas of activity are data collection, data transcription, data transmission, processing, and the distribution of the output.

DATA COLLECTION

This is a facet of data processing which at times does not receive the attention of detailed planning and investigation that it should. The value of computer processing can be negated if the data collection system presented is inefficient or inaccurate. Any information system requires sources of data to provide accurate and relevant data.

This entails, then certain conditions to be met. The data should be captured at the point it is created to minimise possibility of error in manually prepared copies. There should be an authority allocated to key personnel who are the only ones delegated to provide the data to ensure that irrelevant data is not fed indiscriminately into the system.

These manual areas of data collection use special forms which are laid out in a manner to facilitate the presentation of the data in a standardised format. This also ensures that all items of data are presented, as any omissions become obvious. The designing of these forms raises problems as their format must suit the user entering in the data on the form and it must also suit the data transcription system for converting it into a machine readable media.

DATA TRANSCRIPTION

This is the function of converting hand or type-written data into a machine readable form. In the A. D. P. Branch the media used currently are punched cards and paper. Sometime in the future, with improvements in technology, magnetic ink character recognition (MICR) and optical character recognition (OCR) may also be utilised.

The work is carried out in sections known as Data Transcription Units (D. T. U.) and there are several of these located in strategic areas. There is one located at Central Office in the A. D. P. Branch and another in the North Sydney Data Processing Centre. Others are located in or near sources of data.

The operators of the machines undergo a period of training in both punched card and paper tape punching equipment and must achieve a certain standard of proficiency. They later sit for further tests in higher proficiency rating for advancement and promotion.

Each particular punching job has its own set of punching instructions as each produces records in various formats and the operators should become familiar with these procedures.

DATA TRANSMISSION

Currently, data is transmitted largely by manual means. The output of cards and paper tape from the D. T. U. 's is transported to the North Sydney D. P. C. by airmail bags and also by trucks from Melbourne.

There is also an automatic transmission system used, at the moment, on a limited basis. A special unit reads paper tape and the data is transmitted over telephone lines to the Sydney D. P. C. A similar unit there receives the messages and punches them into paper tape which may then be processed by the computer.

Some experimentation has been carried out using the Department's small computer at the Research Laboratories in Melbourne to communicate directly with another computer.

With improvements and advances in technology it is hoped to use automatic means of transmission to a greater extent in the future. This would allow for earlier processing of the data and production of reports.

It can also permit of a centralised computer installation with data being transmitted from offices directly to the computer centre.

A further development could be a number of computers located in capital cities and communicating directly with each other.

COMPUTER PROCESSING

Because the computer carries out a job automatically once it is started, the programs require tests to be incorporated in them to check the validity of data being presented. The computer will read data and process it as instructed. It has no knowledge that the data being presented corresponds to the particular program currently operating unless the input data includes identification codes. The program is written to recognise these codes and refuse to accept any other code, thus ensuring that only payroll data, say, enters the processing of the payroll programs.

The installation in North Sydney contains two computers. One is a large high speed computer known as the Honeywell 1800 and the other is a small computer known as the Honeywell 200. The speed of reading cards and paper tape and printing reports is relatively slow for the H-1800 system. Thus cards and paper tape are read by equipment on the H-200 and, after programs have validated the input data, are stored on magnetic tape. The reels of magnetic tape are then processed as input to the H-1800. Any reports are written back on magnetic tape by the H-1800 and these are then read by the H-200 and output on the high speed printer.

DISTRIBUTION OF OUTPUT

Recipients of reports emanating from the computer system have each been allocated a number and this number appears in headings of the reports. All report messages are sorted on this number so that the parts of the report pertinent to the recipient are together and may be despatched to him.

A. D. P. IN THE P. M. G. DEPARTMENT

INTRODUCTION

During the past decade, numerous computer processing systems have been developed by or on behalf of the Post Office. With one exception, each has been developed to meet a well-circumscribed fragment of Post Office needs. Most have been developed by officers engaged in normal duties, frequently in their own time. Undoubtedly, many have been economically profitable, virtually all profitable in terms of human experience. Most branches of most Administrations - Central and State - have participated in these efforts to exploit the faculties of the computer.

The A. D. P. Branch has supported and participated in many of these systems, particularly the larger ones. Through training, programming advice, computer hiring contracts and the Sydney Data Processing Centre, it has been the focal point or co-ordinator of most endeavours in the A. D. P. field.

The major task of the A. D. P. Branch, and the sole official purpose of the Sydney D. P. C., relates to telephone accounting - for New South Wales and Victoria switched network services. However, throughout time, the adopted policy of the A. D. P. Branch has included :

* that the application of A. D. P. to telephone accounting be with a system that can conceivably cover all needs of the Post Office; and

* that the Sydney D. P. C. be made available to all staff as a computer service bureau, subject to priority attention to telephone accounting and the finite limit to its capacity.

While the Post Office exists for installing telephones, connecting calls, delivering mail, etc., to function it needs information in myriad forms about the multitudinous events and instructions that occur each day. Thus behind the muscle is a complex nervous system conveying information to and fro, reforming, withholding, summarising or augmenting it, as needed. While this information tends to have certain distinctive pathways - e.g. between trunk exchange and accounting branch, post office and money order section - with rare exceptions there is a significant chain of information links between any two positions in the organisation.

An information system that embraces all the needs of all positions in an organisation is often termed a 'total' or 'integrated' information system. When we talk about such, in a computer context, we mean a total system wherein all information reports are made to computers or by computers, and wherein all accompanying or consequential processes are effected by the computers automatically from each stimulating input.

Because of the complexities and ramifications of the Post Office, its total information system presses the limits of comprehension. A computerised total information system is thus more of a concept than a specifiable entity.

THE A. D. P. BRANCH APPROACH

The approach of the A. D. P. Branch has been the creation of a basic computerised information system that allows almost unlimited expansion in terms of applications and unlimited communication between applications, the whole presenting one common face to staff. The system has been termed the 'Z System', merely to identify it; it has the simple precept that every relevant officer in the Post Office forwards to and receives from the system relevant information in a manner independent of office or application. Within the system, the routing and processing of information is automatic, and there are no system limits to the complexity of processing and/or record inter-relationships that can be accomplished. Thus, for instance, information on staff, supplies, or work activities of a field engineering group can enter the system at one point, and will then affect personnel, plant, service, supply and costing records automatically.

The approach of the A. D. P. Branch with the Z System might be likened to the creation of a telephone network with full inter-service automatic dialling, compared with most A. D. P. approaches which might be likened to the creation of individual manual exchanges or even point-to-point circuits. Of course, the practical realisation of the Z system concept is currently minimal, equivalent to the existence of one automatic exchange. Its value lies in its in-built scope to add the others.

GENERAL OUTLINE OF ACTIVITIES

The Australian Post Office, one of the biggest users of automatic data processing, is gaining appreciable economic and other operational efficiency advantages from the use of computers.

The Post Office handles about one million transactions each day, probably a greater diversity of problems and volume of data than any other Australian enterprise.

The first Post Office computer was installed in the Melbourne Research Laboratories in 1963, mainly for use on engineering calculations and the partial technical assessment of tenders.

In 1964, the Sydney Data Processing Centre was brought into operation for more general use. The Sydney centre acts as a general service bureau for Post Office computing.

Now in its first phase, the system is planned as a fully-automatic, nation-wide network of computers.

At present it handles about 10 per cent of all accounting for trunk and phonogram business, but final trials of full telephone accounting - all trunk call and phonogram dockets for Melbourne and Sydney subscribers will be processed on computers - are underway.

The full coverage of line occupancy, charge calculations, issue of bills, crediting of payments and debit collection will be introduced.

As the system is developed and extended, more advanced techniques and equipment will be employed permitting on-line, immediate interrogation of records for inquiry and other purposes.

Telephone accounting is only the start.

Many Post Office transactions appear as isolated occurrences, but are actually interwoven.

The integrated Post Office system designed for computer operations, allows such interchange and provides an information vehicle whereby any one event will cause the necessary chain reaction to set the interwoven events going.

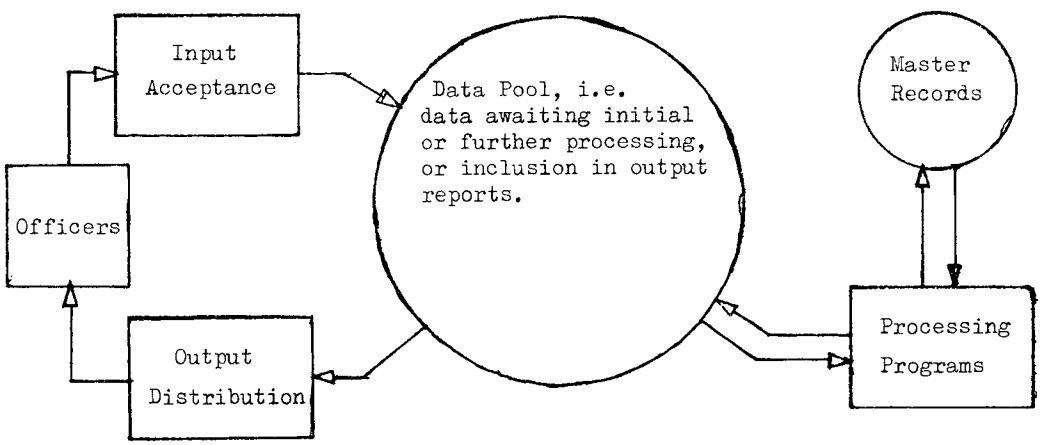
As an example, an application for provision of any customer service could automatically cause the allocation of plant, the initiation of accounting records, the provision of directory information, the preparation of installation instructions, the issue of equipment from store and updating of stores ledger records and the reporting of stock status.

Among other applications using the Sydney installation, though not yet within the integrated system, are the analysis according to origin, route and destination of samples of trunk representing about three million calls a year.

Other applications are the planning of the switched network, central stores recording and an analysis of faults on telephone lines throughout Australia, which highlights any markedly superior of inferior practice or use of materials.

THE 'Z' SYSTEM

Expressed simply, the Z System concept can be figured as follows :



In practice, the processing programs and associated master records exist in libraries, various members of which are brought into use as needed, e.g., the telephone master records and associated set of processing programs might be processed, then the debtors records and associated program set. Each program set has standard constituents that allow it to operate on the data pool. As such it provides sets of computer programs to perform the processing which is common to all applications wherever they be concerned with Telephone Accounting, Engineering Works, Planning, Supply, Pay and Personnel or any other. Z establishes the standard routines and disciplines which are necessary for the successful processing of applications so that these do not require spelling-out again and again for successive unrelated tasks. Additionally it provides an effective means of cross-talk between processing applications, e.g., generated information concerning plant usage as a result of accounting action.

The standard features provided by Z programs are as follows :

READ input media, e.g, punched cards, tape, etc.;

EDIT input data for correctness of layout, and apply the prescribed constraints or limits;

REGISTER input collections of data (Messages) against their originating sources;

REJECT input errors including apparent duplications;

REPORT input rejections and reasons therefore;

CREATE a Journal (or Pool) of edited data with each message tagged with the identity of the processing applications which will require it.

ALLOW operation upon the Journal by any number, and in any sequence, of the various processing applications, each of which consists of one or more Main Sequence Runs (or set of programs which must operate sequentially within the Run), each of these being capable of generating new data, tagging it for other processing applications and placing it in the Journal;

REJECT data which, although input in correct form, is incompatible with file records;

EDIT and REGISTER (Yet to be developed) output from the various Main Sequence Runs; and

PRINT (or punch cards or tapes as required) output reports, e.g., Bills, Statements, Analyses, Rejections, etc..

Assignment No. 2 (ADP)

1. Discuss a possible application of a computer to a job currently being done manually with particular reference to the following:-

   (a) Brief outline of the job together with input and output data required.

   (b) Choice of punched card or paper tape input (or both) and your reasons for it.

   (c) Selection of the peripheral devices and your reasons for your selection.

SOME COMMON COMPUTER TERMS

ACCESS TIME - The length of time required for computers to store data or to retrieve data from storage.

ADDRESS - A label, name, or number identifying a register, a storage location, or a device from which information is received or to which it is transmitted. Any part of an instruction that specifies the location of an operand for the instruction.

A.D.P. - Automatic data processing. A system that uses a minimum of manual operations in processing data. Used in the Commonwealth Public Service as a term to cover data processing by computer exclusively.

ALGOL - The abbreviation of algorithmic - oriented language, one of the common programming languages.

ANALOG COMPUTER - A computer that processes data by measuring variations in electrical and other physical properties. Contrast with digital computer.

ARITHMETIC UNIT - The part of the computer processing section that does the adding, subtracting, multiplying, dividing, and comparing.

AUTOMATION - The process of getting work performed without any human effort except that of telling the machine what to do and when to do it.

BINARY NUMBER SYSTEM - A number system using the base two, as opposed to the decimal number system which uses the base ten.

BIT - An abbreviation of "binary digit". The smallest unit of information in the binary number system. Normally a bit refers to one ("on") while a not bit means zero ("off").

BRUSH - An electrical conductor for reading data from a punched card.

CHARACTER - A symbol used to designate a number (1 to 10), a letter, special symbol, or punctuation mark.

CHARACTER RECOGNITION - The identification of characters by automatic means.

COBOL - Common business oriented language. A coding language by which business data processing procedures may be precisely described in a standard form.

CONTROL UNIT - The part of a computer system that effects the retrieval of instructions in proper sequence, the interpretation of each instruction, and the application of the proper signals to the arithmetic unit and other parts of the system in accordance with this interpretation.

CYBERNETICS - The comparative study of the control and communication of information-handling machines and the nervous system of man in order to understand and improve communication.

CYCLE - An interval during which one set of events or phenomena is completed. A set of operations that is repeated regularly in the same sequence.

DATA - A general term used to denote any facts, numbers, letters, and symbols, or facts that refer to or describe an object, idea, condition, situation, or other factors.

DATA PROCESSING - Any operation or combination of operations on data to achieve a desired result.

DIGITAL COMPUTER - A calculating device utilizing numbers to express all the variables and quantities of a problem.

DUMP - A copying or print out of all or part of the contents of a particular storage device. Synonymous with memory dump.

EDP - Electronic data processing. The general term used to define a system for data processing by means of machines utilizing electronic circuitry at electronic speed, as opposed to electromechanical equipment.

ERASE - To replace all the binary digits in a storage device by binary zeros. To remove data from a magnetic surface or other memory unit.

EXTERNAL STORAGE - The storage of data on a device such as magnetic tape which is not an integral part of a computer, but is in a form prescribed for use by a computer.

FLOW CHART - A graphical representation of the definition, analysis, or solution of a problem using symbols to represent operations, data flow, and equipment.

FORTRAN - Formula translator. A programming language designed for problems which can be expressed in algebraic notation, allowing for exponentiation and up to three subscripts. The FORTRAN compiler is a routine for a given machine which accepts a program written in FORTRAN source language and produces a machine language object program.

HARDWARE - A colloquialism applied to the mechanical, electrical, and electronic features of a data processing system.

HOLLERITH CODE - A standard 12-channel punched card code in which each decimal digit, letter, or special character is represented by one or more rectangular holes punched in a vertical column.

INPUT - Information transferred into the internal storage of a data processing system, including data to be processed or information to help control the process.

INTERNAL STORAGE - Storage facilities integrated as a physical part of the computer and directly controlled by the computer.

LINE PRINTING - The printing of an entire line of characters as a unit.

MACHINE LANGUAGE - The instructions written in a form that is intelligible to the internal circuitry of the computer; not ordinarily comprehensible to persons without special training. Sometimes called "actual" or "absolute".

MAGNETIC CARD - A card with a magnetic surface on which data can be stored by selective magnetization of portions of the flat surface.

MAGNETIC CORE - A small doughnut-shaped piece of ferromagnetic material, about the size of a pin head, capable of storing one binary digit represented by the polarity of its magnetic field. Thousands of these cores strung on wire grids form an internal memory device. Cores can be individually charged to hold data and sensed to issue data.

MAGNETIC DISK - A storage device by which information is recorded on the magnetizable surface of a rotating disk. A magnetic disk storage system is an array of such devices, with associated reading and writing heads mounted on movable arms.

MAGNETIC DRUM - A rotating cylinder, the surface of which is coated with a material on which information may be recorded as small magnetic spots representing binary information.

MAGNETIC INK - An ink that contains particles of a magnetic substance whose presence can be detected by magnetic sensors.

MAGNETIC INK CHARACTER READER - A device capable of interpreting data typed, written, or printed in magnetic ink.

MAGNETIC TAPE - A tape or ribbon of material impregnated or coated with magnetic material on which information may be placed in the form of magnetically polarized spots.

MEMORY - The part of a computer that stores the program, holds intermediate results and various constant data. Same as storage.

MICR - Magnetic ink character recognition. Machine recognition of characters printed with magnetic ink.

OCR - Optical character recognition. The machine recognition of printed characters.

OPTICAL SCANNER - A device that optically scans printed or written data and generates its digital representations.

OUTPUT - Information transferred from the internal storage of a data processing system to any device external to the system. Also, the results of operations performed on data in data processing.

PERIPHERAL EQUIPMENT - Units that work in conjunction with the computer but are not part of the computer itself, e.g., tape reader, card reader, magnetic tape feed, high-speed printer, typewriter, etc.

PROGRAM - The complete plan for the solution of a problem; more specifically, the complete sequence of machine instructions and routines necessary to solve a problem.

PROGRAMMER - A person who prepares the planned sequence of events the computer must follow to solve a problem.

PUNCHED CARD - A heavy stiff paper of uniform size and shape suitable for being punched with a pattern of holes to represent data and for being handled mechanically.

PUNCHED TAPE - A tape, usually paper, on which a pattern of holes or cuts is used to represent data.

RANDOM ACCESS STORAGE - A storage device, such as magnetic core, magnetic disk, and magnetic drum, in which each record has a specific, pre-determined address which may be reached directly. Access time in this type of storage is effectively independent of the location of the data.

SOFTWARE - The programs and routines used to extend the capabilities of computers, such as compilers, assemblers, routines, and subroutines. Also, all documents associated with a computer, e.g., manuals, circuit diagrams, Cf. hardware.

SOURCE PROGRAM - A program usually written in some form of symbolic language and intended for translation into a machine-language program.

STORAGE - A device into which data can be entered, in which it can be held, and from which it can be retrieved at a later time.

SYSTEMS ANALYSIS - The study of an activity, procedure, method, technique, or a business to determine what must be accomplished and how the necessary operations may best be accomplished.

TEST DECK - A set of cards representative of all operations performed in a particular application. Used to test control panel wiring and machine operations.

UPDATE - To put into a master file changes required by current information or transactions.

VERIFY - To determine whether a transcription of data or other operation has been accomplished accurately. To check the results of keypunching.