EXHIBIT 13

TYPES OF COMPUTER EQUIPMENT

There are two main groups of computers called respectively digital computers and analog computers. The latter group is mainly used in scientific research and will therefore not be considered here.

Within the group of digital computers, there are some which are specially modified for use on scientific work, mainly in order to cope rapidly with large numbers. These will not be considered here. Computers in commercial use are usually designed to cope rapidly with large volumes of information, although they can of course perform many of the calculations done on scientific computers. There are some all-purpose computers.

Computers can range in size from small desk models for calculations through to the large computers as in maintaining a world wide seat reservation service for airlines.

An important feature of the computer industry is the rate of change of equipment. New techniques are very quickly developed and in some cases computers are sold to the customer before a particular model has been produced in running order. Because of this rate of change, the tendency is to hire computers rather than purchase them. In order that a computer manufacturer can keep a particular customer, he has to ensure that when a particular model becomes out of date, the next model should be adapted to solving the same problems as the one it replaces. As far as possible therefore, the manufacturer attempts to ensure that program instructions written for the first model will also operate the second. This principle, called compatibility, also applies when a given customer requires a more powerful computer than he already has. The next computer in the manufacturer's series, must be compatible with the less powerful model.

A computer system is a complex of hardware (the physical equipment) and software (the program instructions to perform different operations). These are discussed below.

Hardware

The hardware can be divided into the central processor which contains all the equipment to control the operations of the peripheral equipment.

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Control Processor

The central processor has the following major components: a memory, a processing section, an input/output control section, an operating console.

The memory section is one of the commonest means evaluating differences between computers. A small computer may have a memory size of 4,000 characters (4K). Extra memory can be added on to many computers quite easily, generally going up in size from 4K to 8K to 16K, etc. An average service bureau computer may have a 64K character memory.

The other important point of comparison between computers is the speed with which characters are read into or out of memory. This can also be increased quite easily. One range of modern computers has speed ranging from 1.45 through 1.28 to 0.68 millionths of a second per character. A character may be treated differently on different computers, so that comparison in terms of characters is not always meaningful.

The processor section contains all the logical equipment for performing arithmetic and other operations. The input/output control section controls the movement of characters from the peripheral equipment to memory and back. An average computer will have 75% of its time available for calculation whilst performing simultaneously the following operations: reading 900 cards per minute (72,000 characters per minute), reading 60,000 characters per second from magnetic tape, writing the same number to another magnetic tape, printing a total of 3,600 lines per minute on three printers (each line can have 136 characters). The computer is controlled by a typewriter operating console.

Peripherals

a) card reader: an average card reader reads 900 cards per minute which is equivalent to 72,000 characters per minute. This is the principal channel by which data is fed into the computer.

b) card punch: an average card punch punches 100-300 cards per minute, which is equivalent to 8,000 - 24,000 characters per minute.

c) printer: an average printer can operate at up to 1,200 lines per minute with about 136 characters per line. There is a choice of 64 characters. The stationery can be composed of forms, linked continuously, of about 3 to 19 inches wide and up to 22 inches long.

d) magnetic drum storage: can store from about 4.5 to 12.5 million characters which can be read from the drum at the rate of about 370,000 characters per second.

e) magnetic tape storage: one tape can store about 20 million characters per second. There are many types of magnetic tape. Some can contain more characters and be read faster.

f) perforated paper tape reader/punch: can read 500 characters per second or punch 150 characters per second. This is another important means of feeding data into the computer. Some readers are separate units from the punch.

g) magnetic disk storage: some disks are removable from the disk unit. A disk, depending on the size, can store 1.5 to 7.8 million characters.

h) magnetic mass data storage: specially coated cards can be used to store characters. One storage unit can store up to 500 million characters.

i) magnetic reader/sorter: can be used to read specially printed figures, as on some cheques.

Peripherals for Remote Access

In some cases a computer can be used from a distant point by use of a device bearing some resemblance to a telex machine so that contact can be maintained between the user and the computer over a telephone line. As with a normal typewriter, the rate of operation is of the order of 10 characters per second, although calculations are done at computer speeds.

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Special Peripherals

Increasing use is being made of certain special peripherals. These include television screens to display information in the form of characters or lines. These can be altered by use of a light pencil. Fast printers using photoelectric techniques are also being developed.

Comments on Peripherals

It is very important to note the rates at which different peripherals can operate. If the computer is instructed to use a slow peripheral like the card punch, rather than a fast one like a disk unit, then it is wasting valuable time, unless no other method is suitable. For this reason, some sophisticated computer systems have two computers linked together - one which is expensive and uses fast peripherals, another which uses slow peripherals but is cheap. The fast one does the calculation and then transfers the results quickly to storage on a 'fast' peripheral, the slow one then reads the information from the fast peripheral and writes it out via the relatively slow printer. This saves wasting time on the fast expensive computer.

The distinction between use of magnetic tape storage and magnetic disk storage is an important one. If a series of names and addresses are stored in alphabetical order on a tape, presumably the tape will have to be updated periodically. If there are a large number of modifications each time, then the time spent in reading through the tape will not be wasted. If, however, there are only a few modifications, or the modifications are all in the last quarter of the alphabet, a considerable amount of computer time will be wasted in searching through the tape until it gets to the last quarter or the odd items to be corrected. In cases like this, a magnetic disk unit can be used. With a disk unit the computer is able to go straight to the part of the disk where the out of date name and address is stored and make the correction. No time is wasted in reading through a tape. Many computer installations do not use magnetic tapes.

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Accessory and Classical Equipment

Computers have taken over many functions which were performed by other card machines. These are still used as essential accessories in a computer installation. They include:

a) card punch: this machine possesses a keyboard similar to that of a typewriter. It is the main method by which data to be processed by the computer is transferred from a printed document to the standard 80 column card. An average operator can punch 8,000 characters per hour.

b) card verifier: this machine is almost identical to the card punch. The verifier operator reads the same document as that read by the punch operator and depresses a key in the same way. The key depression results in a check of the data punched into the card by the punch operator. If the card is incorrect the verifier operator removes it from the deck of alteration. The rate of operation is the same as that for a punch. In most installations, the precaution is taken to have all punched cards for the computer checked by a verifier. This is not absolutely essential.

c) card interpreter: this machine 'interprets' the holes punched by the card punch into each card and prints out the equivalent numbers and letters so that the contents of the card can be read. This is very useful if a set of cards has to be checked through manually. An interpreter operates at about 100 cards a minute. Because it is so slow, most installations try to avoid the need for using one.

d) sorter: each card produced generally bears some code (e.g. customer account number). Time is often saved by sorting cards on a special sorter prior to sending the cards to the computer. Sorters can operate at up to 900 cards per minute.

e) collator: in some cases two separate sequences of cards must be blended together in number order. This is done by a collator which operates at about 300 cards per minute.

f) tabulator: prior to the installation of computers, the tabulator performed most accounting operations. It reads cards and performs calculations based on a specially wired set of instructions. The results are printed out. The program can be changed very easily.

g) mark sense equipment: in some cases it is useful for computer cards to be marked in with a special pencil (e.g. by warehouse stock clerk). The cards are then magnetized, read by the mark sense equipment which punches equivalent holes which the computer or tabulator can read in the normal way. This avoids the necessity for a printed document to be prepared which must then be used to punch and verify punched cards.

The above items of classical equipment still form the basis for many highly successful data process installations. The disadvantages of this equipment are: lack of processing flexibility, slow speed of operation, no memory (available for complex operations), no storage other than trays of cards.

Software

The hardware peripheral listed above is absolutely useless without some form of instructions to control operations. Software is the term given to the codes, instructions and languages that have been developed to facilitate instructing the computer to perform the operations required to solve a given problem.

The term software covers: the languages, many of which resemble basic English, that have been developed to control a particular computer (there are now about 1000 computer languages); the standard programs written to perform common operations.; the particular programs written to deal with a particular application of a given organization.

Examples of computer languages which are independent of a particular make of computer are: COBOL, FORTRAN, ALGOL. Examples of standard programs provided by most computer manufacturers are: tape sort, tape merge, payroll routine, square root routine.

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Types of Processing

a) Wire Program - no memory

This type of processing is only applicable to the accessory equipment such as the sorter, collator or tabulator.

b) Program - no operating system

In the second generation of computers which has now been largely superseded, programs were read into the computer one by one on completion of each job. All control remained in the hands of the operator.

This wasted a lot of valuable computer time. With the current third generation, many of the operator's functions are performed automatically by a special collection of programs known as the operating system. Only when the latter cannot correct errors is control given to the human operator.

c) Programs with Operating System

d) Multi-Processing or Time-Sharing

As explained earlier, when the computer has a lot of reading or writing operations to perform, about 75% of its computing time is being wasted. Many third generation computers are able to perform two or more jobs virtually simultaneously.

e) Remote Access or Real-Time Computing

Associated with multi-processing is the facility by which many typewriter-like terminals can be linked to one computer from a great distance. Such is the speed of the computer, that it is able to deal with each terminal, one after the other, and yet give the impression to each of the human operators of only one or two seconds delay between question and answer. The limitation of this form of processing is that the emphasis is on calculations rather than systematic processing of large volumes of data, it is therefore more suitable to scientific applications or checking a particular customers credit.

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f) Integrated System

In some large installations, it is possible to arrange that every item of information needed for calculations is registered as soon as possible (e.g. the slip prepared by the counter sales girl) in a manner adapted to automation data processing. This cuts out all intermediate manipulation. If it is important enough, the manager of the installation can obtain immediate information on any field of the organization's activity. A typical example of such a system is the airlines seat reservation system. Each firm booking is immediately notified to the computer.

Preparation of a Program

The operations required to process all the data and produce all the printed information required are divided into groups. Each group consists of one data processing job. This may be invoicing, preparing a balance sheet, sending payment reminders, etc. At least one program is required for each job.

The program is the set of instruction to the computer on how to perform each of the operations necessary to complete the processing for that job. The operations must be specified in great detail before the program can be written.

Once the program has been written on a standard form, the latter is used by a punch card operator to prepare cards. When these cards have been verified and grouped together, they constitute the 'source program deck'.

The source program cards are then fed into the computer through the card reader. The computer assembles the program and converts it into special machine language code. Whilst doing this, it checks to see whether the programmer has not made any errors, although it cannot detect errors in logic. Error messages are printed oot. The programmer prepares a corrected source program until the computer finds no errors. When this stage is reached, the computer punches out an 'object program' in machine language.

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The object program is then tested by using the sort of data which the job is required to deal with in practice, e.g. orders, invoice payments, etc. This test may reveal errors in logic, in which case the programmer must prepare a new source program and repeat the procedure. When there are no errors at this large stage, the program can be used to deal with real data on a regular basis.

Modifications to the system once it is in operation, mean that the programmer must prepare a new source program, and test it. The new program may have an effect on related programs which might also have to be altered and tested.