ELECTRONIC DATA PROCESSING

TECHNIQUES IN COMMERCIAL, INDUSTRIAL AND

LOCAL GOVERNMENT INSTITUTIONS

- by -

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P R E F A C E

Originally computers were restricted to science and technology. However, their fields of application are being widened. As we see, the applications of computers in scientific, technological, industrial, graphic design, linguistics, information retrieval research fields are increasing day by day. There are also other non-numerical applications of computing machines such as in games playing, creating music and art. The present study is intended to investigate the suitability of computer applications in commerce, industry and local government. In this study, I have not considered the technical side of computers in the aspects of logical design and programming. Appendix II has been included as a guide for users. It contains a list of a number of machines and peripherals, with various capacities and costs.

My obligations in this work are many. I am deeply indebted to Dr A. J. Cole, Director of the Computing Laboratory, University of St. Andrews - my supervisor, for his invaluable guidance. His tolerance, understanding and encouragement through constructive criticisms and suggestions enabled me to master 'this monster' as the computer was known to me prior to taking up this Course.

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PART I

INTRODUCTION

Electronic Data Processing, shortly known as EDP, has brought a revolutionary change in the mechanisation of brainwork. In the industrial revolution, man's muscles were replaced by mechanical power. Now man's mental work is being replaced by computers. The computers known at the moment are at most twenty years old. Many persons believe that the period we are undergoing is the period of computer revolution. In science, arts and commerce - in all branches of human thought and action, computers are playing their part. Man has a limit to his capabilities, but the computer, which is a creation of man, has no obvious limit in its spheres of thought or action. The machine is fundamentally a calculator, but of enormous power, which is affecting all branches of human thought. Sir George Thomson, F.R.S., in his presidential address to the physics and mathematics section of the British Association for the Advancement of Science, said in 1956:

> 'The electronic computer has not made the headlines in the same way as nuclear energy, but I believe it is comparable in importance. The ability to apply precise reasoning to very large amounts of data in a reasonable time is something new, and the introduction of computers in science may prove not much less important than the introduction of mathematics in the seventeenth century ... They can do much to take drudgery out of the office, and can be to the clerk what the bulldozer is to the navvy.'

Since this speech, the importance of computers has been increasing. They are not only being used in scientific calculations, but also in

commercial calculations. Modern commerce and industries are complex. Human judgements of decision making and decision execution may not be perfect. Therefore the use of the electronic computer has been successful in formulating and executing commercial policies, as we see from the following:(1)

'The application of computers to industry is causing a second industrial revolution, as significant to the human race as was the first industrial revolution. This analogy is worth pursuing. The first industrial revolution involved the replacement of human and animal muscle power by the power of machines. It released mankind from a lot of backbreaking physical work, and although we failed to avoid some unpleasant initial effects, no one would doubt that the material effects in the long run have been of great benefit to all of us. The non-material benefits have also been significant: increased leisure, wider experience for all of us, and in the main, increased happiness.

'Even though this first industrial revolution is still not complete, we have now been caught up with a second similar phenomenon, as computers spread into industry, commerce and the government service. Just as the machines relieved us of the necessity for so much unpleasant physical work, so computers can relieve us of much detailed and stultifying routine mental effort. Much of the drudgery of bookkeeping and filing, for example, can now be done by computers. Routine design calculations can also

(1) The Rt. Hon. Lord Bowden, Principal, Manchester Institute of Science & Technology, University of Manchester, wrote in an article, 'The Second Industrial Revolution - the Gentle Computer', New Scientist, page 4 (1966).

be computerised. Machines are thus freeing the human mind, in the same way as the human muscle was freed over 100 years ago.' In 1956, when Sir George made his speech, the computer was in its infancy and there has been a remarkable development since then, as we see from the writing of Lord Bowden. People earlier thought that it was just an electronic calculator, but that idea is now removed. The difference is now realised from the following objective points of view:

1. An electronic calculator cannot decide on the course of action in the light of previous results. It cannot adjust its actions to varying conditions which its own activities show to exist. The electronic computer can take a decisive role.

2. The mass storage of data cannot be done by electronic calculators, but electronic computers can store virtually limitless quantities of data.

3. Electronic computers can carry out different types of operations which electronic calculators cannot do.

4. An electronic calculator is a special purpose device only for addition, subtraction, etc., but an electronic computer is a multipurpose device. For example, the latter can prepare billing, which work is only a dream to expect from a calculator.

5. The speed of computers is of a different order of magnitude to calculators. It is as high as valves and transistors can generate electronic pulses at rates of the order of a million or more pulses a second.

(1) Dr Richard W. Hamming points out that, 'the first steam engines

(1) Director of Mathematics Research, Bell Telephone Laboratories.

were only about ten times as effective as animal power. Steam powered vehicles were about ten times faster than the horse and buggy. Computers, however, are up to ten million times as fast as the mechanical calculators they replace.'

It is of interest to consider the actual rate of growth in the number of computers being installed. As computer applications become more widespread, people are understanding more about them and therefore more computers are being installed.

Table A: (1)

INSTALLATIONS OF FIRST GENERATION COMPUTERS IN THE U.K. 1961

Manufacturers	Computer	U.K. Origin	U.S.A. Origin	Total
Burroughs	E 101	-	3	
English Electric	Deuce	29		
Ferranti	Mark 1	8		
	Pegasus	35		
	Mercury	14		
I.B.M.	305/650/704/705/709	-	23	
Power Saunas	P.C.C.	74		
Hollerith	1201/1202	45		
Leo Computers	I. & II.	12		
N.C.R.	401/402/403/405	35		
	802	7		
Standard Telephone	Zebra	16		
		275	26	301

Table B:

ESTIMATED INSTALLATIONS OF SECOND GENERATION COMPUTERS IN THE U.K. - JANUARY, 1960 TO DECEMBER, 1964

Manufacturers	Computer	U.K. Origin	U.K. Total	U.S.A. Origin	French Origin	Total
A.E.I.	1010	7	7			
Burroughs	2000			12		
	Bull 30*			5		
	10				11	
English Electric	KDP6	10				
	KDP10*			8		
	KDN2	7				
	KDF9	16				
Leo Computers	III.	25				
	360	1	59			
Honeywell				15		
I.B.M.						
I.C.T. (E.M.I.)	1100	24		346		
	2400	4				
(I.C.T.)	1300	43				
	1301	62				
	1500*			55		
Ferranti	Sirius	16				
	Orion	11				
	Atlas	5				
	Argus	13	178			
N.C.R./Elliot	315			23		
	502/3	11				
	803	130	141			
			385	464	11	860

* Bull 30, KDP10, ICT 1500 are identical machines manufactured by Radio Corporation of America and sold under licence in this country.
Source: Computers in Britain, Bow Group, page 49.

(1) The figures in this and subsequent tables have been built up from a variety of sources, largely from the Computer survey, the Diebold Computer Census, the half-yearly John Diebold Census of computer installations in the U.S.
Source: Computers in Britain, Bow Group, page 48.

Table C:

ESTIMATES OF ORDER IN HAND OF THIRD GENERATION COMPUTERS AT SEPTEMBER, 1966

	U.S.A.	U.K.
I.B.M.	8,000	500
Honeywell	1,200	50
Univac	800	10
G.E.	400	5
C.D.C.	200	3
R.C.A.	400	-
I.C.T.	-	400

(Sources of Tables 1, 2 and 3: Computers in Britain, Bow Group (1967), pages 48, 49 and 13).

From the above tables, it appears that every year the number of installations is increasing. However, taking into account Europe and U.S.A., the same trend continues, as the following table will show:

Table D:

NUMBER OF COMPUTER INSTALLATIONS OF ALL GENERATIONS (I, II & III GENERATIONS) AT WORK AT END MARCH, 1967. THIS TABLE EXCLUDES VERY SMALL MACHINES SUCH AS DESK TOP AND VISIBLE INDEX. BY COURTESY OF 'ELECTRONICS WEEKLY'.

Country	Population (millions)	Computer Consultants	Diebold	International Business Automation	Computers per head
U.K.	54¼	2,611	2,252	2,290	0.445
Germany	59	2,211	2,963	2,674	0.44
France	49	1,924	2,008	2,240	0.409
Italy	51½	1,822	-	1,243	0.29
Belgium-Luxembourg	10	376	960	-	0.38
Holland	12	432	-	-	0.38
Switzerland	6	500	-	-	0.83
United States≠	180	-	30,785*	-	0.71

* To end 1966.

≠ 'Electronic News' estimate just under 32,000.

(Source: The Times Business News, 7.6.67. E.E.C. entry would increase computer staff shortage, by Francis Cairncross.)

Table E:*

COMPUTERS INSTALLED PER MILLION OF POPULATION

	1962	1963	1964	1965	1966
U.K.	10	14	20	26	37
U.S.A.	not available	not available	not available	104	144
W. Germany	12	18	26	32	48
France	11	17	22	26	31
Switzerland	23	34	43	50	63
Netherlands	10	14	18	21	33

* The Table - produced by the Minister of Technology in answer to a House of Commons question - shows unofficial estimates of the number of computers installed per million of population in six countries. Figures are believed to be consistent, but comparison between countries is unreliable since differing definitions of 'computer' may have been used.

(Source: The Times, 22.6.67)

Having considered the growth rate, we consider next whether or not there is a limit to the possible applications of computers. We investigate the abilities and disabilities of computers, with their limitations particularly in mind.

The Abilities of Electronic Computers:

The abilities are varied, as we will see later by their uses in science and other fields. The major abilities of a computer can be tabulated as follows:

1. Electronic computers can add, subtract, multiply and divide.

The normal unit of time is the [1] millisecond or, more commonly, the [2] microsecond for additions and subtractions. The multiplication and division speeds of some automatic computers are slower than those for additions and subtractions, as they do multiplications and divisions by making repeated additions or subtractions. Many modern computers have special circuits to perform multiplication and division and the resulting speeds are not much slower than for addition and subtraction.

2. Electronic computers are logical machines for the processing of information. The logical operations of the computer can range from the simple to complex, and are dependant upon two factors:

(a) programming skill.

(b) particular type of computer.

The logic system employed in most computers is a variety of Boolean logic. The logical ability of a computer enables it to make a decision. Simple tests such as equal to, greater than or smaller than, can be made and the subsequent course of action made to depend on the result.

3. Electronic computers can recall and remember. Computers can store vast amounts of information and recall this information. Recall speed depends on [3] Access time.

4. Electronic computers follow programmes. The latter list instructions to the computer telling it -

(a) What to do.

(b) When to do it.

(1) One one-thousandth of a second.
(2) One one-millionth of a second.
(3) Access time means the time which elapses from the instant when the computer demands information from its storage unit to the instant when information is fully recalled.

Thereby it has the ability to process the information loaded into it under instruction without human intervention.

5. Electronic computers can accept the information they are required to process and the instructions they are required to follow in doing the processing, and subsequently to output the results. The ability of a computer to communicate with the operators and other machines is very important.

6. Automatic computers can check on their own accuracy in many ways such as built-in checks, or through performing the same processing in different ways and then comparing the results. Modern circuitry can enable errors not only to be detected but also to be corrected.

7. Computers can do scientific and mathematical calculations, including the calculation of trigonometric and other functions.

8. Computers can be used for information retrieval.

The Disabilities of Electronic Computers:

1. Without a programme, an electronic computer cannot process the data of an application.

2. Moreover, every decision to be taken by the computer must first be programmed for it. Computers can only make pre-determined decisions.

3. Computers in the past have not been able to construct their own programmes. The programming could only be constructed by human operation. Modern research is concerned with changing this operation and at least with minimising the programming effort required.

4. Computers cannot be efficient in non-recurring tasks. To programme an application, which may be done by human operation,

frequently takes a much longer time than to process the data by hand. It is obvious that a programme which has been prepared can be reused any number of times without further preparation, so it is understood that unless the application is repeated frequently, the cost of time and effort in making a programme will not usually be worthwhile.

5. Sorting by computers is relatively inefficient, as computers are required to go through the data several times before finally sorting it out. This is only a relative inefficiency and sorting is frequently done as part of a larger calculation.

6. Computers cannot process information which is external to themselves.

7. Computers can make errors like any other mechanical device. Through a fault in an electrical circuit, it is possible for a computer to make mistakes. This, however, is a very infrequent cause of error. A much more common source of error is in programme errors or in the provision of incorrect data.

It is seen from the above that a computer can only act under human instructions. The human operation of instructing the automatic computer is called programming, and the resulting set of instructions is called a programme or a routine. Like time and motion study, as enunciated by Taylor and applied in an undertaking, where a job is broken down into a sequence of simple components, a computer programming activity needs also the breaking down of a complex operation into a sequence of simple operations such as multiplying, adding, etc. It also needs the modifying and writing up of the sequence of simple operations into a set of instructions that a

computer understands in its [1] language.

System analysis designates the first activity and programming applies to the second activity. For effective system analysis work, a flow chart is essential to show the flow of work through an organisation, or of information through a calculation.

It would not be out of place to mention a few lines about three aspects of programming.

Firstly, the written programme by the computing staff is called the source programme. Secondly, there is the computer version of the programme which is called the object programme. Thirdly, there must be a translation programme that operates on a version of the source programme and generates from it a sequence of binary digits that represents the object programme. For the translation programme, the source and object programmes are merely the input and output data. This translation programme is often called the compiling programme, or the compiler. It is prepared and stored once and for all in the computer before any source programme is read in. Thus two stages are required in carrying out a particular computation:

1. The source programme is translated or compiled into the equivalent object programme.
2. The object programme is executed.

Symbols of Flow Charting:

Input or output document symbol data coming in and going out.

Procedures symbol - indicates action such as sorting, calculation, or output.

(1) Languages used are Algol and Fortran for scientific calculation, and Cobol, PL1 for commercial calculation.

Symbols of Flow Charting (cont.):

File symbol - data stored in organised fashion.

Card symbol - indicating data stored in punched cards.

Connector symbol - identifying location that an item or action comes from or goes to.

Line and arrow - indicating flow of action or data.

Decision symbol - showing the alternative courses of action.

Magnetic tape symbols - representing data stored on magnetic tape.

The Applications of Computers:

The applications of computers are varied. Some of these applications are as follows:

Scientific Research & Technological Research:

The following are more typical applications:

1. To calculate electron density in a crystal.
2. To calculate the energy levels of the electron in the hydrogen molecule ion consisting of two protons and one electron.
3. To design optical systems from their most basic geometrical requirements.
4. To translate the scientific papers from one language to another.
5. To prepare a manual of aerial navigation.
6. To control space flights.

7. To study molecular biology.

8. To deal with any situation that can be resolved into mathematical calculations.

9. To control a machine tool.

Industrial Research:

This includes:

1. Mathematical calculations.

2. Planning of routes for long distance transport.

3. Scheduling of production.

4. Making proper use of land, machinery, labour and capital.

5. Controlling industries on the whole.

Organisational & Informative Research:

Here the computer has helped in the following ways by giving a scientific approach to organisational problems. The airways are specially worthy of mention. Computers have undertaken -

(a) air booking.

(b) air traffic control.

Computers can solve logical problems such as the preparation of school and examination timetables, to make medical diagnoses, and also to check legal documents for consistency.

Graphic Design:

A system called 'Sketchpad' enables information on engineering drawings to be displayed on a TV type screen, and for a designer to amend the data by means of a 'light' pen.

Linguistic Research & Information Retrieval:

A computer holds words and phrases for the required language in its

store, and on receipt of written input in one language, it finds the equivalent in the second. Moreover, it can be used to help in the analysis of old texts and to investigate their authorship. Work in both these fields is still in the experimental stage, despite some claims.

Information retrieval is important, as the computer can hold information relating to many fields and retrieve it as required.

Non-Numerical Applications:

Most of the above are numerical applications. There are also non-numerical applications such as in game playing, music composing, etc., and simulation techniques.

Local governments, industry, commerce and public bodies are using computers for the following applications, which have been discussed in more detail in the survey results in chapter 14:-

1. Sales.
2. Purchases.
3. Cash and bank payments and receipts.
4. Order processing and production control.
5. Production scheduling and adjustments.
6. Analysis of sales and purchases.
7. Stock control.
8. Public utility billing.
9. Forecasting.
10. Market research and planning.
11. Financial records and accounting for share transactions.
12. Local authority accounting.
13. Process control.

14. Advertisement bookings.

15. Name and address identification.

16. Steel mill control.

17. Computer type setting.

18. Teaching.

19. Message switching.

20. Overseas trade figures.

21. Simulation of planned investment.

22. Civil and other engineering calculations.

23. General accounting for all industry, commerce and the money market.

The offices of these bodies have installed computers and the following table shows some reasons given for installing EDP in these offices.

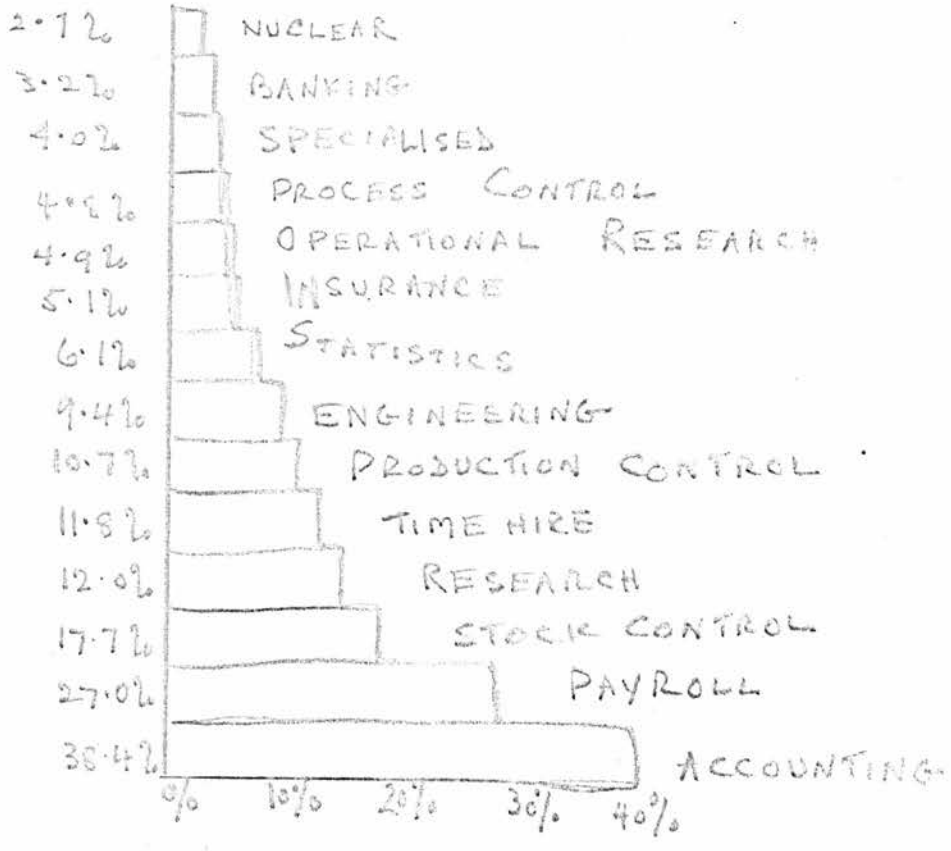
	%
Better service to customers	4
Savings in manpower	5½
Savings in office space	8
Replacement of worn out equipment	9
Better quality results	15
Quicker processing	19
Saving in data processing costs	18
Better service to management	15½
	100%

(Source: Ministry of Labour Manpower Studies No. 4. Computers in Offices, p. 13.)

It is of interest to see how British Computers earned their upkeep in 1964. The following chart shows what percentages of 1,350

installations were doing different types of work (courtesy, Computer Survey):

Fig. 1:



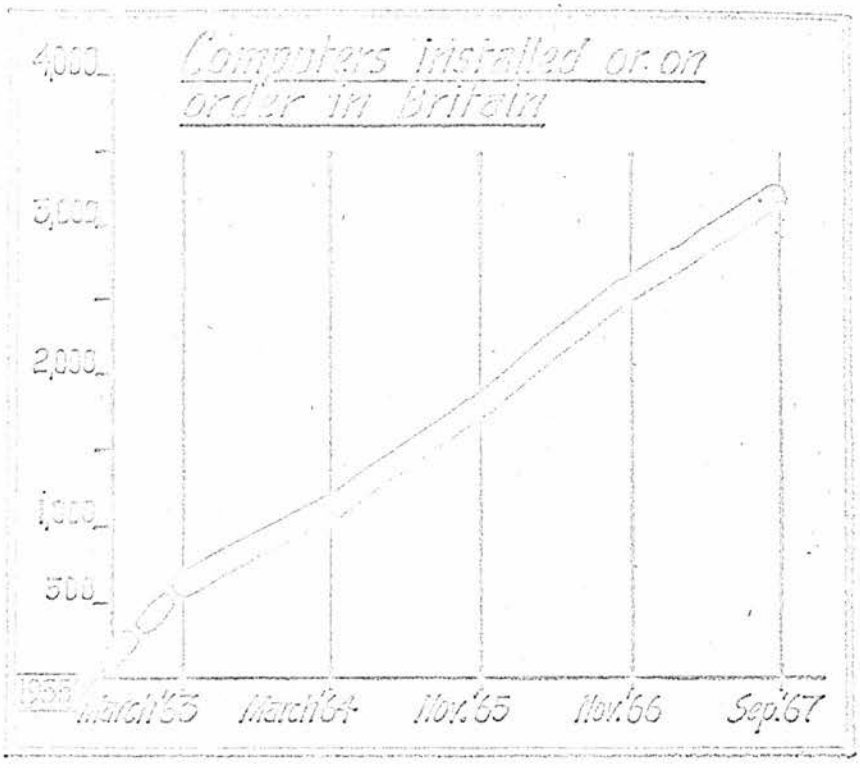
Source: The Gentle Computer, New Scientist, page 9, (1966).

In spite of all the benefits computers have given us, humans can never be replaced. The original ideas come from us and we build machines and ask the latter to do things. We are the masters of machines, whether the latter are employed in science, art or commerce - as we see from the following:(1)

> 'The man, who has mastered art will understand that commerce is not a game with innumerable rules, but part of the volatile, developing and uncertain flux of what we call society. He will know that human beings make the rules as they go along - and often show a diabolical aptitude at the task. He will know that people can bend the line one way or another, for better or for worse, depending on their viewpoint. With the right use of computers, the probability is that the line will be bent for the better. It can result in more skilful human navigators who will use the most modern techniques to take the ship of business or industry through uncharted shoals and narrows. The computer will do what the human cannot do quickly enough, the human what the machine cannot do at all. This is the essence of the computing art.'

(1) The Rt. Hon. Lord Robens, Chairman, National Coal Board - The Computing Art: Opportunities & Dangers. The Gentle Computer - New Scientist (1966), page 31.

Fig. 2 :



Source: Anthony Tucker, Computer in Management, The Guardian, September 25, 1967, page 7.

Table D1:

HARVARD TABLE: D1

CURRENT & PREDICTED IMPACT OF COMPUTERS ON TOP MANAGEMENT DECISION MAKING IN LARGE R. & D. & MANUFACTURING COMPANIES

Area of Impact	1967	1970	1975	1980
Kinds of information received	slight	moderate	substantial	substantial
Volume of information received	slight	slight	moderate	substantial
Accuracy of information received	moderate	moderate	substantial	great
Timing of information received	substantial	great	very great	very great
Kinds of decisions to be made	none	slight	moderate	substantial
Decision process	slight	moderate	substantial	great
Top management organisation	slight	slight	moderate	substantial
Overall impact	slight	moderate	substantial	great

Source: Brady, R.H., Computers in Top-level Decision Making, Vol. 45, No. 4, July-August 1967, p. 75. Harvard Business Review.

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THE HISTORY AND GROWTH OF E.D.P.

1. HISTORY OF COMPUTER EVOLUTION
2. WHAT IS A COMPUTER
3. LAYOUT OF A COMPUTER

History of Computer Evolution.

Fingers are the first aids to calculation. The abacus was invented, which is a semitic word meaning dust or sand. A primitive form of abacus consisted of a sand tray in which lines could be drawn by the fingers and on which pebbles were placed to indicate the numbers taking part in the calculation. The Latin word for pebbles gives the word, calculation. The abacus was common and used by the Greeks and Romans in pre-Christian times, and was known to the Chinese. The Chinese forms of abacus are beads on a wire counting frame, and it is still used in parts of the Far East for commercial arithmetic. In England, the abacus took the form of a table divided into strips by lines on which counters were placed.

Arabic numerals were introduced into Europe through Spain by the Moors in the eighth or ninth century A.D. In A.D. 825, Abu Ja'far Mohammid Ben Musa, surnamed 'the Native of Khiva' (al-Khowarazmi) wrote a widely used arithmetic book, which was translated into Latin in the twelfth century under the title 'Liber Algorismi de Numero Indorum'. From the form of the author's surname the term, 'algorism' was applied to written calculations using the Arabic numerals. In England the algorists did not displace the abacists until the end of the 16th century when the term, counter caster, was a contemporary description of a

clumsy calculator.

The first machine for performing the four fundamental operations of arithmetic was invented by Blair Pascal. It was used for money calculations up to six figures in francs, and included dials for sous and deniers. Subtraction was performed by adding complements, multiplication by repeated addition, and division by repeating subtraction. The machine contained a wheel for each digit of a number, and each wheel was marked with the numbers from 0 to 9.

In 1671 Gottfried Wilhelm Von Leibnitz conceived the principle of the first multiplying calculator machine - multiplying by rapidly repeated addition. Figure wheels were used with a sliding device that enabled the user to perform repeated additions rapidly. Leibnitz commended his machine for scientific and commercial arithmetic. The development of arithmetical machines was stimulated by a large volume of computation being generated, particularly in astronomy, by the introduction into science of the mathematical theories of Galileo and Newton and their successors.

Leibnitz said of his machine: 'The astronomers surely will not have to continue to exercise the patience which is required for computation. It is this that deters them from computing or correcting tables ... working on hypotheses, and from discussions of observations with each other. For it is unworthy of excellent men to lose hours like slaves in the labour of calculations, which could be safely relegated to someone else if the machine were used.'

An account written in Latin in 1685 is preserved in the Royal Library at Hanover, thus: 'There are two parts of the machine, one

designed for addition (subtraction) and the other for multiplication (division) and they should get together. The adding (subtracting) machine coincides completely with the calculating box of Pascal. Something, however, must be added for the sake of multiplication...'

Leibnitz goes on to describe his machine and refers to Pascal as follows:

'Pascal's machine is an example of the most fortunate genius but while it facilitates only additions and subtractions, the difficulties of which are not very great in themselves, it commits multiplication and division to a previous calculation so that it commended itself rather by refinement to the curious than as of practical use to people engaged on business affairs.'

And now we may give final praise to the machine and say that it will be desirable to all who are engaged in computations which, it is well known, are the managers of financial affairs, the administrators of other estates, merchants, surveyors, geographers, navigators, astronomers, and those connected with any of the crafts that use mathematics.

Towards the end of the same century, Kelvin devised his 'Tidal Analyser' - a machine for predicting the tides. He commended it as 'substituting brass for brain in the great mechanical labour of calculating.' Kelvin's analyser simulated the movement of tides by combining mechanisms and performing analogous movement.

Other developments include the introduction of punch cards in 1725, which has been developed. It was not until 1810 that the first successful commercial machine was made by Charles Thomas of Colmar,

Alsace. Some 1,500 machines to his basic design, which embodied the Leibnitz stepped wheel mechanism, are believed to have been made over a period of about 60 years.

A variant of the Leibnitz wheel - a wheel with a variable number of protruding teeth - was patented by F.J. Baldwin in 1875, and a number of machines using Baldwin's device were made by H.T. Odhner a little later. A large number of Odhner type machines have been made in many countries. We are all familiar with the well known Brunsviga Desk Calculator.

The automatic calculating machine probably saw its inception with the invention in 1786 by T.J. Muller of the first difference engine. This was designed to build up, for example, a table of logarithms, automatically by the turning of a handle. The human operator only initially set into the machine certain constants. Muller did not construct the machine but in 1822 Charles Babbage, with a considerable grant from the British Government, set to work to build a (1) difference engine of his own. By the 1830's he, having failed in the design of the difference engine, proposed a new device, which he called the (2) 'analytical engine'. This had all the properties of the so-called modern digital computing machines. It had a store to contain some thousand numbers, each of fifty decimal digits, and a mill which was to operate on the numbers, that is to perform the operations of addition, subtraction, multiplication and division. It was to have an input in the form of punched cards invented by (3) Jacquard, and not only was this

(1) This machine is found in the London Science Museum.
(2) ibid.
(3) Joseph Marie Jacquard (1752-1834) invented a system of controlling the threads by means of punched cards.

input to be automatic but the machine was capable of checking that the right input had been given to it by the untrained operator for it to perform a given calculation. At the end of the calculation, the output was to be set up in type in a form ready for printing. Although he was near to success, he was unable to bring this device to a successful conclusion. The basic reasons of his failure were, (1) the machinery available was incapable of producing identical components of gear wheels, shafting, transmission and so on.

Some years later, a Swedish engineer, Georg Schentz, stimulated by published accounts of Babbage's ideas, started to experiment on similar lines. He succeeded with the help of his son in building (1) a working machine which would tabulate fourth degree polynomials to fourteen decimal places.

From the time of Babbage, large scale calculating machine construction languished until 1889, when Herman Hollerith, working for the U.S. Bureau of Census, put punched cards to use again for the processing of census records in his sorting machine. It is interesting to note that Babbage's analytical engine was to have been controlled by perforated cards, and Hollerith used the same principle.

In 1926, Dr L.J. Comrie of the British Nautical Almanac Office found that the Burroughs accounting machine, designed solely for commercial work, could be used as a 'difference engine' to perform the tasks of subtabulating, printing and checking astronomical tables. Two years later he took the next step towards full mechanisation. When he adapted the Hollerith punched card system to the work of the office, calculation

(1) This machine is found in the London Science Museum.

of future positions of the moon was made possible. Following this initial success, Comrie rapidly expanded the use of punched card machines in offices.

The IBM 600 series of multipliers was developed in 1931.

In 1937 Howard Aitken set about the construction of a large automatic calculating machine in conjunction with the International Business Machines Corporation, one of the largest manufacturers of punched card machinery. The result of their collaboration was the Automatic Sequence control Calculator Mark I, which was unveiled in 1944 after a period of operation on wartime duties and presented to the University of Harvard in the same year. It was said that Babbage's dream had come true. But this machine differed considerably from the concept of Babbage and lacked one particular feature which Babbage had clearly foreseen. This facility, which is usually called nowdays a 'branch' or 'jump' instruction, and which may be likened to the feedback process, was later added to the Mark I so as to bring it up to date. In its original form, therefore, it was inferior to the engine proposed by Babbage. Aitken himself went on to construct several other calculators, the first operating with relays, the next with simple electronics and the last, a modern electronic device, with a magnetic drum store, known as the Mark IV.

The next major advance - the application of electronic techniques to computer design - followed very quickly. The reasons are that telegraph companies and the universities at the same time were becoming interested in the field of digital calculation. In this country, A.M. Turing proposed a so-called automatic machine in a paper on

mathematical logic published in 1937. The first electronic digital computer, the ENIAC (Electronic Numerical Integrator and Calculator) was completed in 1946, only two years after ASCC, being designed by J.P. Eckert and J.W. Manchly of the Moore School of Electrical Engineering of the University of Pennsylvania. A course of lectures was also delivered in the same year on 'The Theory and Techniques of Electronic Digital Computers'. The new ideas had been worked out by a group of mathematicians and engineers, led by John Von Neumann. The deliberations of John Von Neumann for a new type of machine, which would be considerably smaller and much more powerful than ENIAC resulted first in the design of a machine called EDVAC and began operating in 1949, and later, at the Institute for Advanced Study, in the design of what must be one of the most beautiful examples of human ingenuity and intellect, the Princeton Electronic Computer. At about the same time a group at the National Physical Laboratory was constructing the machine known as Ace Pilot or Deuce.

From EDVAC came SEAC at the National Bureau of Standards, which came into operation in 1950.

The first commercial stored-programme computer was built by Eckert and Manchley, and delivered to the American Bureau of the Census in 1951. Lyons Electronic Office, LEO for short, started operating from Christmas Eve, 1953.

Other historic computers of this era are the Whirlwind I, at M.I.T; the IBM 701 and 650. The 650 was the first modern digital computer produced in quantity. Many more since 1950 have been produced.

The Generations of Computers.

Computers are divided by the type of circuitry utilised to perform their various functions. First generation models are those that used vacuum tubes or relays as the active elements. The second generation devices use transistors. The third generation units use microelectronic circuitry.

Table E1: **Table of Computer Evolution**

Date	Name	Details
1642	Pascal	First mechanical device to add & subtract.
1671	Leibnitz	Proposed rapid repeated addition for multiplication.
1694	"	Actual machine built.
1725	Jacques	Punched card
1786	Muller	idea given
1820	Thomas	Machine built, could add, subtract, divide and multiply.
1822	Babbage	Construction of difference engine of six digits.
1833	"	Conception of analytical engine (first automatic calculator.
1854	Schentz	Demonstrated 16 digit engine.
1890	Hollerith	Developed punch cards.
1926	L.S.Comrie	
1931	IBM 600	Multiplication.
1937	Aitken	
1944	ENIAC	Electronic Numerical Integrator & system.
1946		Dr Von Neumann's ideas.
1949	EDSAC	
1951	UNIVAC I	
1953	LEO	Lyons Electronic Office.

What is a Computer?

In order to be called a computer, the following characteristics are required to be found in a machine:

1. It must operate at electronic speed.
2. It must be [1] automatic in operation.
3. It possesses powers to store instructions and data and obeys its stored instructions.
4. It must be able to discriminate between different courses of action.

Types of Computer.

There are two types of computers - analogue and digital. Analogue computers are not applied to commercial work, whereas digital computers are universally used.

There are several reasons why analogue computers have not found application in commercial work which are ennumerated as follows:

1. Their accuracy is low, partly because of the difficulty in setting and maintaining values in the electrical circuits and partly because the computing units have inherent limitations.

2. Problems take a considerable time to set up, during which time the computer cannot be used for other work.

3. Since each computing unit introduces errors, the model should have as few units as possible, but minimisation takes time and effort and may diminish the analogy with the real system.

4. The computing units are accurate only over a limited range and the calculations must be scaled to stay within those limits.

It is obvious that in using an analogue computer, the problem to be

(1) Without human intervention.

solved has to be arranged as a model in which the behaviour of the component parts of, say, the engineering system under study is mimicked by that of electronic computing units, although there is a close correspondence between the model and its physical counterpart, which makes it easy to translate the measurements and ideas from one to the other, but the method has practical limitations, as mentioned above. The fundamental difference between analogue and digital computers is in the methods used to represent numbers. In analogue machines, numbers are represented by the magnitude of some measured quantity.

The Layout of a Digital Computer.

A digital computer possesses the following units.

(a) A control unit which governs the overall operation of the complete machine and co-ordinates the other undermentioned four units.

(b) Input units.

(c) Output units.

(d) An Arithmetic and logical unit.

(e) A storage unit, also called memory unit.

The Input Unit.

The following are true of the many input devices of a computer system:

(i) Punched Cards:

The unit reads the information which has been recorded by means of holes punched in the cards, if the input has been prepared in punched card form.

Conventional card readers operate 200-2000 cards per minute. There are several sizes of punched cards; perhaps the 80 column Hollerith and the 65 column Power Samas variety have proved most popular for computer input.

Card readers are usually provided with a buffer store into which an image of the information punched on the card is placed as the card is read. When the next card is being moved to the reading station, the computer reads information from the buffer and carries out the necessary conversion. The holes are sensed photoelectrically. The holes in the card are made by the punch card apparatus. The advantages of punched cards are their permanency and the fact that they can be easily revised and brought up to date. The disadvantages are that their great bulk demands a lot of storage space and the difficulty found in transferring data from them to the machine at the fast rate.

(ii) Perforated Paper Tape:

The data is prepared in the form of perforated paper tape. Holes are punched accross the width of a continuous reel of paper tape according to some pre-arranged code. The coded paper tape is then fed into the tape reader, which provides the input required by the computer. It is less bulky and can be read much more quickly. A disadvantage is that a wrong hole in the paper tape cannot be rectified.

(iii) Magnetic Tape Unit:

Magnetic tape usually consists of a thin layer of magnetic material, often ferric oxide, between two layers of plastic. The tape is usually $\frac{1}{2}$ inch wide and is divided into up to nine channels.

It may be an advantage with some computer applications to convert

the input information from perforated paper tape or punched cards to magnetic tape using the computer for this purpose. When a particular piece of information is desired, the computer remembers what to look for, and it skims the magnetic tapes until the data is located. Magnetic tapes are a convenient way of recording and obtaining data and are quite flexible. They do, however, share the awkwardness of paper tape in that the whole tape may have to be perused in order to obtain data stored at its end and it is obviously more expensive than paper tape. An error in magnetic tape can be erased. Data can be transferred at a rate of 180,000 bits (binary digits) per second or, exceptionally, 680,000 bits per second can be transferred.

(iv) The above three methods involve changing the data into holes or into magnetism. It will be more convenient, if we can record data in ordinary language or figures in such a way that it can be read directly by a machine. No computer has yet been fitted with a reader that can take any document written in any way and read it into the computer.

(a) Magnetic character readers are well developed and they are useful in dealing with cheques on which numbers have been specially printed in such a way that the machine can recognize the pattern of the magnetic ink blobs.

(b) Optical character readers can identify the printed character by the reflection of light on it; the ink does not need to be magnetic, but the print must be of a particular type. 500 characters can be read per second.

(c) Optical mark readers can transfer data by noting the positions

on a sheet of paper of marks made with an ordinary lead pencil. This type of reader can manage 30 to 40 sheets per minute.

(d) Electric typewriters.

The Output Unit.

These devices translate the results of computation into everyday language understandable by humans. In that case the result will be printed. But if the output is to be used by the computer, results may be in the form of punched cards, punched tapes, or magnetic tapes.

These are known respectively as 'on-line' and 'off-line' methods. On-line output means that the printing devices are operated directly from the computer, so that the results are printed as they become available. With off-line output, the results are punched into cards or paper tape, or are recorded magnetically. These are then used to activate printing machines which are separate from the actual computer.

The range of equipment which can be used for output purposes includes:

(a) Electric Typewriters:

Impulses in these machines are passed to the typewriter activating mechanical printing heads, which strike the paper. Since the printing is performed a character at a time, the output speed is relatively slow.

(b) Tabulators:

The printing transfer is accomplished in these machines by mechanical type bars or wheels, a line at a time. Tabulators can be fitted with counter devices to provide totalling facilities.

(c) Printers:

The printer prints a whole line at a time, using a row of hammers to

strike the paper revolving type-wheels, with an inked ribbon or a carbon paper interposed. The output rate is at least 600 characters per second, or 1,800 lines per minute, 1,000 lines per minute being typical.

If the information from a computer is required as a graph, a graph plotter, working directly with the computer output, will produce large graphs with speed and accuracy.

The above devices are on-line. The following machines enable output to be interpreted and printed off-line or, alternatively, re-entered into the computer system via the input for further processing.

(d) Paper tape and Card Punches:

Output may be in the form of paper tape and punch cards.

(e) Another form of output is the visual display, often combined with printing. A cathode-ray tube can display a computer output. One such tube is the charactron shaped-beam tube. The Xerox photocopying process is used to reproduce the information on the screen in permanent form. A visual display can be changed by the operator by using a light pen and the changes are reflected then in the records of a computer.

(f) Magnetic Tape Film or some other media:

By this method, output data is systematically transferred at high speed to a tape, film or some other media and recorded in the form of magnetic spots on the surface, in accordance with a pre-determined code.

The Storage Unit.

Computer stores are of two types: static and dynamic. The static is applied to those devices in which data once stored, is retained permanently. Dynamic stores have the property that data is available only at certain fixed times, dependent upon the position in which data

is to be found. The static stored data can be recalled in a time (the access time) which is independent substantially of the storage position. Computers require several types of information storage. Therefore the storage position can be divided also into three - (1) a small, high speed memory for split-second insertion and extraction of small amounts of data, (2) a slower but larger store for information not required at once, and (3) a bulk storage space.

The following are the principal storage devices used in various types of computer:

1. Magnetic tapes or punched cards or magnetic cards.*
2. Magnetic Drums.
3. Magnetic Cores.
4. Magnetic Discs.
5. Delay Lines.
6. Cathode Ray (Williams) Tubes.
7. Magnetic Films.

Magnetic Tapes.

Data is stored in coded form on reels of magnetic tape. The tape is a thin ribbon of plastic material, usually a polyester compound known by its trade name 'Mylar'. By means of reading heads, data can be written, read or replaced. Information on magnetic tape is stored in sequential order since the tape is read serially, and thus the random access time is slow. The heads are housed in a special operating unit into which the reels of tape can be easily inserted. For this reason magnetic tape can be used for the external storage of information.

* Similar to the above, but data is stored in coded form on cards.

Magnetic Discs.

These consist of a metal disk perhaps 2 to 3 feet in diameter, which revolves continuously on an axle. The flat faces of the disk are coated with iron oxides and used for magnetic recording. The records are arranged as concentric rings or 'tracks' of magnetic spots, and are written and read by a head, which is moved radially across the disk to 'select' the wanted track as the disk is rotating.

Magnetic Cores.

These consist of screens of wires with a network of tiny ferrite cores at the intersections of the wires. The cores are magnetised to hold and issue information in accordance with some pre-arranged code.

Magnetic Films.

These are similar in character to magnetic tape. The media used is similar to ordinary cinematograph film specially coated with a substance that can be magnetised.

Delay Lines.

This is one of the original working internal store devices. Sound waves take a given time to pass through a line containing mercury or nickel.

Cathode Ray (Williams) Tube.

This method uses tubes similar to those used in television sets. Information stored on the fact of the tube is immediately available.

Delay lines and cathode ray tubes are the methods of storage where information is volatile; the other methods expressed above are permanent in form.

Let us now compare the various methods of storage which are permanent in form:

	Punched Cards	Magnetic Card	Magnetic Drum	Magnetic Cores	Magnetic Discs	Magnetic Tape/Film
Speed	Low speed	Medium	Medium	High	Medium	Medium
Storage	Unlimited capacity	High capacity	High capacity	Low capacity	High capacity	High capacity
Memory Backup	Input and output and not	Secondary memory	Secondary memory	Primary memory	Primary/ Secondary memory	Secondary memory
Access Time	Access time longer	Access time medium	Access time medium	Access time faster	Access time medium	Access time medium

The Arithmetic and Logical Unit:

The calculations are done through this unit. These units of electronic data processing systems are composed of electronic circuitry - valves, transistors, capacitors, etc. - and these are able to complete their operations at electronic speeds measured in millionths of a second. The arithmetical and logical units of the digital computer of this kind employed in business use pulse techniques, and thus the language in which computers do their arithmetic is the (1)(2) 'Binary Code', although some computers can be programmed in ordinary numbers and letters. The numbers can be added, subtracted, multiplied and divided, and the sizes of any two numbers can be compared. It can be determined

(1) Binary notation. There are two different digits '0' and '1' instead of the ten of the ordinary decimal scale.
(2) Most modern commercial machines use a composite system of binary decimal called binary coded decimal.

whether a number is positive, negative or zero and an answer of 'yes' or 'no' can be given to a simple two-way question. The actual operations take place in one of the accumulators, which are the fastest working parts of the machine, and numbers are taken to the accumulators from their places in the stores as and when they are needed.

The logical units are referred to as the 'decision making' units. When a programme is being constructed, certain simple logical questions can be inserted in the programme for which the answer 'yes' or 'no' is required. The computer will then select one of two separate programmes of instructions in accordance with the answer given to the question. It is possible for alternative courses of action to be taken by the machine according to whether this result is positive or negative or zero.

The Control Unit.

The control unit co-ordinates the actions of the parts of an EDP system so that they combine to execute the instructions in its programme. The control unit usually has a console, providing the operator with a means of monitoring the various sections of the computer and thus enabling him to ascertain what is taking place. The console also provides a means of communicating directly with the computer system. If any information is needed to be fed manually into the computer, this operation can be performed through the console. This has visual indicators in the form of rows of small lights or on the screens of cathode ray tubes, which give a continuous display of information circulating in the data processing system. The operator is able to scan the visual indicators which may give some indication of the causes of an error or stoppage of the machine.

The control unit often operates to a two-beat rhythm. On the first beat, it obtains the next instruction from the store and places it in a special single-location store. Computers contain a number of these special-purpose stores. They are normally called registers. In the second beat, the control unit decodes and examines the binary digits that make up the instruction and so determines which are the appropriate electrical controls to initiate the performance of the required operation. When the operation has been completed a signal is returned to the control unit, which then proceeds to obtain the next instruction.

As well as controlling the central processor, the control unit directs the execution of instructions calling for the transfer of data to or from peripheral units, such as card readers, magnetic tapes and printers. These mechanisms are very slow compared with electronic operations in the central processor. The control unit deals with them by galvanising them into activity and then turning to another instruction which may be waiting for them to complete their operation. The other instruction may be one for a fast central-processor operation, or it too may initiate action by another slow peripheral unit or dispose of the results of an earlier peripheral instruction. To allow for this loose-jointed form of operation, the peripheral equipment is provided with small inidvidual stores called buffer registers. They empty and fill these buffers at their own pace, and the buffers transfer their contents at very much higher electronic speeds to or from the main store in the central processor. Several peripheral devices may be kept operating in this way simultaneously with computing. Peripherals which operate directly connected to the central processor in this way are said

to work'on line'. By contrast a printer, say, working independently of the central processor under the control of a magnetic tape previously recorded by the processor would be 'off line'. A greater degree of overlapping can be arranged by interleaving the activities of several programmes, which make differently timed demands on the central processor and on the peripheral units. In this 'time sharing' the several programmes appear to proceed simultaneously. As the central processor can execute only one instruction at a time, it is correct to say that programmes run concurrently. Time sharing offers efficiency. A practical application of time sharing is in 'real time' processing. In this the computer processes data as it arises and keeps in time with events as they occur.

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CHOOSING THE E.D.P. SYSTEM AND FINANCING IT

Before a system is selected, it must be preceded by two phases, namely, feasibility and investigation.

Feasibility starts with the question - can a computer help? It is essential to determine the scope of work that a computer will do, to make an initial estimate of the cost of achieving the system. Investigation starts with (1) objects behind the system, (2) what is to be done. Feasibility study and investigation are both undertaken by a committee within the organisation. The committee may consist of senior management. Let us call this the steering committee. The terms of reference of the steering committee will depend on the existing organisation within the concern and should include the following instructions:

1. To make recommendations, if the committee thinks fit to use a computer, to the proprietors or to the Board in accordance with the type of organisation.

2. To form a special study group to advise on co-ordination and communication.

The steering committee, before the formation of a study group, will take into account the importance of a computer installation. They will see that it will be useful insofar as:

1. There are repetitive operations.
2. There are complex computational problems.
3. There are substantially increasing clerical costs.
4. They need many informative and authentic reports for effective running of the organisation.

The committee will then hand over its duties to the study group, who will be drawn from each department.

The standing of the study group will depend upon the support of top management. The status and relationship are dependent upon the individual quality of each member comprising the group. The personal quality means that the member -

1. Is able to review critically current practices and subsequently to re-think in terms of present requirements of management.

2. He understands the business operations fully and is conversant with the potentialities of all equipment required to perform the business operations.

3. He has a sense of team spirit and possesses the confidence of all levels of management and staff.

The members of the study group will have a great deal of responsibility.

The study group must study articles on computers as related to business applications, pay visits to various firms where computers are already installed, take short courses on computer appreciation and application from colleges or manufacturers.

The terms of reference of the study group will be based on the following:

1. To issue all progress reports and recommendations to the steering committee.

2. To report the activities of the individual members of the study group to their respective managers.

3. To examine and understand the purpose of introduction of

electronic data processing.

4. To ensure proper co-ordination of the different activities of the group.

To be very much conversant with their work and to know how effectively the computer is being used, the members must consult users, when they go to visit other installations. The enquiries should be founded on the following points:

1. What is the effective output for the computer and its ancilliary equipment?

2. Is staff training satisfactory?

3. Is the suppliers' advice on accommodation, floor space, structural modifications, ventilation, filtration and similar matters fair?

4. What are the maintenance arrangements and were they satisfactory?

5. What type of faults have occurred and how were these faults corrected?

6. Has all the time phasing of the installation been satisfactory?

7. Did the machine come up to requirements?

8. Are there alternative arrangements for using another computer, should this one break down?

9. What benefits do you derive from the use of electronic data processing?

10. Did you buy or rent a computer? If you bought it, why did you buy it?

11. Do you use the facilities of a service bureau? If not, why not?

After all this information has been gathered, the study group will be in a position to formulate a definite plan; they will use the experience of the users.

Now the specific scope of work of the study group falls under two main sections:

1. Within the organisation.
2. Outside the organisation.

Within the organisation, the study group should see that -

1. The organisation does not lack adequate systems and procedures in almost all areas of operations. So changes, if any are required, in existing systems and methods will be investigated. The form in which information will be made available and what results will be required.

2. The computer must fit into the existing organisation if it is installed, from work and staff points of view.

3. The computer system must fill the requirements of the organisation.

4. The economics of electronic data processing should be such as to take a decision.

5. Prepare a recommendation for sending to the steering committee.

The following considerations are also taken into account before deciding the type of work to be handled by a computer.

1. The responsibilities and functions of each department in relation to the organisation as a whole. (1) 'No area or department of a business has the right to be the sole user of EDP. EDP is employed most

(1) A.B. Toan, Jr. - Current Concepts in the use of Computers, their implications and development, pages 760-768 - Accountancy, November 1966.

advantageously where it serves a variety of users.'

2. What information will be required to perform the functions of 1.

3. The initial data available, differentiating between that which arises from inside and outside services.

The long term objective is to see that principles of integrated data processing are applied so that effective use of the machine may be made and that the processing of data should be so organised that it serves all forseeable needs. Systems should be tailored according to requirements. It is obvious that certain rules must be observed in studying the re-organisation of the reporting and information system, which are:

1. Simplify work loads of executives in providing too many reports.
2. Clarify relationships, responsibility and authority.
3. Determine the essential information.
4. As varied a work load as possible.

The procedural work on information depends on many factors:

1. Who will receive the information.
2. What kind of information does he need to receive.
3. At what time and how often is this needed.

Feasibility study on reporting method for management information can be best shown by two factors:

1. Current information methods and practices.
2. Proposed computer system.

When the systems study is undertaken initially, four major elements will be there:

1. What jobs should be put first in the computer system.

2. The integration, relating intimately the source documents and reports required for management control.

3. Determination of cost and other elements.

4. Proposed system's operational capabilities to compare with present system.

Now the study group will study the other factors outside the organisation. They will undertake the study of equipment by:

1. Writing to the manufacturers.

2. Visiting the manufacturers.

3. Consulting other users.

The study group will require the manufacturers to supply the following information about the computer ranges:

1. Relevant computer specifications.

2. Total cost of the computer and whether hire facilities are available.

3. Extent and cost of the peripheral equipment.

4. Time required for delivery, installation and running in.

5. Arrangements for spares and maintenance.

6. Whether or not a library of programmes is available.

7. Possible development in the equipment.

It may be very helpful if these questions are asked methodically to all manufacturers so as to have (1) an effective idea about the machines available, (2) to find out the suitability of a computer system to meet all requirements of the organisation.

The questions are:

1. Why do you recommend the proposed system?

2. What types of work will the system handle?

3. What are the components of the machine?

(a) Thoroughput (internal speed in micro seconds):

Floating point:

Addition	"	"	"	"	"	...
Multiplication	"	"	"	"	"	...
Subtraction	"	"	"	"	"	...
Division	"	"	"	"	"	...

Fixed point:

Addition	"	"	"	"	"	...
Multiplication	"	"	"	"	"	...
Subtraction	"	"	"	"	"	...
Division	"	"	"	"	"	...

(b) Storage:

Magnetic drum	"	"	"	"	"	...
Magnetic core	"	"	"	"	"	...
Magnetic tape	"	"	"	"	"	...
Magnetic disk	"	"	"	"	"	...
Punched tape	"	"	"	"	"	...
Other	"	"	"	"	"	...

(c) Capacity	(in characters):		Binary	Decimal
Magnetic core	"	"	...	...
Magnetic disk	"	"	...	...
Magnetic drum	"	"	...	...
Punched tape	"	"	...	...
Magnetic tape	"	"	...	...
Other	"	"	...	...

(d) Input Media:

	Types of Media of Input					
	Cards	Magnetic Tape	Punched Tape	Keyboard	Memory to Memory	Instru-ments
Off or on line						
Type of channels						
Fixed or variable length						
Alpha						
Decimal or binary words/ blocks						
Record size						
Speed						
Type of buffer						

(e) Output Media:

	Types of Output Media					
	Cards	Magnetic Tape	Punched Tape	Printer	Memory to Memory	Motor Activity
Off or on line						
Type of channels						
Fixed or variable length						
Alpha						
Decimal or Binary						
Words/blocks						
Record size						
Speed						
Type of Buffer						

3. Special considerations:

What is the:

Word size ...

Code structure ...

Instruction type ...

Parity checking ...

Does it have:

Thin films ...

Scratch pads ...

Monoliths ...

Error Correcting circuits ...

4. Historical considerations:

Number of years in research and development ...

Number of years in application ...

When first introduced in the market ...

When available ...

Backlog ...

On order ...

If ordered how long the delivery delay ...

5. Developments:

(a) Immediate developments within 3 years.

Faster printers?

Faster tapes?

Faster card reader punches?

Other reading devices (character sensing)?

Central computer changes - memory size?

Developments in economic memory?

Cost range?

(b) Long range developments.

Peripheral equipment:

Computers: (1) CPU, random access memory,

very fast access storage?

Communications networks - computer to computer

or computer to remote data base?

Any other development?

6. Auxiliary electromechanical equipment suggested:

	cost	speed	unit
(a) Film storage units	...	...	...
(b) Accounting machines	...	...	...
(c) Calculating punches, summary punches	...	...	...
(d) Reproducers, gang punches	...	...	...
(e) Interpreters, sorters	...	...	...

7. Maintenance:

(a) How many maintenance people?

(b) Background experience?

(c) Maintenance coverage on all shifts?

(d) Where is the inventory for parts and workshop to be situated?

Now enquiries should be lodged as to the computer room.

1. Physical site:

A site preparation.

How many engineers, architects?

How long and when will they work?

Physical dimensions both in feet and in metres.

2. Housing requirements:

Space - flooring.

Maintenance area.

Magnetic tape files.

Card files.

Spare parts inventories.

3. Air conditioning:

	During Operation	When Idle
Temperature range	...	...
Relative humidity range	...	...

4. Power requirements:

Voltage: Normal

Maximum

Maximum variation

Frequency: Standard

Maximum variation

Power consumption, by components and total:

Configuration and cost of the proper power production unit for the data processing system you propose, if such installation is considered to be necessary.

Equipment:

Delivery Date:

How long from signing of contract?

How much notice must be given for an extension by lessee? by vendor?

Any penalty clause with extension?

Transportation Costs:

Packing.

Transportation proper from origin C.I.F. destination.

Insurance.

Installation of Hardware:

Delivery time.

Assembly time on site.

Engineering testing time on site.

Acceptance Tests:

Extent of vendor's tests.

Can the customer impose acceptance tests on computer?

On peripheral equipment?

Back-up Facilities:

Will they be fully compatible with the proposed installation?

Location of the facility?

Will it be manufacturer's or will another be used?

On what basis will time be available?

Time Rental Facilities:

Location of computing installation?

Equipment available?

Time available to customers?

Can it be used for some of the conversion work?

Rates?

Temporary Lease of Equipment (3 to 12 months):

Is short-term lease available for peripheral equipment?

During conversion?

For peak-period use?

The study group will now make machine comparison studies between the manufacturers and makes and then decide which computer is to be bought or whether rental will be sufficient. The study group may also consider a few more points:

On Manufacturers:

What is the computer manufacturer's record with respect to:

(a) delivery schedules.

(b) financial status.

(c) educational facilities.

(d) computer development.

(e) maintenance facilities.

(f) cost of the computers and peripherals.

(g) cost of rental.

(h) staff training facilities.

(i) software.

(j) hardware.

After this the study group should study:

1. The capabilities of large and small computers.

2. Factors governing the size and usefulness of computers.

3. Advice of independent computer consultants.

<u>The Capabilities of Large and Small Computers.</u>

The size of computers should be examined to determine how they fit

into firms of different sizes. Computers do take independent jobs but the true potential for systems is to condense and integrate information or accounting systems. It is pointed out that the smaller computers - especially those limited to one type of input-output such as paper tape or punched cards, and only one channel of input-output at that - may be able to take over single, self-contained jobs. Obviously the small computers cannot provide a combined data processing system for all the procedures of a firm. The smaller computers cannot supply to the management the expert analysis of information quickly, with accurate forecasts over a long range of subjects, which would enable management to take better decisions. Small computers fail to provide this integrated approach not only to large firms but also to small and medium firms. The small computers cannot take into account the inter-relationship between many departments and variables which management must take into account in formulating policy, as this will entail sorting and merging of files prior to computer unit, which is not the proper aim of EDP. Full benefits of EDP will not therefore accrue to small firms. The small firms will have to rest content with the placing of individual jobs on the computer, and not aim to achieve an inter-related system. These will help the firms in some savings of one kind or another. The purchase of a large enough computer to give better management control for lack of experiment and research may also not be justified by small firms. Here a thorough study of the system is required to decide whether or not to install a computer, or whether the use of a service bureau would be sufficient.

If it is thought that the computer is beneficial, it is necessary

to know the factors governing size and usefulness of computers. The features for a computer suitable for an integrated system may be the following:

1. Basic machine speed.
2. Ample fast store.
3. Large backing-up store.
4. Multiple input-output channels.
5. Flexible and powerful programme techniques and hardware suitable for commercial work.
6. The provision of buffers or other devices to permit several operations to be carried out at once.
7. Preparation of input information.

Speed.

The basic pulse rate of a computer gives a good indication of the overall speed of the machine, although, of course, one must take into account speed of access to storage, parallel or serial mode, binary or coded binary, input-output rates, printing speeds, etc. However, a one megacycle machine (1,000,000 pulses per second) will do more in a given time than, for example, a 300 kilocycle machine (300,000 pulses per second).

In commercial applications the internal arithmetic speed of the computer is also important, because the 'red tape' or 'housekeeping' instructions required are really enormous in order to permit a commercial problem to thread its way through alternatives and exceptions. The speed has two consequences - the cost per arithmetic operation is very low, in spite of the high cost of purchasing a computer and running

it. The cost of a machine does not rise in direct proportion to its speed, so that the larger the machine, the cheaper is the cost of doing arithmetic calculations, provided the computer is kept occupied. Secondly, the speed of electronic computing enables results to be obtained within a shorter time interval. Results thus obtained are valuable in forecasting. In some cases 'real time' applications of a computer are possible.

Fast Store.

This is desirable for:

1. Keeping the computer continually processing the data.

2. Obtaining and transferring information in a minimal time.

The fast store is costly. It varies from 1000words to 64,000 words or more. The fast store will be used to hold:

1. As many programmes as possible so as to permit the larger, inner loops of commercial problems to be obeyed without the need to wait for transfers from other slower parts of the store.

2. Index tables to help determine the location of records.

Backing up Store.

Access must be possible in an integrated system to large files and masses of data. When processing one particular type of data the computer must be able to refer to all files. The files may be on external or internal storage. Large internal storage may be necessary to accumulate statistics and other information, which at the end of the run can be analysed and reported to management. A large backing up store will also be required for the voluminous programmes required in commercial work. If the store is too small, several runs will be required to complete an

analysis. For a really combined system, one expects unlimited words as external capacity, probably on magnetic tape, and at least 8,000 words as internal capacity. A large programme can, however, be put in sections into the computer, unless many sections must be kept available for use in a random sequence.

Buffers.

A computer than can perform input, internal operations and output simultaneously by the use of input-output buffers, or tackle more than one problem at once by some means of time sharing, is not suitable for integrated procedures. Small computers are not fast enough internally to take advantage of time sharing or parallel programming. On the larger machines it is much better if there is a buffer for each input-output device and also buffers between the fast store and the drums or disks, so that unnecessary delays in the transfer of data can be avoided.

Multiple Input-Output Channels.

By multiple input-output channels is meant, (1) more than one type of media, (2) ability to use several channels for each type of media. When a combined job such as stock control, credit control, customer accounts, and invoicing is carried out, the data of two types might be on two punched card units and the files to which the input data refer might be on three or more magnetic tape units. The combination of the input and semi-permanent information might require a printed output on a line at a time printer, and the statistical data accumulated internally might be output at the end of the run on to another magnetic tape unit. This is a flexibility, which will prevent the need for several runs of the same input information and assist in the establishment of an overall

system for the firm's procedures.

Software and Hardware Facilities.

The programme code must be suitable for commercial work - floating point arithmetic would not be as useful as a table look-up instruction, or special indexing facilities. It is useless to have large storage if it is difficult to find out where any piece of information is stored. The ability to use field selection is much more important for business operations. Optimum programming is a disadvantage to commercial users unless there exists a library routine, which will optimize programmes for users. Simple provision in hardware to convert to and from sterling saves programming expense and time. Proper flow charting and block diagrams must be prepared for effective use of software.

Preparation of Input Information.

Magnetic tape, punched cards and punched tapes can be read into computers at satisfactory speeds. Satisfactory methods of preparing magnetic tape directly from written documents have not yet been produced. Punched tapes or punched cards are a means of preparing data to be transferred to magnetic tape and information is fed to the computer via magnetic tape. There are other means of input, but whatever be the means, sometimes the same information is punched twice. This is to be avoided. Data checking can be done by the computer through feasibility checks.

Computer Consultants.

The study group may turn to computer consultants for their professional advice. The study group may submit its report to the steering committee and leave the latter to consult them. In either case,

computer consultants are practising professional people, giving independent advice to users. This is the expert advice, called in by firms to protect themselves against dishonest or incompetent salesmen. It is good only when the consultancy firm is a genuine one. It is no use hiring a person's services, if he knows little more than his client or who tries to boost the sale of a particular make of equipment by always recommending it to all clients and thereby gaining the favour of the suppliers.

(1) 'Consultancy is certainly a field where the motto "caveat emptor" applies, and choosing a consultant merits just as much care as choosing a computer.'

This is a young profession. Many consultants are simply ex-accounting machine or punched card salesmen and do not possess any experience of computers at all. It is natural that such people are over-influenced by that particular make with which they have worked. Because of very good fees, of the order of £3,000 to £4,000, many have embarked into the market to practise. But it is up to the users to find out a consultant who is genuine in the field. Usually a consultant is expected to be (1) in the 30-35 age group, (2) to possess an honours degree, subject immaterial, (3) to have two years' experience as a user-programmer and two years' experience as a systems analyst between two firms of suppliers, (4) 1-2 years as a systems analyst for a computer user, (5) one year's experience as a consultant.

The client can easily trace from testimonials and visitations to a firm where the consultancy service has been given. A competent consultant

(1) David Shirley, Computer Consultants.

can always define a firm's needs better than the staff of the firm.

The client must also be careful about the consultant's fees, which average £250 per man week, and computer selection jobs usually take at least 2-3 months.

The Computer Bureau.

The study group then turns to a commercial computer bureau. Usually the range of jobs processed in a bureau are:

Payrolls, sales analysis, invoicing, stock controll, production control, production breakdowns, material scheduling, insurance, scheme valuations, stock exchange accounting for brokers and jobbers, share registration and a variety of mathematical and management science applications for customers associated with the Stock Exchange, banking, insurance, building, steel, engineering, fashion, food, fruit, furs, motors, petroleum, photography, printing, radios, records, wines and spirits and other trades. They also process accounting work for local authorities and non-commercial organisations.

The types of work to be done are described to the Bureau and a quotation of their charges should be taken. The study group should ask the bureau the following questions:

1. Types of work the bureau can handle for the organisation.
2. Costs of services.
3. Time they will take in processing information and despatching, priority processing.
4. A comparative study, if possible, between the use of a service bureau and buying or renting a computer, from the bureau.

Financing a Computer.

The study group should make a comparison between all possible alternatives of using electronic data processing in the organisation. Then it should decide as to the capital costs to be incurred, should the firm decide to install a computer.

The capital costs associated with a computer are:

1. Building.
2. Accoustic tiling.
3. Air conditioning unit.
4. Special expenditure on computer room.
5. Partitioning.
6. The computer (central processor).
7. Input preparation equipment.
8. Input/output unit.
9. Replacement equipment.
10. Data links.
11. Office furniture and equipment.

Finance may be obtained for the whole of the above as a complete installation or any one or a group of the items of expenditure. The methods of finance are at the moment: (a) purchase from existing cash resources, (b) purchase by bank facilities, (c) purchase by new capital issue, (d) hire purchase, (e) leasing, (f) manufacturer's rental scheme.

When buying, three considerations of cost factors are given:

1. Tax situation.

2. Depreciation.

3. Interest on Capital.

Tax Situation.

Capital expenditure receives certain capital allowances, namely:

1. Initial allowances.

2. Annual allowances.

3. Investment grants.

Relief by way of initial and annual allowances is dealt with by the Income Tax Act 1952, sections 265-340, as amended by subsequent Finance Acts. The Finance Act 1966 and the Industrial Development Act 1966 made very important changes by introducing the scheme of investment grants. The rates are increased where expenditure is incurred in a development area. Some expenditure on machinery and plant does not qualify for investment grants and certain types of expenditure are excluded from the scope for grants.

Building:

Expenditure incurred on buildings is not eligible for investment grants. If incurred on 'industrial buildings', it will qualify for capital allowances, so that the expenditure on the computer building should qualify for the relief of 25 per cent of initial allowance and 4 per cent straight line annual allowance.

Plant:

Under headings 2-12 the items of capital costs are normally plant for capital expenditure. Any special expenditure made to an existing building incidental to the installation of new machinery such as a computer is deemed to be part of the machinery.

Investment grants are given when the expenditure has been incurred after 17th January 1966 for new machinery and plant used in a qualifying process or industrial research and for a new computer. The standard rate of grant on the computer is 25 per cent on expenditure incurred between 1st January 1967 and on or before 31st December 1968. In a development area, the rate is 45 per cent.

Peripheral Equipment:

Essential peripheral equipment used to prepare or feed information to a computer and to make use of its operation will qualify for investment grants, whether acquired at the same time as the central processor or at a later date. In the case of input such as magnetic tapes or punch cards, it is the initial stock which will qualify and any subsequent permanent increase in the stock essential to the installation. Some software provided by the computer manufacturer and included in the purchase price will qualify for the investment grant.

Repayment of investment grants is claimed by the Board of Trade, where the asset -

1. Is not brought into use within six months.

2. Is disposed of to another person or ceases to be used for a qualifying process within one year.

3. Where grants have been made during the period of manufacture and the asset is not completed.

Partial repayment is claimed -

1. When the asset is moved from a development area to another location.

2. If the asset is sold or disposed of to any other person including

a separate company within the group.

3. If the asset ceases to be used by the firm, and for the purposes described in the application form within a period of three years.

4. If an item of peripheral equipment forming part of a computer installation on which a grant has been received is detached from the installation and disposed of separately within three years, the principles applying to repayment of grants will apply to the amount upon which the grant was received. The amount of grant to be refunded will be the proportion that is represented by the period of use to the requisite three years.

Taxation Allowances:

Initial allowances are given when expenditure does not qualify for investment grants. Otherwise annual allowances are allowable on the net expenditure (i.e. after deducting investment or other grants) against the taxable income of the proprietors or companies.

Cost of new computer:	£120,000
Less Investment grant 25%	30,000
	90,000
Allowance 1st year say 20%	18,000
	72,000
Annual Allowance 2nd year	14,400
	57,600

	£57,600		
Annual Allowance 3rd year	11,520-		
	46,080		
Annual Allowance 4th year	11,520		
	34,560		
Annual Allowance 5th year	6,912		
	27,648		27,648
Annual Allowance 6th year			
Less sales	25,648		29,000
Balancing Allowance	£2,000	Balancing Charge	£1,352

Provision of Finance:

When the cash budget does not permit adequate finance to buy a computer, capital must be raised from a bank loan or from a merchant bank. The rate of interest payable is a charge against profit. Banks charge lower rates than the merchant bank. If capital is raised from the market, the method of raising can be very different from the treatment of dividends and interest for corporations. The position in a summarized form is:

(a) Dividend on equity or preference capital is not allowable as a deduction.

(b) Debenture and/or loan interest is allowable as a deduction against income before computing profit assessable to corporation tax.

Leasing or Rental Schemes.

Any benefits by way of investment grants or initial allowances and

annual allowances accrue to the manufacturer and not to the hirer, although the payments under the leasing arrangement or the rental scheme are allowable as a charge against income.

It is needless to say that any allowable charges against income attracts relief at 40 per cent if liable to corporation tax or 8s.3d. in the £ if income tax with the appropriate rate of surtax applied in other cases.

The advantages found are in favour of outright purchase, where the asset is to be retained for a period of more than three years and where financial resources are available or can be secured at a reasonable cost, but the true answer lies in the close examination of facts for each individual case.

This is one task of the study group, who should consult the accountants for the firm and see how the firm fits in in the installation of EDP.

Report of the Study Group.

Having gathered sufficient information to arrive at a conclusion, it should make a report to the steering committee on the following:

1. Whether EDP services can be introduced as useful and economic services within the organisation.
2. A recommendation -
   (a) Whether or not a service bureau should be used.
   (b) Whether the computer should be rented or accepted on lease.
   (c) Whether the computer should be bought and installed.
3. A comparative cost study of all the manufacturers' tenders to install computers.

4. The types of equipment recommended and available.
5. Information relating to staff and staff training.
6. A suggested timetable for the changeover.
7. An estimate of savings of costs from the use of EDP.
8. A detailed case, summarizing the advantages and disadvantages.
9. A list of other expenditure, such as training of programmers and other staff, additional expense of the changeover and of parallel running.
10. An estimate of operating costs such as salaries of programming staff, operating staff, maintenance, depreciation.
11. A site for the computer.

The steering committee will study this report and if it agrees with the recommendations, the case will be presented to the proprietors or to the Board, in whose hands the final decisions lie.

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STAFF SELECTION AND THEIR ROLES IN E.D.P.

If the study group recommends that the computer system be installed, the study group would also devote time as to the selection and training of staff. In a computerised organisation, four types of staff are needed:

1. The data processing manager.
2. The systems analysts.
3. The programmers.
4. The operators.

Let us now describe the roles of these staff.

The Role of the Data Processing Manager.

With the increase in the use of digital computers in commercial concerns, the importance of a data processing manager is increasing day by day. In this section, it is proposed to examine his capabilities, position and personality. To examine the situation, it is essential that his role within the management structure is mentioned. He manages the data processing department. Many establishments have created the department within the organisation. But the creation of a separate department is dependent upon the size of the firm. It is obvious that a separate department can only be created if it is necessary for the firm in the interest of efficient operations of EDP to meet with the requirements of the system.

Functions.

Any work done by EDP is under his control. He sees that the work is properly handled by the system and carried out in accordance with the policy of the firm, laid down for the purpose. He has to ascertain that

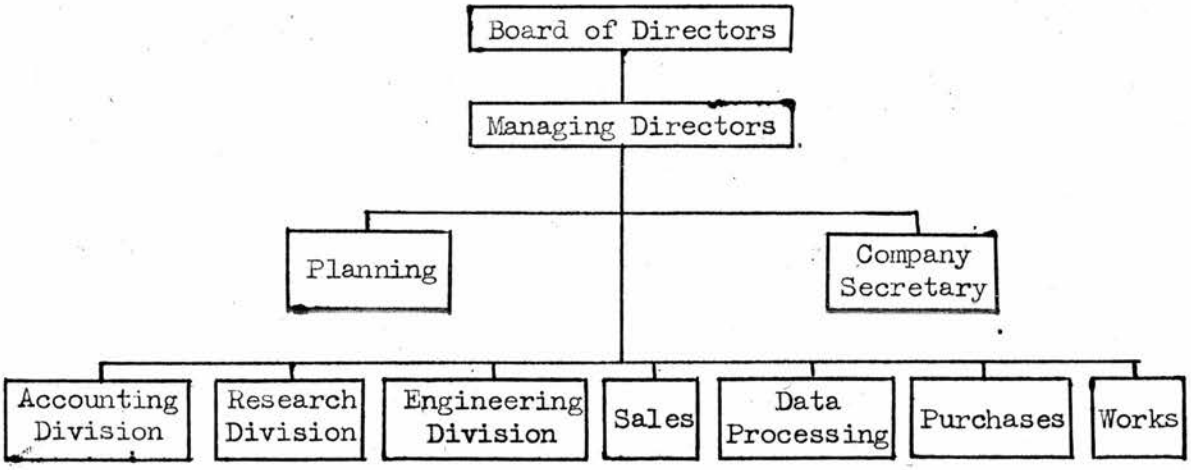
system study and design is carried out. From the staff point of view, he engages the staff of his department, unless the personnel department is in consultation with him, and makes the appointment. He divides responsibility within the department for two purposes - (1) efficient handling of work so that each staff member knows what he is required to do, (2) for internal control. He is assisted by a few staff comprising the system analysts, programmers, punched card operators and other juniors. The work performed through the EDP system may be varied and is based on the execution of the aims and objects of the organisation, meaning that the computer is being used as an aid to decision on the one hand, and on the other hand, for normal accounting and administrative work. This may be general accounting, budgetary control, stock control, forecasting, management information, production control, engineering and drawing work, and staff records. He has to supervise the smoothness in the completion of tasks. He has to see that proper flow charts are prepared and that programmes are in accordance with the needs. He has to check staff work if necessary, and input and output. He should allocate time for each job and see that the computer is properly maintained. It appears that his responsibilities are twofold:

1. The operational work of the computer.
2. Administrative work so that staff are properly deployed to do the operational work.

Position in the Management Structure.

It is often said that he is subordinate to the accountant, but it is not true in the real sense, although sometimes the accountants are also the data processing managers, and work in a dual capacity. He is

the head of the department, which is no less important than any other department - departments of purchases, sales, production, research or development. All heads of departments have direct access to the management, i.e. the managing director, the Board of Directors, etc. If he is put under the accountant, who is the head of the accounting department, the internal control will be loose - but this depends upon the size of the institution. So he should be independent to manage the data processing department with access to the management on the same level as those of other departmental managers. His position can be shown as under:



This chart can be varied a little but nevertheless his position and status remains the same.

Qualities.

He may have academic or professional qualifications, but the main qualifications required of him are:

1. He must appreciate system analysis and programming.
2. Must be conversant with the operations of the computer and its

performance from the management point of view.

4. Must be acquainted with policies, plans and ideals of the organisation.

5. Must have administrative capacity -

(i) To control subordinates.

(ii) To get along with his colleagues and staff.

(iii) To be able to supervise and adjust to repetitive operations.

(iv) To be able to show a sense of humour when needed.

(v) To be able to regulate the flow of work.

(vi) To deal with complaints.

(vii) To work in co-operation with accountants and accept and evaluate suggestions.

(viii) To show leadership.

(ix) To eliminate factors causing bad effects on work and waste of time and energy.

Many of these qualities are, of course, not unique to E.D.P. managers.

6. He must ensure proper maintenance to the computer and other ancillary equipment.

Promotion Prospects.

The importance of the EDP manager cannot be underestimated. It is not remote that he will be promoted to a directorship or even become the managing director or chairman of the organisation. Management does realize the shortage of trained data processing managers and therefore appreciates the necessity of annual increases of salary and the availability of a promotion to a directorship.

The factors which influence management to employ a person as a data processing manager are:

1. Is he able to work and supervise?

2. Is he able to grasp new ideas and help in research with new ideas?

3. Is he able to take responsibility for efficient operations?

4. Is he able to instruct clearly?

5. Does he know the work of system analysis and programming?

6. Can he determine specific ways in which he can assist in effecting economies in the use of the computer, power, light, heat, space, time and effort, and suggest elements for costing system?

Investigation.

An investigation was made regarding the training, pay, promotion prospects, his access to management, his departmental position. The following questions were asked:

1. Where did he receive his training?

2. Is the data processing department situated in a separate department?

3. What are his promotion prospects?

4. Is his pay adequate with the standard market rate?

5. Has he access to the senior management level?

The outcome of the investigation from a particular city's firms of various types such as insurance, banks, grocers, manufacturing companies, and hospitals was very satisfactory. The training was received through the manufacturers' courses and home study. The data processing department was separated to simplify the division of work within the

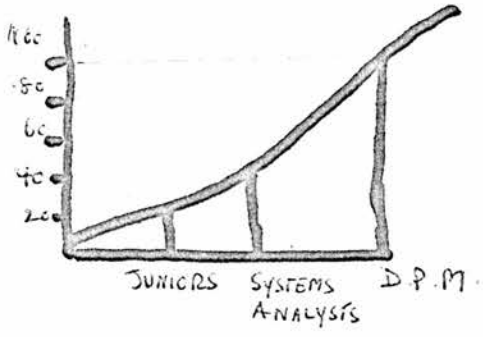
organisation. The pay was satisfactory, as there is more demand than supply of trained computing managers. The managers have promotion prospects up to the topmost positions and they have access to the top management levels, i.e. Boards of Directors. The investigation revealed how much senior management appreciates his existence with the introduction of EDP in the structure. He is an executive of high status no less than anybody in the industrial and commercial world, who undertakes a very great degree of responsibility, as the bar chart and curve show. He enjoys his rights of being important and indispensable.

Fig. 3:

Data Processing Manager

System Analysts & Programmers

Others



If full responsibility is taken to be 100 per cent, which is undertaken by the Data Processing Manager (DPM), the division of responsibility between systems analysts, programmers and operators will depend on the size of the firm.

The Systems Analyst.

The analyst is much more than the man who adapts an existing job for computer processing. Duplication and inconsistency exist for want of a means of resolving a variety of functions into an integrated process.

The analyst combines the essentials of what is being done and what ought to be done. He undertakes the following:

1. Analysis - what goes on now.
2. Design - what will be done.
3. Agreement - acceptance of the new system.
4. Programming - preparing software for the system.
5. Data preparation - converting manual data into computer media.
6. Clerical - changing due to manual methods.
7. Implementation - bringing the clerical and computer systems together.

The analyst comes in to gather quantative data and studies the pattern of work flow, measures the effectiveness of the systems. The computer is taken as a tool; the design of the system is an object. The analyst co-ordinates the above seven stages of work, and studies the problem to decide:

1. What is to be done?
2. How it is done?
3. When it is to be done?

Training for Systems Work:

The training can be broken down into five areas:

1. The computer.
2. The peripherals.
3. The techniques.
4. The management.
5. The problem.

Computer Area:

He must know the principal types of computer and the significant features of each. These features are:

Input - various devices available, their pros and cons.

Output - available forms of output, their pros and cons.

The Central Processor:

The balance of core store and backing store, the operations which are possible, and any limitations imposed by the size of the store.

Backing Files:

He must know the advantages and disadvantages of magnetic tapes, fixed random access stores, and the moveable pack access store.

Software:

He must also be capable of writing a simple programme.

The Peripheral Area:

This area covers the prime input to the system. Converting data into computer form is a knowledge which is no more than an appreciation of punched cards or paper tape. The data must be prepared in such a way that a reasonable flow can be maintained to the computer.

The Techniques:

He must be conversant with the following groups of techniques:

1. Basic study technique to consider a problem as a whole.

2. Measurement technique depending on the nature of the problem, calling for work sampling and activity surveys.

3. Clerical techniques involving work and study methods calling in form design, clerical methods, controlling batches, carrying out an audit of the work.

The Management Area:

The analyst must be capable of dealing with the management problem, which can be subdivided as follows:

1. Managerial functions - if the systems analyst controls and organises other people.

2. Selling the computer system - the ability to present a case, taking into account costs, benefits, both tangible and intangible.

The Problem Area:

This is the problem of giving the analyst training in the type of work he has to analyse. It is subdivided into two main headings:

1. Basic problem training.

2. Specialized problem training.

Basic Problem Training:

It applies mainly to commercial work. Many companies have similar systems to cover such work as sales accounting, production control, payrolls and share registration.

Non-basic Problem Training:

It applies mainly to the specialized and complex problem. It is the highest form of mathematical model making. At this stage the analyst must be completely problem orientated.

The systems analyst's approach to the various stages of design may be summarized as follows:

1. In the analysis stage it becomes general.

2. In the design stage it becomes detailed.

3. In the agreement stage he is selling the system.

4. In the programming stage he is the middle man, interpreting

the system for the programmers.

5. In the data preparation stage it is organisation.

6. In the implementation stage, it is co-ordination.

His educational attainment must be based on hardware and software.

The Programmers.

The programmer transcribes the processing requirements as set out for him by the systems analyst into a series of orders expressed in the particular language understood by the computer with which he is dealing. So he must have to be conversant with two fields of knowledge.

1. To do with computers and the way they work.

2. To solve the problems.

Experience has shown that he need not be a mathematician, unless the problem is of a mathematical nature. But it all depends on the type of machine used. For commercial work, most manufacturers are keen to produce straightforward machines and to compile easily handled utility programmes. A quality of mind and character is needed to make a programmer as well as technical skill. The skill of a programmer is determined by the following:

1. He does not waste the computer time.

2. He can prune unnecessary output and write programmes in such a way that only necessary information comes out.

3. He can write a programme correctly, relying on his knowledge of a problem.

For writing a programme, he needs to be conversant -

1. With the problem.

2. With the source language.

3. With the hardware.

In some organisations the programme is written and operated by one person, or at least by one group of people working as one team.

In other organisations, there are two groups - one writing the programme, the other running the production jobs.

Sometimes it happens that full responsibility rests on the operating staff to run the job.

However the programmer occupies an important position. His qualifications and training are based on -

1. Writing a programme in a source language.

2. Tackling a problem in the system, should an error crop up in software.

Operators.

In the operation of the equipment, there is a great need for thoughtfulness, initiative, care and commonsense. The operating staff must be conversant with the machine and their jobs.

Sources of Recruitment.

The study group will also recommend how to recruit staff and what sort of training they should possess.

There are two ways of recruiting:

1. From within the organisation.

2. From outside the organisation.

Whatever the sources of recruitment, the study group will see that staff are trained from:

1. Manufacturers' courses.

2. Technical or commercial colleges and universities.

3. Professional bodies.

4. Computer symposiums.

The study group should also see that staff possess the requisite -

1. Aptitude.
2. Right type of training.
3. Right type of mind.

The study group may recommend staff from inside the organisation to be trained, or recruit staff from outside.

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PART II

Case Studies

BANKING & E.D.P.

In the financial market, commercial banks have not remained behind in understanding the importance of the introduction of digital computers for accounting and administrative control. The banks realised in the early fifties that they were to face rising costs, as effects of post war reconstruction in the British economy made themselves felt. The rising costs related to:

1. Salaries and wages of staff of various grades.
2. Operating costs.

Moreover, it was found in the post war reconstruction, that there were many attractive openings for their staff in other countries. Therefore the banks had to revise their pay scales to make the banking service a more lucrative profession. Operating costs and rent and rates of office accommodation, due largely to their security value, soared rapidly. The huge paper work of many millions of cheque transactions cost a great deal as well. The recording of such transactions by conventional methods added to their costs. The question arises, 'What are the functions of a bank and what records were being kept which EDP could take over?'

Functions.

A: Banking Services.

1. They receive deposits from customers, collect cheques, bills of exchange and other credit instruments on their behalf.
2. They grant loans and overdrafts. Some branches prefer to a dvance a fixed sum on loan accounts, crediting the amount thereof to the customer's current account so that he can draw against it.

In other cases, the required accommodation is given by way of overdraft, i.e. the customer is allowed to draw cheques up to a specified limit in excess of the amount standing to the credit of his current account. Interest is charged on the amount of overdraft for the time being or on the amount of the fixed loan, whichever the case is.

3. They discount Bills of Exchange and Promissory Notes on behalf of customers and others.

B: Agency Services.

These include the collection of foreign cheques, Bills of Exchange, Dividend Warrants and other credit instruments, the payment of standing orders for insurance premiums, subscriptions, other recurring liabilities on behalf of customers, the purchase and sale of securities for customers through the bank's brokers, the services of the new issue department in connection with raising fresh capital by a limited company, which is mainly the receipt of application monies, financial business up to the allotment of securities and the specialised services of the Executor and Trustee department.

C: Miscellaneous Services.

Transactions of foreign exchange business, using travellers' cheques, letters of credit, etc., the receipt of safe custody of jewellery, title deeds of property, stock and share certificates and other valuables on behalf of the customers.

Observations.

The banks' resources are used for the purpose of earning income in

such a way that a sufficient proportion of their assets is in a form in which they can be easily and speedily realised. The total amount, which the Banks will lend at any time is determined by the ratio of cash reserves, i.e. cash and notes in the till plus balances at the Bank of England, to their liabilities. The ratio system is itself a good example of where EDP can be used very effectively.

The banks' accounts are based on a slip system of posting. Conventional accounting machines were used until recently for recording all banking transactions. This led to considerable difficulty in maintaining and completing accounting records, so the Committee of London Clearing Banks was established to investigate alternative methods.

Electronics Sub-Committee.

The London Clearing Banks charged the Electronics Sub-Committee, which they formed, to discover what the banks would require of the new electronic data processing techniques. It was also asked to examine the equipment which was available to determine where the gaps in the integrated system of the future might lie. In 1960 the Committee engaged the services of the National Physical Laboratory to report on the technical qualities of three magnetic character styles - E13B, CMB, and FRED. By that time, a few of the American Banks were already operating on the E13B code line. Having guidance from these American bankers and frank, open-minded discussions, the Committee announced the adoption of ABA style E13B characters as the common language for vouchers passing through the Banking system. The General Electic Company, working with the Bank of America and the Standard Research Institute, was responsible for research and development of magnetic

characters and E13B typefront. On 5th February, 1962, full details of the clearing banks' paper specification No. 1 were released.

Great Britain has an unique position in branch banking, as 12,000 branches out of the total branches pass more than 900 million cheques a year through the clearing system. Nowhere else is seen so highly centralised a cheque clearing system as in London and the banks were facing the prospect of a continued increase of cheques in circulation, extended use of the recently introduced credit transfer scheme, and the spread of the banking habit. A solution had to be found to relieve the British banks of this burden and they have, in fact, taken full advantage of technological developments.

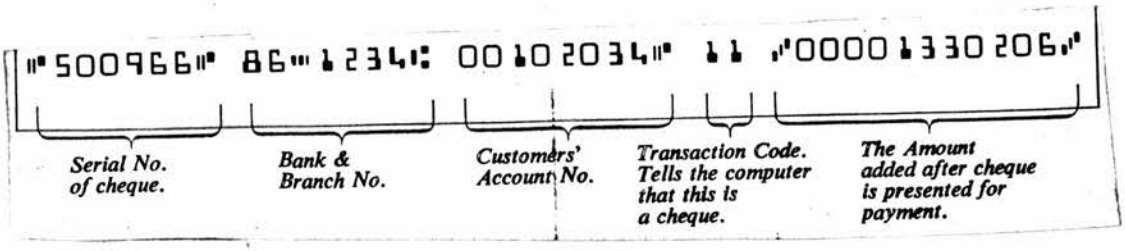
The Committee of London Clearing Bankers consisted of:

1. Westminster Bank Ltd.
2. Lloyds Bank Ltd.
3. Barclays Bank Ltd.
4. National Provincial Bank Ltd.
5. Midland Bank Ltd.
6. District Bank Ltd.
7. William Deacon's Bank.
8. National Bank.
9. Glyn Mills & Co.
10. Martins Bank Ltd.
11. Coutts & Co.

These banks started using MCIR in cheques. Before the banks went in for MCIR, usually they sent printed notices to their customers, as follows:

(1) 'Personalised Cheques

Your cheques have been personalised by having your name printed on them. In addition, your account number has been printed on the code line at the bottom of each cheque, along with the cheque serial number, the bank and branch number, and transaction code, as illustrated below:



These rather unusual looking figures are printed in magnetic ink in a style known as E13B, which has been adopted by the British banks as a standard code for automatic processing. With the addition of amounts to the code line as indicated in the illustration, your cheques can be sorted, listed and posted to your account automatically.

Every account has its own individual number, and consequently, if you have more than one account, you will receive a personalised cheque book for each. When you wish to draw cheques on specific accounts, it is most important that you use the appropriately designated cheque book. To avoid any possibility of confusion, it is advisable not to allow your blank cheques to be used by any other customer of the bank.

Automation will make no difference to the way you write cheques - simply complete them as you have done in the past.

Pay-in Slips

Later on, we shall be introducing pay-in-slips incorporating a space for account number and, when these come into use, it will be a great help to us, if you will enter your account number in the space provided each time you pay in to your account.'

(1) By courtesy of the Royal Bank of Scotland and Mr William Richmond, Accountant, St. Andrews Branch.

The Advantages of Electronic Data Processing.

The manufacturers' specifications of the services that computers can render, coupled with experience, gained by the American bankers and followed by the recommendation of the Committee of London Clearing Bankers brought a great impetus to the banks in the use of computers in banking operations. The advantages have been classified into three headings:

(i) To the bankers as institutions.

(ii) To the customers.

(iii) To the bankers' staff.

In more detail under these heads we have:

(i) Advantages to the bankers as institutions:

(a) Accurate and up to date control of banking operations and their automatic recording.

(b) Better relations with their customers.

(c) Better relations with their employees.

(d) Management easily gets information reports.

(e) Better audit control.

(f) Savings in office space and staff.

(ii) Advantages to customers:

(a) Faster service at the counter.

(b) Neat and attractive machine printed statement entries.

(c) Assurance of accuracy and completeness of statement entries.

(d) More attention to customers, as staff have more time to devote to good relationships.

(iii) Advantages to the staff:

(a) There is no need for mental calculations.

(b) There is improved working space arrangements through elimination of ledger files.

(c) There is less responsibility to watch errors.

(d) Easier balancing at close of business as cash balancing figures are provided automatically.

Procedures:

When the decision is taken as a preliminary study to adopt the recommendations of the London Clearing Bankers' Association, all Clearing Banks in England and the Scottish banks have to think as follows:

1. Do we want to be a data processing centre just for the Bank or for the Bank and outsiders.
2. What services might we offer to the Bank's customers and outsiders, if we cater for both as a data processing centre.
3. How should we price the services.

To decide the above, the Bank appointed a Committee. The Committee took steps as follows:

1. During the immediate period, other development may alter the whole course of automation.
2. There may be people, resenting the central processing by the computer, as they feel that a computer is beyond their grasp or endangering their sphere of business.
3. There are people who may not understand a major change in cheque handling.

Then the banks started their feasibility studies, for which the banks received the backing of the top level management. The banks informed all officials beforehand about their plans and asked for staff suggestions. In this study, a bank also had to decide:

1. How much is required to be invested?
2. What is the adequacy of personnel training? How will the staff be trained?
3. Will the bank management support the programme in all respects?
4. Is the plan economically sound and could it be affected economically?

Afterwards the management has to draw up a formal contract, set up new departments of data processing, pursue the important areas of detailed procedure studies, personnel training, manual preparation, customer and employee orientation, media preparation and form design.

Personnel Training:

About this, the banks knew that the following facts would come into play.

1. Should hire trained staff.
2. Should educate employees to take over from within.
3. Should not expect immediately any reduction in personnel.
4. Should re-allocate employees in some other duties.
5. Should make parallel runs successful.
6. Should see that all programmes are functioning properly.

<u>The Reactions of the 'Big Five' & a Study of the Westminster Bank Ltd.</u>

With keen competition in giving services to the public, the 'big five' started by introducing computers for branch current accounting, other accounting and cheque clearing. The Westminster Bank, one of the

'big five', started to make use of electronic data processing in 1962 and claimed to be the leader. The Westminster Bank's current role in data processing can be described as follows:

The bank is using at the moment ten IBM computers to perform a wide range of tasks, the machines being situated in three centres in London. The Bank's head office is situated in Lothbury. An IBM 7010 system, used for maintaining current accounting, savings, deposits and personal loan accounts is installed in Lothbury, the head office. 95 data centres are linked to IBM 1460.

At the second computer centre in London an IBM 1401 system is performing work, which includes pay rolls, the administration of staff pension funds, and work connected with the registrars and new issue departments. The work is concerned also with the share registers of many companies and public authorities for which the bank acts.

The third computer centre, which constitutes the bank's largest data processing installation, is situated in Northumberland Alley in the City of London. There, a 7010 and a 1410 computer are being used for maintaining current, deposit, savings and loan accounts, and for processing standing order payments. These two systems, together with the 7010 computer located at Lothbury, are at present processing transactions to approximately three quarters of a million accounts, derived from 175 branches.

In Northumberland Alley there are also five 1401 computers, which have been installed, together with five IBM 1419 reader-sorters, principally for cheque clearing work.

Central Accounting.

Each day except Tuesday, half a million cheques are cleared by the Westminster Bank Ltd. On Tuesday, more cheques than that are cleared since branches send Saturday and Monday cheques together. In the Westminster Bank, as with other banks, the basis of the system is a line of magnetic ink characters in the E13B code, which is printed across the bottom of cheques, as mentioned earlier. When reading these characters by machine, it is possible to sort cheques automatically and transfer data directly onto magnetic tape. The code line is divided into four sections. Cheques belonging to customers whose accounts are not maintained would not bear a magnetic ink account number and would thus be rejected.

Cheques received from 1370 branches are sorted manually in the morning into those drawn on the Westminster Bank and those drawn on other banks. The cheques drawn on the Westminster Bank are passed first for encoding. The remaining cheques are sorted into groups corresponding to the banks on which they were drawn. After being sorted, the cheques for each bank are split up into bundles of 500 cheques and each bundle is given a reference number. The bundles of cheques when completed are then sent to the respective clearing departments of the banks concerned. Following this, control dockets, which are listings of the values of cheques for each branch within each bundle, are summarised to produce the total value of cheques in each bundle. The relevant bundle, numbers of which are also transcribed onto the summaries, are then sent with the control dockets to the other banks' clearing departments for agreement purposes. The dockets are then returned to the Westminster Bank Ltd

during the afternoon. The procedures are similar for bundles of cheques drawn on the Westminster Bank but which have been presented to other banks' branches. The bundles, followed later by their respective control dockets and summaries, are distributed to one of six 'clearing rooms', each of which deals specifically with cheques from a particular bank. One room for Lloyds and so on. In spite of this division, one room can deal with cheques from other banks but the division is carried out for convenience of distribution. The Westminster Bank is using approximately 200 Burroughs and NCR encoding machines, each operating in conjunction with an adding machine, thus enabling the sterling amount of the cheques (in magnetic ink characters) to be printed on cheques.

The encoding procedure is applied to all cheques drawn on the Westminster Bank, passing through the central clearing department whether the customer's account is maintained by the computer or not. This manual procedure is performed in the following manner. After taking a bundle of cheques, the operator first of all feeds a bundle control slip into the machine. The slip bears a special E13B code description in a position corresponding to the account number field on a cheque. When sensed during subsequent sorting operations this code ensures that the appropriate section of the computer's store does not contain any data. The operator then reads the amount in sterling written on the first cheque and enters the amount on the keyboard of the adding machine. The cheque is placed in an input position on the encoding machine, after which the operator depresses a motor bar. This initiates the magnetic ink printing operation, during the course of which a machine reference number is printed on the back of the cheque. The cheque thus encoded

with the amount is then automatically fed into a stacker and the corresponding sterling amount is printed by the adding machine. If, during the encoding procedure, the operator is unable to process the cheque (i.e. the amount position on the bottom of the cheque has been for some reason torn), the details of the cheque are transcribed onto a special form called a document substitute. The operator then enters on the keyboard of the adding machine the amount and this is printed on the bottom of the document substitute in the normal manner, so the document substitute replaces the original cheque which is, however, attached to the bundle on completion of the encoding operations. When an operator discovers that she has encoded a cheque with an incorrect amount, no effort is made to rectify the error at this stage. When the cheques in each bundle have been encoded, they are agreed with the control docket listing and machine prelist. If an amount encoded on a cheque is incorrect, the erroneous amount is obliterated by means of a 'magnetic pencil' and the corresponding prelist is altered accordingly. The bundles of cheques are accumulated in each tray; a total summary of the total amount of cheques is prepared and placed in the appropriate trays. Tracer slips are prepared and will be directed on each of the four processes carried out during the sorting procedure. The cheque sorting operations are carried out on five IBM 1419 reader sorters, each equipped with 13 pockets, and each reader sorter is controlled by an IBM 1401 computer. In addition, an IBM 1403 printer, an IBM 1402 card reader-punch and two magnetic tape units are connected to each system. Each 1401 computer controls the sorting operations of its associated reader sorter by means of a 'sort pattern' which is held on magnetic tape,

portions of which are fed into the computer's store during each pass. The sort pattern in each of the five systems is the same.

Pass one is to segregate computer branch cheques from non-computer branch cheques - computer cheques are directed to pocket one and non-computer branch cheques are fed into pockets three to twelve according to instructions contained in the sort pattern. The allocation of pockets for non-computer branch cheques is based on the volume of cheques drawn on each branch - the volume of each branch is considered to be high, medium, or low. During pass one, master control lists are produced by the 1403 printers. Each list shows for each cheque a serial number, bank and branch number, pocket number (into which the cheque was sorted) and account numbers relating to the computer branch. If there is a reject, a special symbol is shown. The non-computer branch cheques from each pocket of each reader-sorter are accumulated for pass two. Ten separate runs are performed in pass two. During pass two, the tracer slips encountered at the front of each block cause the appropriate part of the sort pattern to be loaded from the magnetic tape into the core store of the 1401 computer. Control lists are produced in pass two. Many branches are cleared in this run. The sorting operations of pass three follow closely the same procedure of pass two. Pass four is also accomplished in the same way for the remaining branches. A master control list and individual branch control lists are again produced during this pass.

Cheques for computer and non-computer branches are cleared. All these cheques are subsequently returned to the respective branches for checking and cancellation, together with documents such as balance lists,

ledger sheets, customer statements, supplementary lists and statistical tabulation.

Branch Accounting.

The Westminster Bank is on the on-line system. Terminals capable of reading and transmitting paper tape and connected to branch lines, leased from the G.P.O., are sometimes 'single point' (i.e. one terminal per line), and sometimes 'multi drop' (i.e. two or more terminals share a single line). Altogether 19 lines serve 90 terminals at present. Punched paper tape is produced, in batches of 50 or 60 transactions with a control total record. Several batches are grouped on one reel of paper tape. A printer on the terminal, which operates at 15 characters per second, automatically prints out all transactions sent to the computer. Over 150 branches are linked to the computers. The terminals are much faster, transmitting at 100 CPS. A special multiplexor was designed to control this faster and more extensive network. Buffers, and a specially written control programme, enable the computer to handle the extra load, and to provide good checking facilities and error messages. Longer queues of transactions and messages mean that more core is used and therefore no other job is run simultaneously with teleprocessing. The computer has desk storage, and programmes are stored on it, but the computer does not write the transactions on the desk but onto magnetic tape. They are duplicated for security. The data is transmitted to a bigger computer for accounts updating. The terminal used by the Westminster Bank does not permit automatic printing of transactions, as they are transmitted. It is possible to print back error messages. During data collection, the computer stores statistics recording the

level of activity on the network. A later run prints daily figures and abstracts others for monthly reports. It is considered that they will be very valuable in recording system performance, noting volume patterns and trends, and providing basic information for the planning of future systems.

The Westminster Bank faced a great many problems in computerising the accounts for customers, in transmission of data over long distances and in the instant remote servicing of distant and widely separate customers. At present the problems are solved by the use of data processing equipment and a G.P.O. network. The Westminster Bank employed different firms to supply terminals other than the computer supplier, although the multiplexor was supplied by the computer firm, who wrote special programmes for it. It is worth mentioning that the G.P.O. lines have a very low error rate; the equipment used is also very reliable. The banks have a deadline to start full processing, since they must provide branches with the details of one day's transactions and balances by the time doors are opened on the next day. If terminal line or computer breaks down, paper tape is sent by rail or road, but the Westminster Bank has special off-line receivers on each line at the computer centre, so that they can switch over to them and collect data off-line if the CPU or multiplexor breaks down. The computers have fast paper tape readers to accept such delayed input. It is obvious that the Westminster Bank ensures, like any other banks, that the manufacturers supplying terminals have a country-wide force of maintenance engineers and could offer help in a reasonable time. Due to the peak problem, the Westminster Bank selected programme-controlled computer polling rather

than a manually operated dial up system. The latter solution may work well for small networks but was thought liable to cause unacceptable delays in prolonged peak load conditions. The only real programming problems arose from (a) the non-standard multiplexor at Westminster, (b) the limited core storage available to all users, and (c) the absence of normal testing facilities.

(a) This was the manufacturer's problem. His estimate of programming effort required to write a special control programme and most important, diagnostic routines, was comfortably beaten. The bank's programming team also with the help of programmers and engineers met its target and was able to integrate its routines with the special control programme on schedule.

(b) Limited core storage removed the temptation to attempt too much. Control programmes took up surprisingly little core, because much of the work of network handling is done by highly sophisticated transmission control units.

The success of the systen used by the Westminster Bank has been due to the following:

1. They carried out a thorough study of the processing requirements, the organisational implications of changing their method of work, line loading, peak volumes of data, etc.

2. They used systems analysts and programmes of high quality.

3. They considered the costs problem. They think that multi-drop lines, and sharing of terminals by neighbouring branches can cut down costs considerably.

4. They took into account that a teleprocessing system could suffer

from CPU failure, errors in the multiplexor, the line or the terminal. When the area of failure is not immediately established, the manufacturer has provided routines and methods for on-line diagnosis and automatic reporting of failures.

5. Staff training was imparted so as to equip them to handle both at the branches and head offices the equipment and programmes in the correct sequence.

Future Plans.

The Westminster Bank wishes to lead amongst all banks in EDP. By 1970, the Bank will computerise all branches. £5 M will be spent in connecting all branches in the U.K. As the Bank wishes to be first leader in EDP, all details have not been published.

The Westminster Bank's experience with character recognition was described in a conference by Mr Brooks, the general manager. He stated that the banks would not expand their use of the EBB MICR Font currently used for cheques. The bank would opt for OCR-B for other applications. The use of paper as a means of data transfer will disappear in any case. MICR is taken as a matter of good faith. There are favourable consequences, but also disappointments. He further stated that on the debit side of MICR, extra costs involved in printing, paper, staff and equipment, difficulty in correcting errors; but on the credit side, faster sorting of cheques and provision of important information for branch accounting.

It is ascertained that OCR-B (optional character recognition) has advantages on two counts: (1) because it is less stylized, (2) it is

more tolerant to degradation of print quality, and (3) it has a lower reject rate. Similarly, opposed to the advantages, the disadvantages about MICR are that it is too slow to code and four times as expensive as OCR-B to print. The character spacing is also greater for MICR (8 characters/inch) than for OCR-B (10 characters/inch).

Other Bank Applications.

Apart from the book-keeping and transmission systems, the following other services are rendered by the Banks, some of which have been taken over by EDP.

1. Staff records and pay roll.
2. Security analysis.
3. Share registration work.
4. Nominee and trustee work.
5. Statistics.
6. Overseas work.
7. Index of services available to customers.
8. Index of customers with details of services they use.
9. Customers' services such as preparing pay rolls for customers, submitting annual returns for them.
10. Standing orders.
11. Traders' credit.
12. Management planning and reporting.

Some of the above services are being rendered by the Westminster Bank

through their computers, although the services are not given to their customers as the latter expect service from a service bureau.

Report No. 34 of the National Board for Prices and Incomes on Bank Charges.

The report was published in May 1967. The recommendations of the report were that the Banks should and must compete between them. Many bank practices, until now the subject of central agreements, should be competitive. These include interest rates on deposits and advances and collective agreements of charges. The report goes further to suggest that staff involved in the high volume of clerical work should be cut, branch networks could be rationalised as an economy measure, perhaps by further amalgamations of banks themselves, and that banks should experiment with new opening hours. Borrowing and lending rates, which are subject to collective agreements, should be competitive and banks should offer a range of time deposits, whose rates of interest varied with size and maturity dates. Subsidiary activities like hire purchase should not be separated from clearing bank activities, as they form part of the whole spectrum of banking. Charges and commissions on current accounts, which are done arbitrarily, must be made more logical. Banks open new branches even when there is no need for competition there.

To be effective, should the report be accepted by the British Bankers' Association, it is essential that banks should use the assistance of EDP for various purposes, (1) to give more service to customers, (2) to earn at the same time, (3) to open branches to meet the needs of customers and to wipe out competition of opening branches between the banks, (4) to scale down charges.

The Future.

The use of EDP will not only be restricted to meet routine work within any bank, as the Westminster Bank planning shows as a guide, but banks will also use computers as an aid to management. The banks are also lagging behind in management reporting from the top level of management point of view. Time is not too remote, when the banks will see to produce the undermentioned through the EDP.

1. Purpose of loan and analysis of bank lending by size of business.
2. Position of accounts, ie. irregular, regular, dormant, etc.
3. History of areas where industries are slack and under depression, and the success history of industries in a particular area.
4. Lists of securities covering bank advances.
5. Unused borrowing limits of clients.
6. Percentage of bank lending to large companies, small businesses and to individuals.
7. Loan or overdraft on personal guarantee.
8. Limits of loans or overdraft to a particular type of customer.

Until now all banks, including the Westminster Bank Ltd, are keen to introduce yet more services which the EDP will provide as an aid to decision.

1. The banks will be in a position to take a guide from the computers as to how to invest their funds in the most profitable way.

2. What ratios of liquidity to deposits and other ratios to meet

the customers' demands should be kept.

3. In arbitrage operations, the buying and selling of foreign exchange on behalf of customers between countries, what exchange should they buy and what should they sell so as to give customers maximum benefits.

4. Where should they open branches? The modern method of opening a branch through intelligence and market research should be eliminated. Instead, the computer will take into account -

(a) Regional planning.

(b) Ultimate scope of operations.

(c) The factors creating demand and as well meeting the demand for the banking services in an area.

5. Control of staff duties , like hospitals, and appointment of staff can be done. The manual system of going through applications, interviewing, controlling their duties department-wise will be taken over by EDP.

6. Investment analysis, portfolio valuation and selection will be automatic.

7. Cost accounting and profitability analysis.

8. Customer service. A customer can call on any branch he likes and make enquiries about his accounts and use the banking facilities. This will be possible when direct access by every branch becomes a reality.

9. Inter-bank transactions can be sorted out easily through EDP. The setting up of inter-bank data transmission collecting and transmitting centres in the provinces.

10. The use of operational research methods and simulation techniques such as critical path analysis and programme evaluation research techniques under a given set of circumstances. The participants, for example, trainee-managers, could play the simulation game using resources shown on the bank balance sheet. Each decision would be fed into the computer, and its consequences evaluated for a guide.

Although the above services are desirable, two things of more importance have to be yet implemented -

(1) computers making payments to cheques, and

(2) preference of some customers to receive magnetic tape instead of paper vouchers, as the tape may itself be an input to their computers.

A short Study of U.K. Banks: (1)

Although most of the banks have applied data processing techniques, it is needless to say that some banks are very advanced in this respect. A Data Processing Study of

(a) London Clearing Banks, and

(b) Scottish Banks

as at 15th September 1967, will reveal the following:

(1) Letters and personal enquiries by the author.

(a) LONDON CLEARING BANKS AT 15th SEPTEMBER 1967:

Banks[x]	No. of Branches Computerised	Plan to Computerise by 1970	Total number of Branches	Means of Data Transmission to and from branches to Computer Centre	Computerised Branches based & to be based on on-line real line systems
Westminster Bank	402	all	1,160	a. Paper tape to paper tape transmission over S.T.D. lines. b. Paper tape transmission from branches directly on to magnetic tape via the computer at the computer centres	None but will be in the future
Midland Bank	253	2,000	2,650	Use of G.P.O. lines at 1200 bands using a standard G.P.O. modem.	Future based on continuation of real time and slack time processing
District Bank	68	all	370	By road and by telephone line	No
Glyn, Mills & Co.	Not computerised any current a/c operations	4	4	In view of the close geographical situation no immediate plans for data transmission.	No at the outset
William Deacon's Bank	12	150	250	IBM 3980	Not yet

(a) LONDON CLEARING BANKS AT 15th SEPTEMBER 1967 (cont.):

Banks*	No. of Branches Computerised	Plan to Computerise by 1970	Total number of Branches	Means of Data Transmission to and from branches to Computer Centre	Computerised Branches based & to be based on on-line real line systems
Coutts & Co.	7	9	9	By messenger	None
Martins Bank	5	all	725	At present by physical movement of paper tape and print out	No
National Provincial Bank	401	Majority	1,600 (includes 400 offices, agencies to branches)	a. Paper tape to paper tape transmission over public telephone lines b. Staff messenger, courier or rail collection and delivery service c. Paper tape to computer transmission over private telephone lines	In future, not at present

* The remaining three members of the London Clearing House have not furnished any information.

(b) SCOTTISH BANKS AT 15th SEPTEMBER 1967: *

Banks	No. of Branches Computerised	Plan to Computerise by 1970	Total number of Branches	Means of Data Transmission to and from branches to Computer Centre	Computerised Branches based & to be based on on-line real time systems
Clydesdale Bank Ltd	Information not disclosed	Majority	362	Data is fed into computer by two methods: a. On-line from sorter reader from E13B coding on cheques b. Off-line from punched paper tape produced at branch level for other items. Punched paper tape is transmitted according to geographical location of branch from computer centre or Area Data Transmission Centre by: a. Messenger b. Data Courier Service c. GEC100 CPS Data Transmission equipment working over switched lines d. Railway parcel service	No need to adopt costlier methods

(b) SCOTTISH BANKS AT 15th SEPTEMBER 1967 (cont.): ✗

Banks	No. of Branches Computerised	Plan to Computerise by 1970	Total number of Branches	Means of Data Transmission to and from branches to Computer Centre	Computerised Branches based & to be based on on-line real time systems
National Commercial Bank of Scotland Ltd	146	Not prepared to answer this question	366	Punched paper tape transmitted over public or private telephone line - off-line to punched paper tape receivers	None
The Royal Bank of Scotland	103	As speedily as possible dependent upon data transmission system	250	Paper tape to paper tape transmission, using both Talex machines and Marconidata high speed equipment (Data 600 service)	No
The British Linen Bank	None	-	203	None	No

✗ Bank of Scotland has not supplied any information.

Research and Development on Real Time Concepts:

The Banks' technical problems are expected to be solved through the hardware developments in the last two or three years. The magnetic disc is replacing or augmenting the magnetic tape. Discs are direct access devices, as described in an earlier chapter, and enable the computer to locate individual customer's records without the need for lengthy serial searches. The advantages of the use of discs over the magnetic tapes are that discs enable the computer to locate individual customer's records without the need for lengthy serial searches. Discs may also operate serially but at faster speeds than the magnetic tapes currently in use in banks.

Speeds of thousands per second are now attainable with access direct to the computer rather than through intermediate paper tape. Indeed computer to computer connections with very high data transfer rates over long distances are now possible. Keyboard equipment has been produced, enabling branches to key their day's transactions direct into the computer and simultaneously produce lists of their accounting entries. These communications terminals are two-way in operation, permitting the computer to print out information in branches remote from the computer centre as well as to receive data from branches.

The 'real time' concept is also being introduced, allowing branches to interrogate customers' records stored on magnetic discs and to receive the required information from the computer as a printed message on the terminal.

By shifting the cheque amount encoding and cheque sorting and magnetic tape transcription operations from the paying to the presenting

bankers, exchange between banks of magnetic tapes on cheques drawn on individual clearing banks resulted in speed of process of clearing cheques and giving rise to the 'direct debiting' system.

Banks are also making multi-programming approaches. The old systems of using computers from afternoon until the early hours of the following morning for customer accounting and leaving them free for other computer applications during the rest of the day are replaced by on-line enquiry facilities built into the new systems requiring continuous computer time during the day from morning to afternoon, and running simultaneously with customer accounting and the other bank computer applications in multiprogramming mode.

The banks are also giving thought to the G.I.R.O., as it represents severe competition for the banks for deposits, maintained both by individuals and businesses against which regular or anticipated payments are made. By faster and cheqper transfers of funds, made possible by comprehensive computer systems, the banks can successfully withstand such a challenge.

There is a need to develop mass memories of considerably greater capacity and flexibility than those generally available at present.

No electronic transfer system can operate effectively without a central computer capable of providing immediate random access to vast quantities of data. The solution may lie beyond the thin-film memories now being incorporated in third generation machines.

NCR has produced an experimental memory in which data is stored as microscopic spots on a plate coated with light-sensitive material. The data is packed much more densely than in conventional memories, and

even at this early stage of development a plate measuring 6 in. x 4 in. has the same capacity as an array of ferrite cores measuring 7 ft. in all three diminsions.

Data Transmission:

As well as using telephone lines and micro-wave links, a number of computer manufacturers have successfully undertaken the transmission of computer data by communications satellite; in one case on an inter-continental basis. Even so, existing communications networks are capable of meeting the demands of a full scale electronic cash and credit transfer system. Alongside such developments as IDAST (which enables computer data to be passed over telephone lines during the momentary breaks in normal speech transmission) there will have to be a great increase in the number of lines constantly available for business use.

Efficient terminal devices to link remote points with a central bank computer are required to be produced. Equipment is available already, which could be used to pass instructions direct to the computer from private offices or even from outside locations such as railway stations and airports. One New York bank is experimenting with a closed circuit television system that enables deposits and withdrawals to be made instantaneously.

NCR has developed an electronic sales register which, as a by-product of registering point-of-sale data, could automatically instruct a bank computer to transfer funds from the purchaser's account to the retailer's account. It is obvious that to permit the free exchange of funds, customers, suppliers and banks would have to be

linked into a nationwide data transmission network, requiring a degree of co-operation. The growth of modern credit card schemes is taken as the link between consumers, suppliers and bankers. In the U.S.A., a retail outlet keeping an account at one bank is prepared to accept the card of a man who keeps an account in another, which is not the same in the U.K. In conventional credit card system, the signature is the only clue to the identity of the holder, but in the electronic credit card, as seen in the U.S.A., the customer's card is inserted in a terminal device linked by telephone to the bank's computer. The computer immediately interrogates the account data stored in its magnetic files, calculates a credit rating based on the current state of the customer's account, and transmits this information to the terminal device. If everything is in order, the sales assistant presses a 'sale approved' key and registers the sale in the usual way. Information relating to this sale is transmitted to the computer, which automatically credits the retailer's account, debits the card-holder's account and records the essential details on magnetic tape for subsequent processing. This electronic card does not make a check on the identity of the person. So research is being done in the U.S.A. into the bonafides of a person presenting the electronic credit card. Identification is experimented on voice recognition. Every human voice produces an electronic pattern as unique in its way, as a fingerprint; thus it is possible to compare the voice of the person presenting an electronic credit card and a 'voice print' retained by the computer in its magnetic files. The same technique may be used in advanced systems of the future, where verbal messages, authorising transfer of funds, are relayed by telephone to a

computer equipped with voice-response facilities. Another way of identification of a card holder, which has already been acheived, involves the use of a recently developed data storage method called holography, in which case the miniature signature on the credit card is optically scanned by a laser and matched against a whole series of signatures stored at random on a hologram placed in the scanning device. As soon as a matching signature has been found, a photograph of the card holder is retrieved from a file and displayed on a small screen near the counter. So identity of the card holder can be immediately established.

More rational and economic transfer of cash and credit is feasible. Time is not too remote, when banks in the U.K. will have interests in retail departmental stores and other businesses, so as to meet all needs of their customers. It is needless to say that in all fields of customer services, electronic data processing will help to keep records of all businesses transacted and to enable better and immediate services to be rendered.

Summary of Decisions and Actions:

Now a look can be given in a summarised form as to what has actually taken place in the field of Electronic Data Processing in banking. It is clear that not only labour shortage but also to gain additional cost reductions, the banks, like other service industries, are being forced to automate.

The Prices & Incomes Board's report states -

> 'It was in response to continued rising labour costs that the Bank undertook a heavy investment in Computers ... We are equally unable to say how far efficiency has been raised by these expenditures.'

The Prices & Incomes Board did not take into account additional cost reductions and efficiency attained. All banks using data processing

techniques will agree to attainment of these three factors: (1) a solution to labour shortage, (2) additional cost reductions, and (3) efficiency, as described earlier in 'The Advantages of EDP'.

However, the banks were early in this field, as could be seen from (1) joint decisions of clearing banks, and (2) action by clearing and Scottish banks, as undermentioned:

1. Joint Decisions of Clearing Banks:

December 1955	CLCB established Electronics Sub-Committee to examine the banks' requirements for a properly integrated clearing system using newly developed electronic data processing techniques.
February 1957	Adoption of Arabic numerals printed in magnetic ink as common encoding medium. General description of equipment likely to be required was released to manufacturers. Cheques to be personalized and to conform to certain limits of size.
Early 1960	Services of National Physical Laboratory engaged to evaluate the technical qualities of three short-listed magnetic character styles.
December 1960	Adoption of E-13 B type-fount characters as basis of common language for encoding vouchers.
August 1961	Location and arrangement of characters along the code line announced.
February 1962	Full details announced of paper specification for encoded cheques.

2. Action by the Clearing and Scottish Banks:

1959 March	Bank of Scotland install in Edinburgh the first centralized ledger posting unit (IBM 420), operating on punched card or tape, subsequently connected to distant branches (including London) by Telex.
June	Glyn, Mills start paying Army and RAF officers on Leo computer.
August	Barclays order first banking computer (EMIDEC 1100) for delivery in 1961; communication with branches to be by teleprinter, making the computer the first in the world to operate solely on transmitted data.

1960	
January	Martins, in conjunction with Ferranti, operate as an experiment the first complete electronic computer programme for the accounts of one branch.
March	Lloyds order Burroughs automatic sorter-reader for delivery after 18 months, provided E-13 B is adopted by the banks as common machine language.
July	Westminster complete demonstration of part of one of the City offices on Leo II. Order Pegasus II computer. Lloyds order three IBM computers for Pall Mall branch. National Commercial Bank of Scotland order IBM 1401 computer for centralized branch accounting.
August	National Provincial order Ferranti Orion computer for centralized current account book-keeping.
December	Barclays order IBM1210 reader-sorter.
1961	
January	Bank of Scotland order IBM 1412 reader-sorter to attach to IBM 1401 computer which will be installed in replacement of punched card unit.
April	First reader-sorters are installed - IBM 1210 at Barclays and NCR at Westminster.
May	Bank of Scotland start operational use of first medium-speed data transmission system over public telephone lines from Glasgow to Edinburgh. Midland orders English Electric KDP 10.
July	Barclays' computer centre opened with EMIDEC 1100. Martins begin operations with Pegasus II following completion of the installation in May 1961.
August	National Commercial Bank of Scotland install centralized ledger posting unit (IBM punched card). They operate IBM 604 electronic calculator - the first electronic equipment used for centralized accounting in Scotland - carrying out calculation of interest and service charges in sterling with automatic application to customers' accounts. Westminster install Ferranti Pegasus II computer and begin operation of system in parallel for one branch (Eastcheap). IBM 1401 computer system and 1412 reader-sorter ordered.

September	Lloyds open computer centre in West End with IBM 305 computer using random access disc file for branch accounting.
November	Bank of Scotland's computer (IBM 1401) becomes operational. First in Scottish banking. Barclays order second computer. Coutts install Univac (with punched card input).
1962 February	Westminster order second IBM 1401 computer system and 1412 reader-sorter.
June	Westminster install IBM 1401 computer system and 1412 reader-sorter in head office. Lloyds order Burroughs data processing system for installation at clearing department at Stevenage in March 1963.
August	Lloyds install Burroughs B 101 sorter-reader for off-line cheque sorting.
September	Chancellor of the Exchequer officially opens Westminster's head office computer centre, the first in Europe to use magnetically-encoded cheques for direct input to customers' accounts. National Provincial install Ferranti Pegasus.
October	Midland open computer centre with English Electric KDP 10. Midland Bank install two IBM 1210. Lloyds exchange IBM 305 at West End centre for IBM 1401 with random access disc file. Second 1401 delivered December 1962.
November	District install IBM sorter-readers in London office. Westminster open West End computer centre. IBM 1401 system and 1412 sorter-reader installed. Threadneedle Street office attached to Lothbury computer.
December	National Commercial Bank of Scotland install IBM 1401 computer to replace electronic calculator.
1963 January	Bank of Scotland begin operating reader-sorter link with computer.
March	National Provincial install NDP cheque sorter as pilot scheme at their clearing department.

April	Lloyds install Burroughs B 270 sorter-reader system at Stevenage clearing department. Second installed in December 1963.
June	Lloyds install IBM 1401/1419 sorter-reader system in London clearing department. Second installed in December 1963 and third in November 1964. National Commercial begin operating reader-sorter link with computer. District order Burroughs B 272 computer.
August	Lloyds replace existing punched card system for share registration with IBM 1401.
September	Westminster install further IBM 1401 at Lothbury. Three City offices and 40 London branches attachment completed to all three IBM 1401s, plus travel service, staff pay, provident fund, nominee services.
1964 January	Midland install NCR 315 computer in overseas branch. Westminster install IBM 1410 at Lothbury Centre 2.
February	Westminster begin registrar's department attachment and exchange of magnetic tapes with local authority.
May	Midland install eight Burroughs B 103 sorter-readers. Lloyds exchange IBM 1401 for IBM 1410 at West End centre.
June	District install Burroughs B 272 computer at Manchester.
June-July	Westminster. All branches on three IBM 1401 systems transferred to IBM 1410 Lothbury Centre 2. Second IBM 1410 installed at Northumberland Alley. Five IBM 1401 systems and 1419 sorter-readers installed over a period of a few months for commencement of clearing automation.
October	Lloyds open City computer centre, Post Office Court, with IBM 1410 with disc storage for branch accounting on random access.
1965 January	Westminster install IBM 1460 at Lothbury; purpose-built equipment for tele-processing. A joint operation between GOP, IBM and AT & E and Westminster Bank - the fastest teleprocessing equipment installed to date. IBM 7010 installed at Northumberland Alley. Two hundred and fifty branches converted overnight to more sophisticated system on larger computers, with capacity for another 200 branches.

February	Clydesdale open computer centre with NCR 315 computer and two reader-sorters. Midland open second computer centre (in the City) with KDF 8.
May	Royal Bank of Scotland install English Electric Leo III computer in Edinburgh.
June	Midland open computer centre in Birmingham with KDF 8. Clydesdale commence data transmission at 100 characters per second over telephone lines - first at that speed in British banking.
July	Lloyds begin cheque clearing for computer branches written to magnetic tape as by-product of clearing operation, for direct up-dating of customers' accounts.
August	Lloyds begin high-speed on-line data transmission at West End centre.
September	Westminster begin operations with high-speed on-line data transmission. IBM 1410 converted to 7010 at Lothbury.
October	Westminster. First large provincial branch on-line to central computer.
November	Lloyds order IBM system 360 to replace IBM 1401 for share registration work. Delivery February 1968. Royal Bank of Scotland open computer centre with Leo III.
December	Williams Deacon's install IBM 360 computer system in London.
1966 January	Bank of Scotland install first IBM 360 in Scotland. National Provincial open computer centre in Bradford.
March	Midland install two Burroughs B 370 computers in their clearing department. Lloyds open computer centre at Cannon Street with three Burroughs B 370 systems and three IBM 1401/1419 system for cheque clearing and IBM 360/40 system for branch accounting on-line with high-speed data transmissions. Three system 360s installed by May 1967.
April	Barclays open second London computer centre at Lombard Street equipped with IBM 360 computer system. Barclays automate general clearing at St. Swithin's Lane, using IBM 360 computer systems.

May	National Provincial open computer centre in Birmingham. Coutts order IBM 3979 computer-reader-sorter system for clearing operations. The National Bank order IBM 360 computer system for installation in December 1967. It is envisaged that all branches will be incorporated by 1969.
June	Barclays launch Barclaycard credit card scheme with computerized accounting based on Northampton centre equipped with IBM 360 computer system.
August	Midland order two system 4/50s.
November	Westminster IBM 360, Model 40, with 7010 Emulation installed and operational. Martins open computer centre in London with two NCR 315 computers.
December	British Linen order ICT 1903. District open second computer centre at Warrington with Burroughs B 300.
1967	
February	Clydesdale install second NCR 315 computer.
March	Midland announce all branches are to be linked to computers by 1971, based on English Electric Leo Marconi system. Westminster order two IBM 360/65 systems and Burroughs TC 500 terminal equipment. Coutts install NCR 500 computer for trustee and securities work. National Provincial announce all branches are to be linked by computers by February 1971, based on IBM 360. Martins install an additional computer: NCR rod memory core. Glyn, Mills install a Burroughs B 270 clearing system to meet immediate needs pending the creation of a group computer organization to serve the III Banks Group (Royal Bank of Scotland, Williams Deacon's Bank and Glyn, Mills & Co). Barclays order Burroughs B 8500 computer plus terminal computers for branches; all will be linked by 1970.
April	Midland and Westminster order Burroughs terminal computers for branches. Midland order two NCR 315 RMC for clearing department. Barclays open third London computer centre at Tottenham Court Road equipped with IBM 360 computer systems. Westminster. IBM 1401 system transferred from West End centre to Lothbury. IBM 360/30 system installed at West End centre.

September	Installation of an additional IBM 7010 computer in Northumberland Alley centre by Westminster Bank. Setting up of inter-bank Computer Bureau and order worth over £1 million for an ICT 1906E by the Committee of London Clearing Bankers.

Source: Computer Banking - A Survey, The Banker, Vol. CXVII, No. 496, June 1967, pp. 496-501.

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E.D.P. AND INSURANCE

Like any other industry, the Insurance Company finds that EDP will help in various aspects. The Insurance Company sells its promise in the form of a policy to pay a specified amount in the event of a loss, the purchase price, being the premium. The premium rates are different for different risks. They do not vary greatly for similar risks between different companies. Therefore there is keen competition between the insurance companies to keep their old clients and bring in new clients. To satisfy the clientele, insurance must operate on the basis of rendering services, which can only be materialized if they can operate with accuracy, speed and other savings in costs. Apart from the service motive, the insurance company, like the banking institutions, has to operate on a prestige basis. It must choose a good commercial centre for its office. The office must be widely spaced with proper office furniture, and equipment to impress customers. The post war period has raised many crises in office accommodation. The rent also of office accommodation is increasing continually. The task of finding proper office accommodation, equipping it with furniture, fixtures and other equipment, paying a heavy rental, is difficult. New openings in other professions have also added to the insurance companies difficulties in finding staff. The staffing problem, together with increased salaries, was also alarming.

The large volume of paper work involved in many repetitive operations needs to be handled quickly and accurately. Also modern underwriting and selling techniques call for more statistical data.

When the British insurance companies were facing these difficulties, favourable reports came from the North American continent that EDP had been helping them in combatting the problems faced in the insurance industry.

How can computers help in insurance? A vast amount of data is derived daily from a country-wide insurance operation. The computer can be fed with the data and information can be processed in any one of a number of ways, at the same time relating new facts to existing information already held on the magnetic tape or other files. The computer is capable of performing the very important jobs in insurance operations of sorting, collating and summarising statistics, printing out renewals, accounts, statistics and any other documents at extremely high speeds. Automatic data processing thus covers the following fields:

Premium billing

Premium collection

Settlement payments

Waiver of premium

Policy loans

Claims

Lapses

Reinstatement

Surrender value computations

Dividend computations

Reserve valuations

Statistics

Policy issue

Commission accounting

Renewal certificate issues

Renewal notices

Policy writing

Medical statistics

Group pensions

And any other operational works

Operating work: Staff, office and related expenses.

Functions.

Before going further into the computer's use in insurance, we must examine the functions and services of the insurance company. We begin with the premise that there is always a distinction in the usage of the terms 'assurance' and 'insurance', the former being practically confined to life assurance business, which includes endowment assurance and annuities, while the latter term is used to denote insurance contracts covering events, which may or may not happen, e.g. fire, burglary, accidents, illness, etc. In practice, this distinction is rarely adhered to. A contract of assurance is between the two parties, assurer and assured, which guarantees payment of the sum assured by the assurer to the assured upon the happening of a certain event dependent upon human life. Such a contract is not one of indemnity. A contract of insurance contemplates the granting of certain payments or benefits, by the insurer to the insured, consequent upon the happening of certain events, stipulated in the contract, which events may or may not happen. That is why it is called a contract of indemnity against a contingency.

There are some companies which just specialize either in assurance or in a particular field of insurance. Most companies operate in both fields. In order to effect an insurance, the proposer first of all completes a proposal form, which becomes the basis of the contract between the parties. The amount payable by the assurer or insurer on acceptance by the company of the proposal is known as a 'first premium'. Subsequent premiums are termed renewal premiums. The premiums are payable in advance, which may be yearly, half yearly, quarterly or monthly, as the arrangements are made between the parties. The policies issued are divisible into two main classes, 'with profit' and 'without profit'. The former type of policy, in addition to safeguarding the principal sum assured or insured, confers the right to participate in the company's bonus distributions, and the latter, i.e. without profit policies, do not confer any such right. Where large amounts are insured, insurance companies reinsure part of the risk undertaken. Such a reinsurance contract is completely distinct and separate from the original insurance or assurance. The companies, which operate more than one business are called composite companies. The companies, other than life assurance companies, which combine for the fixing of rates for the risks undertaken, are known as tariff companies or tariff offices. For assurance policies, when the holders wish to cancel the contract of assurance, which has been in existence for at least three years, the assured get monetary value of a life assurance policy.

The insurance companies do not have to pay to the insured until the events have happened, but events are certain in the case of assurances.

There are classes of life assurance which are divided into two

broad class, viz. (a) ordinary, (b) industrial. In the former class, the premiums are paid either directly to the company or through the agent, who effected the assurance on behalf of the assured, and the sum assured is rarely less than £50. In the latter class, house to house collection of premiums is made, which may be monthly or weekly from the assured, and the sum assured may be as little as £1.

Like the classes of life assurance, there are different kinds of insurance. In the twentieth century, any risk can be insured. Besides life assurance, the chief kinds of insurance are: marine, fire, personal accident, employer's liability. Other risks such as sickness, third party indemnity, motor car, cycle, burglary, goods and cash in transit, glass, storm, lightning, may be insured.

Life assurance is based upon two principles, (a) the expectation of life, i.e. mean after life time; (b) the rate of interest that will probably be earned on funds invested at compound interest. Expectation of life does not, as is sometimes erroneously supposed, signify the number of years that persons of a given age may reasonably expect still to live, for many lives fall short of this period, and many will live long after it. It is computed over a large number of lives by making excess years of those who live long, and distributing those among those who die early, thus placing all lives of the same age on an equality. This function, the mean after life time, is deducted from mortality tables, which are instruments by means of which are measured the probabilities of life and the probabilities of death. There are two kinds of mortality tables: one is based on census returns, and the deaths that have taken place during a definite period of time, and the other is based upon the

experience of assured lives, derived from a single life office or from a combination of life offices. The data derived from the above sources is examined by specialists, known as actuaries, who graduate[1] them after taking into account all other factors. They bring out the general rate of mortality.

The premium consists of (a) pure premium, i.e. the annual sum if paid by a sufficient number of persons of the same age, and accumulated at compound interest, say $3\frac{1}{2}$ per cent per annum, will amount at death or on attainment of a certain age to various sums assured, and (b) a loading to cover all operating costs, a margin for a possible increase in the future rate of mortality, and for profit. Thus (a) plus (b) make up the office premium charged by the company.

Thirty days' grace is allowed for the payment of assurance premiums, and failing payment, the policy lapses and becomes void. But, whether the assured be alive or dead, the policy is capable of revival within twelve months, if five years' premium has been paid, by the payment of the outstanding premium and a fine. If less than five years' premiums have been paid, the lapsed policy may be revived on the same conditions, but subject to the good health of the assured.

There are times when an assured person desires to surrender his policy before he has completed the contract, then the assurance company will pay to the assured a sum termed the surrender value of the policy. This surrender value is based upon the reserve value of the policy, which consists of that portion of the annual premiums not required to cover the risk for the year accumulated at compound interest. As a rule, a policy

(1) The process of eliminating errors such as inadequate observations.

does not acquire a surrender value until three years' premiums are paid, which is two years in the case of endowment policies. Most life offices guarantee on surrender a minimum of proportion of the premiums paid, which is half of the premiums paid for endowment policies, and one third for whole life policies with an addition for any revisionary bonuses that may attach to the policy.

A life policy may be assigned by one person to another by way of mortgage or absolutely. Assignments by way of mortgage may be either liquid or equitable, and are subject to the mortgagor's equity of redemption. A legal mortgage is effected by deed and deposit of the policy. Equitable mortgage of a policy is effected by deposit of the policy accompanied by a memorandum of charge.

For both types of assignments, the company must be given formal notice of assignment. Notice enables the assignee to sue the company in his own name without joining the assignor as party to the suit. The priorities between the assignees are determined according to the order of notices of assignment.

There are many kinds of policies, two of which are most popular, (1) endowment, (2) whole life policies. Other policies may be policies upon joint lives, children's deferred assurances, sinking fund assurance, short period policies, etc.

Life offices are divided into two main classes; (a) Mutual offices, (b) proprietary, or mixed offices. A mutual office, where the participating policy holders make the proprietors and the whole of the profits are divided between them. A mixed office is a limited company, whose capital is subscribed in the ordinary way. The profits are

divided between the shareholders and the participating policy holders in a ratio varying from 80 to 95 per cent to the participating policy holders and the remainder to the shareholders.

The profits of assurance companies cannot be ascertained by ordinary accounting methods. They are determined by acturial valuations. The Act[1] requires that a valuation must be made once in five years. This is called the quinquennial valuation.

Most companies for their own safety value their assets and liabilities every year.

The major objects of the valuation are:

1. To ascertain the liability on account of annuities and life contracts.
2. To determine the value of the amounts in life and annuity funds.

The method of valuation is to find:

1. As the assurances and annuities fall due, their present value of all sums.
2. The present value of all the pure premiums to be paid by the assured, as they fall due.

The difference between the two is the reserve, which must be set aside, and which with future pure premiums to be paid by the assured and accumulated at the rate of interest adopted for valuation, will enable the company to pay all claims as they arise.

The valuation of the liabilities is not made on the same basis as that adopted for the formation of the premiums charged to the assured, but according to the most stringent mortality table and at the lowest

(1) The Assurance Companies Act 1909.

rate of interest that will permit the payment of a fair rate of bonus to the assured. Reserve must be adequate to meet liabilities and contingencies. Against the reserve required to discharge all its liabilities as they fall due, a company has its life and annuity funds, being past premiums paid, accumulated at compound interest, less claims, management expenses, and profits prior to the valuation. These funds are invested in various ways such as:

1. Mortgages.
2. British Government securities.
3. Stock Exchange securities.
4. Loans on policies and revisionary interests.
5. Debentures.

The difference between the amount required to be reserved by a company, and the amount of its funds in hand, as ascertained by valuation, represents the surplus or deficiency. If the surplus is sufficient, a bonus is declared. If the company is a mixed one, both a bonus and a dividend are declared. However, in the case of a deficiency, both are passed. If there is an actual deficiency, steps must be taken to remedy the situation.

Various Accounts.

The accounts of (1) insurance companies are regulated by the provisions of the Insurance Companies Act 1958. The form of revenue accounts, (2) profit and loss accounts, and (3) balance sheets is prescribed by Statutory Instrument. The ordinary principles of double

(1) It is meant that insurance and assurance companies be taken as a single term.
(2) Subject to the Companies Act 1948, and the Companies Act 1967.
(3) ibid.

entry book-keeping apply. Although the books may vary, they usually include:

1. New policy registers.
2. Renewal premium registers.
3. Premium cash books.
4. Investment and Dividend books.
5. Agency cash books.
6. Claims registers.
7. General cash book.
8. Registers of lapsed policies.
9. Register of surrender valued policies.

What does happen in matters of procedure?

1. Clients call on their agents or the insurance companies for policies.
2. Clients are accepted and issued with policies.
3. Clients pay first premium.
4. Renewal notices are sent by the companies.
5. Renewal premiums are received.
6. Policy matures or events occur.
7. Payments to clients made.

How do they invest funds?

1. Funds come from share capital.
2. Funds accumulate from premium receipts.
3. Funds lent out for investment either in stocks and shares or to borrowers.
4. Interest from investments regularly received.

Expenditure comes from:

1. Operating costs.
2. Payment of surrender values.
3. Payment on maturity of a policy or on the happening of a contingency, payment of bonus.
4. Tax payments.
5. Dividend payments.
6. Costs of re-insurance.

So it appears that all income, expenditure and other administrative work has to be recorded properly. To comply with the Statutory Instrument, they must keep proper books. So with the use of computers for administrative and accounting purposes, the insurance companies are greatly relieved. The companies have two great advantages:

1. Experience of the American insurance companies.
2. Experience of the London clearing bankers.

With these as their knowledge of assets, they embard on deciding the following questions.

1. What aspects of the company's operations lend themselves to computer application?
2. What improvements are needed for management information.
3. What advantages in the use of computers will be accrued to
   (i) the company,
   (ii) clients,
   (iii) staff?
4. How rapidly should the conventional accounting system be converted to EDP?

We have seen that the computer applications can be effectively used in accounting and administrative control, and also know that management information can be instantly produced. Management does not at present see much of the information, as it believes that to produce it, unjustified costs will be incurred, as there will be unnecessary searches for information, costing time of staff and disrupting work of other staff. But with EDP it is not so, as instant information at a low cost will be produced in no or little time, thus providing a guide for the management so as to maximise the company's resources and use all services to the greatest benefit.

The Advantages of Computers in Insurance.

On staff:

1. Less pressure of work, so their skills can be best used in proper jobs.
2. Improved working space arrangements through elimination of many spaces occupied by the conventional machines and their operators.
3. Elimination of all mental calculations and easier balancing of all accounts.
4. Less responsibility to watch errors and keep records on the individual responsibility.

On the Insurance Company:

1. Clients will be happier as they derive more attention from staff and so they are always satisfied, which will mean improved relations between them.
2. Employees are satisfied as they are not under pressure of

over-work. There is no fear of wrong calculations.

3. Accurate and up to date automatic control of the work.

4. Easy availability of management information, and reports.

5. Better internal control.

6. Savings in costs of office space and staff.

On the clients:

1. Electronically produced policies, renewal notices with no errors to think about, so assurance of accuracy.

2. Faster and closer attention.

3. Neatly produced policies and other notices.

Preliminary Studies.

After visualising all the merits of EDP, the management will study the problems and proceed to appoint a feasibility study group. The management in doing so takes consideration that during that period, other developments may come, which may alter the course of automation. There may be some objections by the old fashioned staff and clients, objecting to the use of EDP insurance. The management will therefore assess in the first instance:

1. How much capital will be needed to be invested?

2. How far are re-organization plans agreeable?

3. What is the adequacy of personnel training?

4. Are we prepared to get top level backing?

5. What would the staff reactions be, when they are told? Are they prepared to offer any suggestions?

6. Will it be an economically sound proposition?

How much capital will be needed to be invested is dependent upon the

availability of cash. If no cash is available, it may be justified to rent a computer or use a service bureau. But it is needless to say that most of the insurance companies in this country are financially sound. They have so much work to do from accounting and administrative points that they are better to buy a computer. Moreover, a constant flow of work cannot generally be done with the use of service bureaux.

Then the management ought to see how far the re-organization is agreeable. Whether the company will really benefit from the re-organization plans. The company should also see whether they are competent to receive trained people to operate the EDP, whether these people are to be taken from the industry, or whether they should be recruited from outside, or partly trained staff of the company with partly from outside recruitment.

Top level backing is essential. If the board of directors does not back such a programme, the company will not be able to have the full benefits. McKensays is a firm of management consultants. They carried on a research about three years ago to see how far benefits are being received by the firms of the computer users. Out of 27 large computer users in the U.S.A., their findings were that 9 of the companies had realised real benefits, whilst 18 of the installations were only marginally advantageous, or in some cases were not repaying the capital investment. The difference between the two groups was traced to two factors. Firstly, the successful companies, without exception, had top management participation in the project; the others had delegated too much responsibility down the line.

Secondly, the successful companies were not using their computers

merely for day to day processing, they were using them as management tools. The tasks handled over and above the normal data processing included manpower, production scheduling, sales forecasting, inventory management, quality control, etc. Many of these functions are not applicable to insurance, but budgetary control and forecasting can be very useful in insurance.

The staff must be consulted and suggestions are expected from them, as it is they who will deal with computers and computerised accounts and statistics, and as such they must be given a chance to voice their views. Moreover, the very fact that they have such a chance to share their viewpoints with the management will improve their relations.

It must be an economically sound proposition, although the management may not see the immediate benefits, but benefits will definitely accrue sooner or later. If proper costing is done, the outcome will be favourable to the management.

It is of interest to note the following figures about the use of computers in insurance, and their application.

Table F.(1)

Computer Application	No. of Companies
Life valuation	23
Annuity payments	12
Pension schemes costing	12
Salaries	15
Policy renewals and/or associated accounting (one or more branches of business)	40
Dividend payments and/or shareholders' registration	9
Investment accounting	12

(1) Source: Policy, July 1965, page 671.

Table G.[1]

Number of different types of Computers installed or on order for insurance companies.

Manufacturer	Model	Number installed or on order	
ICT	Pegasus	2	
ICT	Orion 1	1	
ICT	Orion 2	2	
ICT	1202	2	20
ICT	1300 & 1307	4	
ICT	1500	5	
ICT	1900 series	4	
IBM	1401	15	
IBM	1410	2	
IBM	1440	1	31
IBM	1460	1	
IBM	System/360	12	
English Electric	KDF6	3	
English Electric	KDF8	1	
English Electric	KDF9	1	7
English Electric	Leo 3	1	
English Electric	KDP10	1	
National Elliot	405	1	2
National Elliot	803	1	
Honeywell	H200	1	
Honeywell	H400	1	5
Honeywell	H1400	3	
De La Rue Bull	300 series	4	
De La Rue Bull	Gamma 30	2	15
De La Rue Bull	Gamma 10	9	

So the world of computers is quickly moving towards the world of insurance. The 'Prudential' was one of the first in the insurance race for the best and most efficient computer system. Within the last few years, the large mergers between the various insurance companies have been effective in making larger amounts of capital available and the computer is one of the leading benefits of larger scale organisation.

(1) Source: Policy, July 1965, page 671.

Obviously EDP will maintain the accounts of the insurance companies. Let us examine now the case of a company and see how EDP is helping the company in accounting and administrative work.

The company is the Provident Mutual Life Assurance Association. Mechanisation started with the company 11 years ago through the conventional 80-column punched card equipment at its sub-head office at Hitchin, Herts. Much of the work of the head office in London was transferred to Hitchin. In 1964, the firm installed an English Electric No. Marconi KDF6 computer. The computer comprises a central processor with a storage capacity of 24,576 characters, four magnetic tape units, a paper tape reader, a paper tape punch and a line printer. Data preparation is carried out now by a card to tape converter, three flexowriters and Zaddo-X and listing machines, each of which is equipped with a paper tape punch and a check digit verifier.

In the transitional period, jobs processed by punched card equipment have been performed in parallel with the new system. A number of punched card files were converted into a single comprehensive magnetic tape file. A number of cards from various files formed the basis of each policy holder's record. Five cards form a single record on average. Two difficulties were found: (1) a few files had to be consulted for one record, (2) delay occurred many times, as the acturial department did not release some files. The consolidation of these files has, of course, eliminated these problems and currently one main magnetic tape file - the policy record file - is maintained. It consists of 14 reels of magnetic tape on which 350,000 policyholders are recorded. 75 per cent of the record consists of 240 characters, the remaining 25 per cent

having additional characters depending on the nature of the record. The standard information recorded on the file for each policyholder includes the policy number, a class code denoting the type of policy such as life, endowment, mortgage protection, the policy term, the year the policy is to terminate, the sum assured, the date of birth of life assured, the renewal premium, policyholders' particulars of address and name. The renewal premium is recorded in character and binary format, the character format for printing purposes, the binary for calculations. Information on up to five policies is recorded on the file as a 'block record' - each block separated by an inter-record gap, i.e. a blank section of magnetic tape.

The punch card installation has continued to function in the normal manner. The cards containing policy amendments become input to the computer - the information being transcribed to paper tape. The data preparation falls into three categories:

1. Amendments to the main file, the details of which are punched into 80-column cards, which are fed into a card to tape converter. The data is transcribed into paper tape. Details relating to new business are punched onto paper tape by means of three flexowriters. Information relating transactions such as premium and loan payments are transcribed onto paper tape by two addo-X add listing machines, each of which is equipped with a paper tape punch and a check digit verifier.

For new business, work is performed by detailing on 'proof sheets' by means of Friden flexowriters. During this operation, paper tape containing the details shown on the proof sheets is simultaneously punched. The proof sheets are then visually checked and any amendments

necessary are made on the sheets. Then the proof sheets and tapes are returned to the flexowriters, which complete the records of policy, index card, premium sheet, acceptance letter, etc. The programme tape is prepared by flexowriters. Afterwards the flexowriters prepare a summary tape of 25 policies, which is used as input to the computer. Payment transactions are premium payments and loan interest, which are transcribed onto paper tape by means of two addo-X add listing machines, each of which is equipped with a paper tape punch. The information of policyholder's number, the amount and a transaction code is recorded. Each transaction is recorded on a control sheet. Each policy number is checked by a check digit verifier linked to the addo-X. A batch total is punched in the relevant section of the tape. For an error, the policy transaction is not listed or punched into tape validity check.

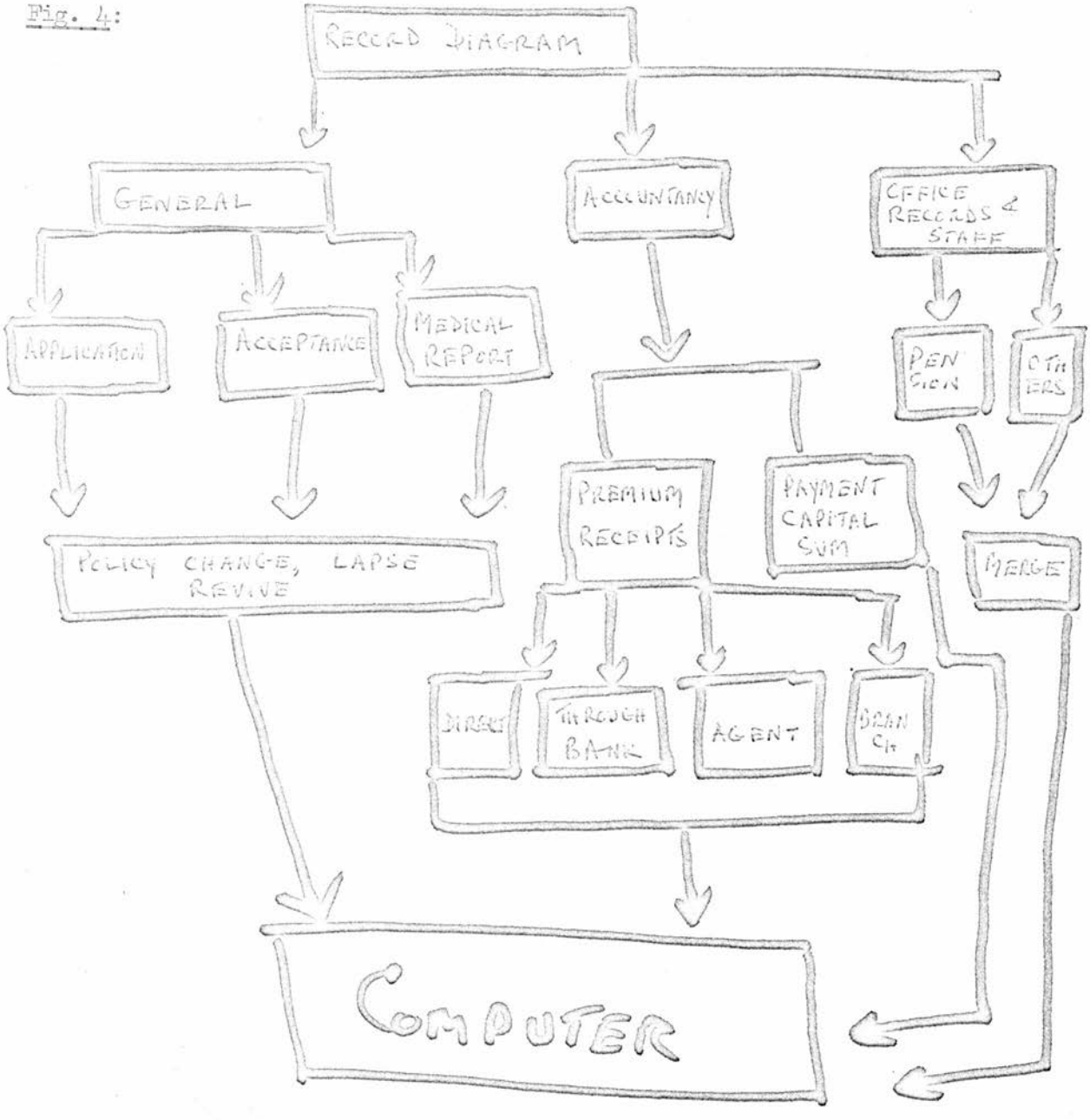
Tapes are fed through the paper tape reader and the information is read into the computer, where it is subjected to a validity check. During this run, a number of checks are performed including the verification of each transaction code, of which there are about 50. All valid data is recorded on magnetic code and invalid is listed on a monitor for verification and re-submission.

Valuation.

The financial position of a life assurance fund is assessed and carried out by mathematical formulae to life, endowment and any other type. The basic data is derived by the computer from the policy record file. The computer also helps in giving annual valuation. The amount, varying between policyholders and type of policy, is used to calculate the bonus. The bonus record is printed and added to the sum assured

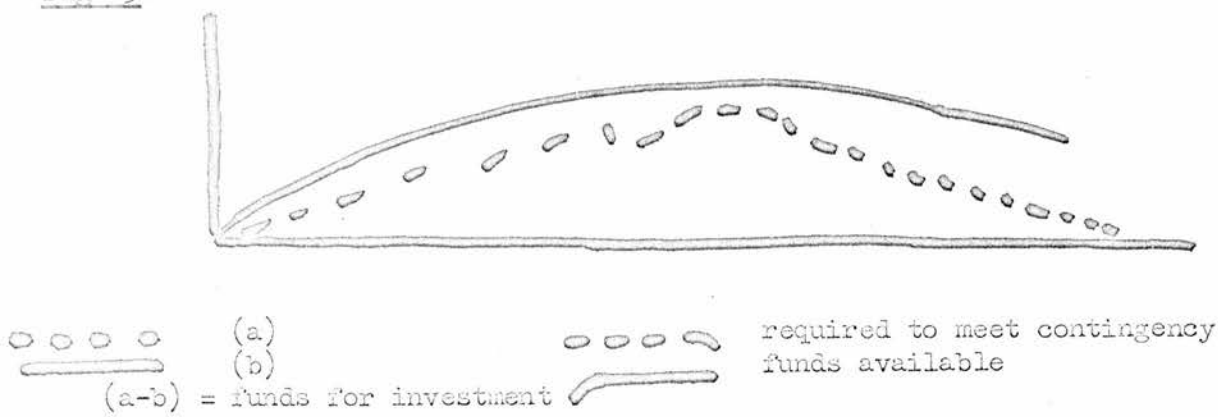
with option to the policyholder to take cash. At the moment the computer is being used for administering group pension schemes. A separate magnetic tape file is maintained for it. The computer is also producing statistics necessary for management.

Fig. 4:



However, the insurance companies have faced many difficulties in the past. Firstly the insurance companies do not have hard and fast rules for investments. If premiums are paid simultaneously on the same date each year, the management will be temporarily in possession of a considerable sum of cash - which may be depleted for losses and expenses incurred, and even may be balanced, which fund does not earn interest. Part of the sum can be invested temporarily to earn interest as it would be repaid in time to meet claims and expenses coming in later periods of the year. It is difficult to determine what proportion of such a fund would not be required to meet fluctuations in the incidence of claims and could therefore be partly invested.

Fig. 5:



The company may be forced to sell securities at an awkward time, so it would seem prudent to hold them in a liquid form or to arrange for the annual maturing of a fair portion of funds. The question arises, What proportion of the unexpired premiums are to be held in easily realisable securities.

The actual rather than anticipated profits on each group of policies will depend on the accuracy of the forecasts made when the premium rates

were fixed. If mortality and expense rates are lower or interest rates are higher than originally anticipated, the profit earned will be higher than expected. If the reverse happens, it will be lower. How can accurate forecasts be made?

Equitable distribution of the profits in the form of bonuses brings another difficulty. The insurance company is divided into groups of endowment or whole life policies. It happens that a surplus is earned by a particular group. But both groups with 'with profits' policies benefit.

Profits fluctuate from one period to another. So do the values of investments. When less profit the bonus is cut. So it appears that the earlier policyholders get less during less profit, but later policyholders share equally in high bonuses. Many companies wish to minimise the inequality by paying different rates. How can one fix the rate in such circumstances?

Then comes the factor of sales ability. There is keen competition between the insurance companies. How does one capture more of the market than the others? How can the insurance companies create demand?

Has the company got a proper sales force, and trained staff to run the organisation?

present training plans so as to meet the situation.

The company does not know what to reinsure and what amounts are to be reinsured. The company usually insures out of past experiences. The question always arises: How much and what business should be reinsured? For reinsurance, the geographical pattern is also taken into consideration and a kind of government interference.

The company will not be able to break into parts premium, which is premium equivalent to loss plus commission plus expenses plus margin. It will also be difficult to know what statistics are needed for the company. (1) 'Accounts tell us what we have gained or lost in monetary terms; they are concerned with the past. Statistics must tell us, clearly and in detail, how and why various things happened, and give us adequate information upon which we may take effective measures to promote the wellbeing of our business. Statistical science is concerned with the past only as a source of data for systematic and scientific treatment, the results of which will provide present and future guidance.'

The computer is able to provide quickly and frequently the condensed statistics which are necessary to assist management to forecast trends and thereby to implement policies based on the above suggestions. Provided that suitable mathematical and statistical models could be built the computer would take the analysis one stage further and make suggestions as to possible policy.

(1) 'Realism in Rating', page 196, J.P. Weber, FC11, Journal of C.I.I. Volume 63, 66.

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E.D.P. AND THE RETAIL TRADE

This is a study of retail organisation. The small retailer must also make managerial judgements. He needs specific business information. Data processing was thought too expensive for retail trade, but that idea has changed due to the co-operation of the computer manufacturers. Four essential tools have been given by the manufacturers to the retailers, (1) Input hardware[1], (2) an integrated system, (3) computer hardware, (4) software.[2]

Input Hardware.

There were immense difficulties in capturing detailed transactions data. Punch card systems were available in the past, but time and cost to punch and verify costs were not favourable to retailers. The development of punched paper tape as input media to go directly into the computer remedied the situation. The development of optical scanning systems made data processing an economic reality for the retail trade. Now point-of-sale information can be captured in optical type font as a by-product of ringing up a sale on a conventional sales register. The register's optical font journal tape can be mailed directly to the data processing centre. Naturally, processing costs are reduced, as the tapes are used as direct input for the computer. According to volume, processing costs vary but it has been brought to a minimum. But an investment in the sales register is still needed.

Integrated System.

Economical input is just one factor but it does not justify the use of data processing. There are three pre-requisites:

(1) Machine.
(2) Programme.

1. Control of cash and merchandise as a by-product of recording sale, purchase and expense.

2. Handling of all types of transactions with control.

3. Establishment of an audit trail from original entries to the final data processing reports.

Hardware.

Can the retailers afford to use computers? The answer is 'yes'. A small minority of retailers can afford to buy, rent or lease their own computers, but the cost problem has been brought to an end by the emergence of data processing centres. The advantages of data processing centres are given as follows:

1. Benefits of computer without investment in it.
2. Minimisation of start-up costs.
3. Specialised programming without employing any personnel programmers.
4. Flexibility of the data processing centre's services.
5. An objective analysis of the retailers' data processing problems.
6. Protection against obsolescence of purchased computer equipment.

Computer Software.

Data processing centres have programme packages, developed for a group of clients, thereby lowering the expense of programming by distributing costs among individual retailers.

However it needs visualisation among retailers how to plan (1) recording of data, (2) recording of credit sales, (3) recording purchase information.

Recording of Data:

There is no difference between the conventional form of keeping accounts and EDP. In recording a cash sale, the salesman performs the following: (1) records the department code, (2) indexes the salesman's number, (3) indexes a three-digit classification code for each article of merchandise, (4) records price.

Credit Sale:

Procedures are the same as in cash sales, but the following additional information is given. The customer's account number is also entered on the keyboard of the register. Payments received on account are recorded by entering the customer's account number, the amount paid, the salesman's identification number and depressing the received amount on the account key.

Purchase Information:

This is recorded by (1) entering the first item's classification number, the amount, and depressing the auditor's debit key. On a second pass over the keyboard, the operator enters a three digit accounts payable code and depresses the auditor's credit key. The auditor's debit and credit keys ensure that debit and credit are always in balance.

Planning.

The retailer assigns classification codes to his inventory with room for later expansion. The system's flexibility allows inter-departmental selling. An important thing is that the customer may check out purchases in any register in the store or the salesman can follow the customer to other departments to sell merchandise.

Software Package.

The retailer needs the management report to show:

1. How much is tied up in inventory.
2. Which items of merchandise are moving fast.
3. Which items are moving slowly.
4. Which classification produces the greatest margin of profit.
5. Where has he had to mark down.

The retailer's monthly inventory report shows the answer to the above questions.

One 'programme' package contains an inventory report, which provides as much as 800 classifications, the classification number, the units sold, opening and closing inventories, purchases, and percentage of total sales per month.

The inventory report enables the retailer to:

1. Know what the customers want.
2. Test advertising media and display areas.
3. Detect style changes.
4. Plot variations in seasonal sales.

Financial Statements.

Once in a year, profit and loss accounts, balance sheets, etc., are prepared. A conventional business system equipped with optical type font or punched paper tape can capture all the necessary information needed for monthly computerised financial statements. Purchase and expense information can be recorded any time convenient to the retailer and the machine's optical journal tapes or punched paper tapes mailed periodically to the data processing centre. A monthly statement of

income or loss to a percentage of sales, and total costs of operations, etc., can also be obtained.

The above applies to small retailers. If the retail trade is a multiple organisation, the above procedure still holds good but will be varied to suit the needs, but the multiple organisations in retail trade can afford their own computers to do their work rather than send for data processing to the computer centres. Now let us see how a computer should be used to control a multiple retail organisation.

The computer can check the stock position. The right amount of stock must be in the right branch at the right time. This can only be ensured if the sales record has been properly kept. The sales data can be read directly into the computer without the need for any media conversion. One method new to the commercial world which may prove to revolutionize data capture, is the use of magnetic ink character documents using CMC7 (1) code.

CMC7 is a magnetic ink character code, which may be read equally well by machines and men. It appears that it will be adopted as the European code-standard for banking organisations. CMC7 has a complete range of alphanumerical and control symbols, whereas E13B has only 14 characters. The original CMC7 coded document may be created 'on-line' or 'off-line'. The reading of the documents is carried out 'on-line', by document readers. The documents may be prepared off-line by a normal accounting machine or typewriter. The advantage with the CMC7 system is that the counterfoils provide direct input to the computer. The CMC7 slips would be prepared against purchase orders, placed on suppliers.

(1) 

The slips would accompany the purchase orders to the supplier, who would be responsible for attaching the slips to the merchandise. The detached counterfoils would be returned for computer processing.

Branch Stock Control.

The aim of the system is to use the branch sales data as direct computer input with a view to:

(1) Achieve integrated stock control.

(2) Automatic branch stock replenishment system.

The computer, based on an operational system, can point out the reduction or increase in stock at all levels of customer service. The decision on how much to order will depend upon a forecast of future supply and demand for the products.

The Computer System.

The operational cycle should start with the arrival of MICR documents from branches. Updating of stock records would take place daily and branches would be replenished weekly. The data will be fed into the computer for the initial run. Bad data is rejected.

The week's sales data, held on a work file on magnetic tape, card or disc, would be sorted into article code by branch sequence in readiness for the updating run on the master branch inventory file. The file contains stock balances for each article code within a branch and demand averages. The machine calculates new demand forecasts for the next stock replenishment cycle. An agreed percentage of safety stock is added to this figure to arrive at the new order level. The machine compares between the actual stockholding and new order level.

After calculating branch requirements, the machine calculates the

sufficiency of stock in the warehouse to meet demand. At this moment, the machine will bring in another permanent file, the warehouse stock file, which will contain stock balances and prices for all items.

During the stock allocation routine, the machine will open another file of stock allocations for each branch. The file would be used by the machine to print out the necessary documentation for the despatch of goods, packing and advice notes, etc. If there is a discrepancy, data will be fed back into the computer to adjust the computer file from which the documents were originally produced. The amended file would then serve the following purposes:

1. The preparation of branch invoices.
2. The updating of the warehouse stock file to record issues from stock.
3. The updating of branch inventory file to record new branch receipts.
4. The updating of branch financial records.

Other postings to the branch financial records such as cash takings, returns and branch transfers would be received on conventional documents and converted to cards or paper tape at the computer centre. Branch stock financial statements would be prepared by the machine and used in checking branch stocks.

In maintaining control, the computer will need to store a vast number of facts all relating to stocks and sales.

The machine will be able to signal:

1. Warehouse stock at re-order point.
2. To provide merchandising department with current sales trends.

3. Provide total stock commitment picture at a moment's notice.

There are some advantages from the adoption of a computer system with CMC7.

1. No manual intervention or less in cycles of operations.
2. It is inexpensive to run.
3. No centralised purchasing department is needed.
4. Staff are saved from unnecessary clerical work.

Let us now go through a supermarket and retail business. Tesco has many problems. In a retail organisation like Tesco, an enormous amount of data has to be handled. Food retailing has become ideally suited to data processing system techniques, and management control is one of the most complex business applications. Tesco knows both these problems. Moreover, Tesco has to handle inventory management, accounting and administration of branches.

Tesco installed an ICT 1300 at their Chestnut offices in May 1965. Tesco have no automatic point-of-sale data collection system to initiate sales accounting and analysis, but at Chestnut they use a mark-reading device in such applications as branch order processing and weekly payroll calculations. The document reader-lector can automatically read and translate handwritten marks on such documents as branch order forms, time sheets and so on. The purpose is that the person originating the information is able to record it directly in machine readable form. As a result, the need for data transcription is eliminated, checking operations are reduced to a minimum and the data handling procedure is considerably accelerated. Information is recorded on a document by marking a series of horizontal marks in pen or soft pencil in appropriate

positions. In the branch order list, each product item is allocated one line of the document. Product descriptions and prices are printed on the left, while the eight vertical columns on the right are given the numerical values, 10, 20, 40, 80, 1, 2, 4 and 8 respectively, and are used to mark in the quantities of each product required. 250 branches obtain 40 per cent of their goods from the central warehouse adjoining head office at Chestnut. A standing file of all food products distributed by the warehouse is kept on punched cards, one card per product. Each card carries, (1) a description of the product, (2) retail price, (3) cost price, (4) product number, (5) number of items per pack. The file is updated weekly to allow for price variations, or new or discontinued lines. The computer produces a printed 'order list' in product number sequence. A copy of the order list is sent to all branch managers. On this list, he indicates his stock requirements for the following week by marking the documents with horizontal lines in the appropriate spaces. The marked lists are then returned to head office, where they are fed into the document reader branch by branch, in scheduled delivery sequence. Since the machine is unable to read product descriptions, it refers to a product by a page and line number. By sensing the positions of the marks, it recognises the quantity ordered for each line of each page. The resultant paper tape output contains a series of page and line numbers with corresponding quantities.

Meanwhile the standing product file, associating each product with a price and with a page and line number, is fed into the computer in product number sequence and stored. The branch orders are then read into the computer via a paper tape reader and processed against the standing

file. The result is a printed invoice for each branch in warehouse location order. This also lists the products ordered, individual prices and totals. Four copies of every invoice are produced. The first is a file copy, second for delivery note, third used as a loading list for the warehouse, and the fourth is used to raise a credit invoice for goods charged but not sent. The computer also produces a weekly review of branch orders, which gives for each product the total quantity ordered by all branches, the warehouse location, total value and other relevant information, together with the number of branches that have ordered the product.

750 major suppliers deliver goods direct to Tesco branches and not to the central warehouse. Twice a week delivery notes received by the branches are sent to Chestnut. For 150 major suppliers, the quantities on each delivery note are translated into marks on a document against the pages and lines relating to the products delivered. As in the warehouse delivery procedure, the mark reader converts the information on the documents into paper tape, which is then read into the computer. In processing direct delivery information, the computer is able to calculate the value of all suppliers' invoices before they are received, and analyse branch purchases.

Payroll accounting is done by holding information on punched cards. The computer produces every week the hours adjustment forms by reading the punched cards. One such form is prepared for each employee at the branch. On these forms the computer prints the information contained in the original file card, and adds dashes to represent 'man number' and branch number so that the document reader is ultimately able to detect

them. All hours adjustment forms for one branch are sent to the relevant manager, who writes in the adjustment necessary to the basic hours of each employee.

Hours adjustment forms are turnover documents. They are initially produced by the computer. They are sent to the branches, and are returned with the input data for the following week's payroll.

Recruitment of staff has been from outside for the position of (1) a data processing manager, (2) two programmers. One further programmer was selected from within the organisation. The operators of the previous accounting system were trained to run the computer. ICT also helped to train the staff and even provided three weekend courses for the Tesco directors.

Future Applications.

Tesco wishes to use [1] visual display units. They will be part of the 32K store ICT 1903 being installed at Chestnut, Herts, in May 1967. The 20 visual units built by Cossor-Raytheon and marketed by ICT will present descriptions of items on delivery notes and invoices to an operator, who will then only need to key in the quantity. Valued at £301,000, the new installation is replacing the ICT 1300, described. It is expected that the 1903 will speed up data processing nine times. The staff also has doubled during the last two years. Two universal document transports will replace two lector systems. In November and December 1967, remote-on-line printers in warehouses in Cheshire and Wiltshire will be linked into the system. The complete system will have two 8 million character discs and four 20KC magnetic tapes. The computer

(1) Computer Weekly, No. 33, Thursday 4th May, 1967, page 1.

will take over the work of the present 600 branches.

Tesco is an example of a commercial concern, where EDP has been by purchase of a computer. But as explained earlier there are many other retailers who cannot afford to buy or rent for many reasons, especially economic reasons. Therefore these concerns must take into account the services of service bureaux. Next we describe Co-op Societies, who make use of service bureaux.

Many small co-op societies exist. If they merge, they will get immense benefits. These benefits of bulk purchasing reducing costs of transport have been proved by the merger of the societies of Dartford, Graveshead, Chatham, Rochester and Gillingham, forming a new society, the North-Western Kent co-operative Society, to undertake grocery warehousing and distribution. The society could not buy a computer to handle their work and so approached Randex E.D.P. Ltd of London, which operates with the aid of a Burroughs B.383 system, which includes a very fast random access disc file with a storage capacity of 9.6 million characters. Randex E.D.P. was able to show that it would be feasible for the new co-operative society to operate a bureau system that would integrate grocery accounting at branch level with warehouse accounting and stock control. This would provide much useful management information, both at branch and at warehouse level, which could contribute towards profitability. Randex E.D.P. does not undertake data preparation for clients on a continuing basis, and there were good arguments for using keyboard accounting machines at the society's office in Dartford. Two small Burroughs Sensimatic accounting machines with paper tape punchers and check digit verifiers were purchased. These machines not only

prepare data for computer procedures but also produce some internal accounting documents.

There is a branch order form, which is filled in once a week by each local grocery manager. This form, a thick sheaf of stapled foolscap sheets, is prepared on the organisation's Xerox plate making equipment and small offset litho machine. It contains a preprinted list of approximately 2,000 commodities held in the warehouse. The grocery order form is divided vertically into two parts. The larger, left-hand portion, headed up for insertion of the branch number and date, and details of goods, is used by the branch manager. The right hand side, which is later detached, is used for data preparation. Details given on the shop order side include cost and selling price, number of cans or packages per pack, description, unit size and unit selling price. This information is followed by two blank columns, one for entering the number ordered, the other for the number actually sent by the warehouse. At the tope of the right-hand side of the form are headings for the insertion of branch name, code number and date. This half of the form is divided into two columns, one of which contains the pre-printed code number of each commodity, while the other is left blank for use by the warehouse staff. The form, having been completed by the local manager, goes to the warehouse staff, who assemble the goods and enter, on both parts of the form, the number actually sent for each item. The data preparation, the right-hand side of the form, is then detached. The main part is returned with the goods to allow the branch manager to check his order, as an advice note. Before data preparation a girl using an adding machine lists the quantities on each branch order and

accumulates the total for the order. This constitutes a control total that can be checked against the same totals accumulated by the accounting machines. After entering the header code, branch code number and date, the operator keys in the code number and quantity of each commodity ordered. The commodity code number is made up of six digits - two to identify the analysis category, three to identify the commodity and one check digit. A similar procedure follows for recording details of goods received in the warehouse. The supplier's advice note is pre-coded with the supplier code number and commodity code numbers. Data preparation is performed on sensimatic machines, which automatically record the relevant information in punched paper tape, which is despatched to the computer bureau. Some goods such as vegetables are not handled through the warehouse and ordered direct, in which case invoices go directly to the accounts office at Dartford, where Xerox copies for the branches are produced.

Randex E.D.P. maintains standing files, which are updated every week with the new information. On the master file is recorded each warehouse item, code number, description, maker's size, warehouse pack size, gross profit, etc. The information relating to items not held in the warehouse includes supplier code number, description, pack cost price and selling price. Amendments to these items in the master file are dealt with weekly by Randex E.D.P., who prepare punched cards containing the amended data from programmes completed at Dartford. A stock history file is also maintained on the magnetic tape. The weekly reports comprise details of warehouse goods received report, a warehouse stock report, a 'direct' history report, branch invoices and a branch

'direct' received report. The warehouse goods received reports give details of all incoming goods, the warehouse stock report deals with addition and issue of stock, the 'direct' history report relates to commodities not issued from the warehouse, the branch invoices contain details of all purchases from all sources including the warehouse, and the branch 'direct' received report is a branch by branch analysis of all direct receipts. Every month each branch receives a summary of all invoices, broken down into the 40 analysis categories. Information includes, (1) quantity, (2) total price, (3) gross profit, (4) sales percentage, (5) stock summary, (6) sales, etc.

However, in this case, the society could not afford to buy a computer. The society wisely thought to seek the services of a computer bureau rather than 'rent or buy a computer'. The advantages gained are the following.

1. Savings in the warehouse reached 25 per cent for the first year and it will be 50 per cent in the current year and remain so always.

2. Savings in clerical labour are great, as 8 girls are now working as against 25 girls before.

3. Up to date invoicing is done, which was in arrear previously.

4. Management information is easily obtainable.

5. Buyers for the warehouse are better informed.

6. Stock control is made possible.

7. The cost of utilising a computer bureau here is £90 per week. The initial cost of programming was £500, which cost will not have to be incurred by subsequent users. So thereby subsequent users are saved from extra costs.

8. Branch invoices are posted on Saturday mornings so as to reach branch managers on Monday following. Issues from warehouse to branches are complete by Thursday. Data preparations are complete by Friday afternoon, as paper tapes are taken from Dartford to London Randex E.D.P., and by 7 p.m. reports are ready, which are picked up by a van driver of the co-op for delivery in Dartford. So information and records both have been made easier and more accurate to obtain through E.D.P.

The benefits accrued through EDP to the retail trade are:

1. Accounting is made accurate, easier and less costly.
2. Staff costs are saved to a great extent.
3. Stock control at branches and warehouses is greatly improved.
4. Management information is accurately and easily obtained.
5. Better customer service can be given.
6. Demands for a particular type of product can be ascertained.
7. Supply from, and delivery to, can be made to suit requirements.
8. Competition between retailers can be found out and avoided by giving better products at lower costs.
9. Price cuts can be determined so as to control losses.
10. Branch control is made effective.

Further Applications.

1. The time is not too remote when the demand of a particular zone will be ascertained and accordingly retailers will move in to meet the demands.

2. Seasonal products, their demand and supply, can be ascertained so as to meet actual consumption and in a particular area at a particular time.

3. The computer will receive telephone calls from customers, prepare orders automatically, control delivery to the customers at the required time. The computer will also prepare invoices and prices accordingly. Thereby the computer will serve customers at their homes and even at the counter.

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E.D.P. AND MISCELLANEOUS TRADES

EDP is being used in almost all types of business at the moment. In this chapter, the following trades will be discussed:

1. Laundry.
2. Quantity Surveying.
3. Mail Order Business.

The above trades have benefitted from the use of the computer services immensely. The advantages in saving of staff, costs and time have been described to boost the trades. The trades are different in the nature of the operations but they have found a common factor - of using a computer to satisfy customers and earn more profit. In all cases, they have not hired the services of a computer bureau, nor rented any computer, but have incurred capital costs in buying a computer, as the size of the business allows them to do so.

This is a case study of Brookgreen Launderers and Dry Cleaners Limited, of Ravenscourt Park, London. For years Brookgreen faced many problems - the main being lack of sufficient trained staff to operate keyboard accounting machines and perform clerical functions. As a result of the shortage of labour, the very high standard of customer service was in danger of being lowered. So the management bought an NCR Elliot 803 Computer system. After a year's operation, the installation has proved to be an unqualified success. The following advantages have been gained by introducing EDP in the laundry business:

1. Management and customers have benefitted by a more efficient accounting system.
2. Production control has been more effective.

3. Management information has been made easier.

4. The labour problem has been solved.

5. Customer service has been improved.

6. Staff are happier, as their morale is boosted.

The computer configuration is small. The central processor has a 4,096 word magnetic core store and data is fed in and out of the computer by means of punched paper tape, for which purpose a high speed paper tape reader and punch are provided. Three Creed 75 teleprinters are used to produce printed output. Data is prepared on three NCR 411 full-figure keyboard machines, which produce printed copies in duplicate on a tally roll as well as punched paper tape containing the information entered on the keyboard. A fourth NCR 411 is used for cash and alteration tapes and this will also be used for the input of all future applications, such as stock control, costing, bonus calculations and payrolls.

Brookgreen has two types of customers - 'van' customers and 'shop' customers. The former number about 10,000, and have work collected from and delivered to their homes through the help of the company's vans. An almost equal number of customers fetch their work to, and carry it from twelve shops. The van customers keep mostly credit accounts and the shop customers pay cash.

Service is an essential part and therefore it is always ensured that both customers enjoy the advantage of fast service. When a customer's parcel is handed over, the manageress attaches to the list card a tab in one of six colours, representing the six working days of a week. This tab is over-printed with an alpha-numerical code which identifies the shop and allocates a serial number to the parcel. Items

arriving at the works are handled step by step as follows:

1. Separate the items into laundry and drycleaning.
2. Check physically against the customer's list and note discrepancies.
3. Put a [1] 'polymark' on each item.
4. Later on, remove 'polymark' from the clean items.

After the laundry has gone through various wholly or partly mechanized washing, ironing and finishing processes, it is re-sorted according to polymarks into customer bundles, rechecked against the customers' lists and packed in boxes or parcels ready for delivery. Similar procedures are followed for drycleaning. Finished garments are hung in serial number order on a rail. When the van man collects the clean work, he picks up both laundry and dry cleaning according to a list prepared by the computer.

Data Preparation.

Customers' books and lists go straight to the data preparation section. Three operators using 411 keyboard machines, record the input data in punched paper tape. The first item determines whether the data relates to laundry or drycleaning; a transaction code is punched at the beginning of a paper tape for each lot. For the fourth 411 machine the code will denote incoming cash. This is followed by a [2] lot number, which is determined by the works manager. Next is another code number to show whether work for a specific customer comes from van collection or shop, and the day it is due to be returned. This will be a number in the

(1) This mark is a serial number printed on tape affixed to the item by an acetate heat-seal.
(2) 200 items or approximately this number make up a lot.

range 1 to 5, indicating Monday to Friday for van customers, or 1 to 6 for shop customers, as shops are open for six days. The remaining items to be entered on the keyboard machines are an account number for van customers, a parcel number for shop customers, a polymark - which appears on the printed copy but is not punched into the paper tape as it is not required by the computer, an 'IQV' (item, quantity value) code indicating the type of article, the number of separate pieces, and its value. The final item to be recorded is the total cost of the customer's work. All this detail is printed out in duplicate by the keyboard machine on a tally-roll. The top copy has a gummed back and as details are completed for each customer, the operator tears off the top copy and attaches it to the customer's list. The carbon copy is kept for file purposes. To obviate the possibility of any of these reaching the computer,a girl checks the printed detail visually with the laundry lists.

When the basic data has been punched for one lot, the tape is fed into the 803 computer and a run is carried out in the course of which computed data is punched into an output tape. This tape is subsequently fed into the teleprinters, and a number of lists are produced. In the case of lots destined for return to shops, a complete list is produced in parcel number order, grouped within each individual shop. This list shows the value of each parcel and the total value of the shop's consignment. Shop 1 might be provided with a list of parcels bearing the numbers 1 to 25, each with its own total value and with a grand total value at the end.

This list performs two functions - (1) the computer has sorted the detail into parcel number order, showing immediately if a parcel is

missing from the series, (2) the list, when returned to the shop with the parcels, provides the manageress with all she needs to make a quick and easy check of cash receipts. Two documents are produced for the van men - (1) the itinerary sheet, listing in route order all customers on whom they should call each week to deliver laundry and dry cleaning, those who owe money and those who have not sent work the previous week, (2) the second document comprises a set of pre-printed receipts, one for each customer. These receipts are on gummed, perforated slips, and show the total balance outstanding. If a customer settles his account, the van man tears off the pre-printed receipt and puts it in his laundry book. If he decides not to pay that week, the receipt is left 'in situ' and is returned by the van man to the office. If a customer pays an amount differing from that shown on the receipt, the van man writes a new receipt provided for that purpose.

For production control reasons, a complete lot analysis showing the number of sheets, towels and shirts is printed. The initial data used to produce the lists form the basis, sometimes in conjunction with other detail filed on punched paper tape, of various weekly returns. These include wages and commissions of shop manageresses, lists of van salesmen's wages and commissions, a summary of shop turnover analysed on an individual shop basis, a production analysis, monthly customer statements, and details of vanmen's route alterations. Sometimes routes are re-arranged, if it is found that one vanman's itinerary is over or under-productive through no fault of his own.

The achievements of Brookgreen through the adoption of EDP are:

1. Staff satisfaction. Staff were informed of all progress. A

number of talks were held to help them understand.

2. Savings in staff costs. 35 or more office staff were needed to do the work which is undertaken by the computer.

3. Sales drives are based on factual information.

4. Better service for the customers means satisfaction and hence brings in more customers.

5. The works manager can deploy labour to optimum advantage, as he knows beforehand about the type of items needing hand or machine processes.

6. A missing parcel is immediately known through the lists produced by EDP.

7. Some of the disadvantages of keyboard accounting machines, which are their slowness, difficulty in finding staff, and inadequate credit control are gone. There has been adequate credit control with the automatic production of customers' statements. A variety of lists and reports are compiled by the computer and printed out on three Creed 75 teleprinters, which are an aid to management function and information.

Quantity Surveying.

The company considered here which adopted EDP is Messrs Monk & Dunstone. The functions of the firm are, as the quantity surveyor, the following:

1. The functions of squaring out the dimensions extracted from drawings.

2. Check this squaring.

3. Abstract dimensions.

4. Check this abstracting.

5. Reduce accumulated sums to the appropriate unit of measurement e.g. concrete items into yards, joinery items into feet.

6. Check these reductions.

7. Prepare a draft bill.

8. Check and edit this billing.

9. Type a proof bill from the draft.

10. Read over word for word against handwritten bill.

11. Correct proof bill.

When agreement is reached between the architect, quantity surveyor and client, the architect prepares detailed drawings of the project and passes these as completed to the quantity surveyor. From these drawings descriptions of labour and material items are extracted together with the measurements appropriate to them. This is a highly skilled task, done by professionally qualified persons in the quantity surveyor's office. The process is called 'taking off' and the men involved are called 'takers off'. A bill of quantity is drawn up. The bill starts from demolition until completion of the building work. He is a sort of construction economist, as his changing function of profession demands.

Messrs Monk & Dunstone chose an NCR 803 after satisfying all considerations of reliability, storage capacity and price considerations. The installation has a core store of 8,192 39 bil words, an automatic floating point unit, two paper tape readers and punches, an on-line teleprinter for output purposes and four Elliot magnetic film handlers. The latter are the equivalent of magnetic tape units with an effective transfer rate of about 2,000 characters per second. Elliot autocode,

Algol and a commercial orientated language, language H, are available on the machine. A 300-line a minute line printer was available on the 803, but off-line typewriters, which were automatic, were preferred for these reasons:

1. A high quantity of print-out was desired and line printers were felt unsuitable.

2. Dependence on one line printer was too risky. If one of the tape punches broke down, one would have to have a spare punch ready to plug in. A spare line printer is too costly and as such this idea was abandoned.

3. For the price of a line printer, a whole bank of typewriters could be bought.

4. The bulk of the output was alphanumeric, of a fairly complex nature, and the automatic typewriters could cope with this work.

The typewriters chosen were Friden Flexowriters with an elite gothic typeface, which provided a pleasing result especially using offset lithography reproduction processes. Creed tape perforators were chosen to prepare input for the computer. Five track code is used which is similar to Elliot's coding. It is possible to read eight track code on the computer. The taker off still concentrates on his normal job. Against each dimension description written by the taker off, a coder writes a code, defining description. The code is extracted from the standard library of descriptions of building works. This code and the dimensions are punched on to the paper tape and fed into the computer.

This squares the dimensions, sorts all items into code number order, which is in effect library and bill order. Also on the magnetic film in

the computer the library of descriptions is coded, and from this the machine chooses the descriptions coded and prints out the bills of quantities.

To code a description, the coder must not only define the code numbers of descriptions, but also the code numbers of headings under which the bills fall. The dimensions,codes and insertions to codes are punched on to paper tape. The tape produced is checked by another operator, when a second verified tape is also produced.

The Computer input: The verified tapes are fed into the computer and the dimensions are squared out. This quantity with the code and inserts are written on to a magnetic film, where all details of the job are built up. After the dimensions have been sorted into order dependent on code number, the dimensions input are checked against a library film. The next computer operation produces an abstract. This provides a print out of all dimension items held in the computer. The updated film is then compared with a film containing the alphanumeric descriptions of the standard library. The code held on the job film picks out the appropriate library description and the bill is punched out from the computer on the paper tape for subsequent printing on the flexowriters. The bill is printed on to continuous offset lithographic paper plates which are sent direct to the printers. The coding techniques are three: quick code, cross code and Black box.

Messrs Monk & Dunstone have derived the following advantages:

1. Customer satisfaction.

   (a) Meeting demand with their specifications in time.

   (b) A great deal of attention can be paid to the customers.

2. Staff satisfaction.

   The colossal and monotonous work is taken over by the computer so they can be engaged in other more interesting work.

3. Saving in office costs and staff costs, and increasing revenue because of meeting with all clients' work in due time have brought a great standing to the firm.

Freemans Ltd is one of the largest firms in the Mail Order business. The company deals with, at the moment, over 100 million customers. The head office of the company and the distributive centres are located in London. A firm of management consultants carried out intensive research on the study of accounting and warehouse procedures. The principal aim of the study was to devise an integrated sales accounting and stock control system for the firm which would -

1. Minimize the enormous amount of clerical work.
2. Provide management with commercial information.

Like other companies in the mail order business, Freemans Ltd is dependent on its agents to reach customers. So re-organization would have to take into account -

1. The preparation of agents' invoices.
2. The maintenance of stock records and stock accounts.
3. A reduction in clerical work.
4. Automatic production of information.
5. Preparation of packing of merchandise in the warehouse.
6. Maintenance of agents' accounts.
7. Preparation of costing, statistical and stock records.

A Leo 326 computer was chosen, which was installed in 1965. The Leo 326 incorporates a 2.5 microsecond store with a capacity of 20,480 (48 bit) words, nine magnetic tape units with data transfer rates of 96,000 characters a second, two 1,000 line per minute printers, four paper tape readers, which operate at a speed of 1,000 characters a second.

Freemans always despatch orders received on the same day. Therefore the original data must be recorded on a suitable form as quickly as possible. Olivetti audit accounting machines were found to be suitable. The machine comprises a desk-sized unit which incorporates a programme control unit, an accounting keyboard and a paper tape punch. The machine embodies a check digit verification feature, used to check the validity of specified items of information. 177 of these machines are being used to handle data preparation work connected with agents' orders. The recording of information relating to internal stock movements and the preparation of amendment tapes used for updating magnetic tape files is carried out by means of seven Creed paper tape punches and seven verifiers. 95 per cent of all orders received are being processed on the computer.

The company issues two sales catalogues each year to its agents, each catalogue being valid for a period of six months. Each item in the catalogue has an item number, comprising two letters and four numerals. When an order is received from a customer, details of the order are entered on a 'request for goods on approval' form. The information entered on the form includes -

1. The agent's number.
2. Agent's name and address.

3. The data.

4. The item number.

5. Quantity and size.

6. Description of each item.

7. Agent's signature.

The orders are sent to head office in London by post.

A special collection of mail is made early in the morning so that work can begin at 6 a.m. A second group of orders is received during the day, usually before noon. The orders received at 6 a.m. are assembled in batches in readiness for the data preparation procedure which starts at 7 a.m. The requisite details shown on each order are transcribed on to paper tape by means of the Olivetti audit accounting machines. The details recorded on the tape are -

1. The agent's number.

2. The item number.

3. The quantity of each item.

4. Size, etc., of the items.

The agent's number and the item numbers are checked automatically by means of a check digit verification feature which is fitted to each machine. During this routine, the machine produces for each batch a printed copy of the punched information, the details of which correspond to the information recorded on the tape. On completion of the data preparation routine, the punched tapes and the printed lists are passed to a batch control section, and from there the order tapes are sent to the computer department. Other punched tapes regarding goods received, purchase orders, or amendments to data recorded on magnetic tape files

are also sent to the computer department. Two runs comprise the computer routine. In the first run, all valid data is recorded on magnetic tape, and any doubtful information is listed on a batch control report prepared by the computer, thus enabling the relevant documents to be identified, corrected and resubmitted on the next run. A similar run is then carried out to verify the data recorded on the 'merchandise' tapes. In this case also, all valid data is recorded on magnetic tape, and a batch control report is printed for any invalid information. There is another computer run in which the order data and merchandise information are arranged in item order number sequence. The sorted data is used to update the merchandise file, which is maintained on magnetic tape. The merchandise file shows a record of the merchandise held in stock. The magnetic file, containing the order data and amendment data, is fed into the computer with the merchandise file. During the run the information from the input tape is used to update the merchandise file and at the same time details of goods allocated to orders are summarized and printed by the computer on a warehouse despatch tabulation. This tabulation serves a two-fold purpose -

1. It enables allocation of staff to each department according to the work of the department.

2. Quantities of each order are valued at the appropriate price and evaluated order data is recorded on a further magnetic tape.

Any amendments relating to agents - additions, subtractions or alterations to existing records, which have been recorded on paper tape, are fed into the computer and are transcribed on to magnetic tape. The details recorded on this tape, together with information contained on

the order data tape, are then fed into the computer and are sorted into agent number order. The new order tape is read afterwards into the computer with an agents' file and the order details are printed on two-part invoice sets.

The computer also prints a stock shortage report. These reports are passed to the appropriate buyers who, by reference to a stock records list, decide whether a particular item is a 'hold-over', 're-order', or 'sold out' item. Details of merchandise are recorded on the merchandise file. The computer also automatically prints, 'please re-order', opposite the relevant item and an indication about time which the agent should wait before re-ordering. Accordingly, if an item is sold out, the words, 'cannot be supplied' are printed automatically on the invoice. When a new catalogue is issued to the agents, the computer prints issuing instructions on each invoice. A record is also placed on the appropriate section of the agents' file. Each invoice set comprises two parts. One copy is retained by Freemans Ltd for internal use; a detachable portion of this, containing the agent's name, address and number, being used as a label. The other copy is passed to the warehouse and is sent with the goods to the agent. A stock record summary is prepared by computer for each merchandise department. Using the information supplied by the buying department on actual demand figures, the computer produces an updated stock records sheet, which contains -

1. Information as to what quantities of merchandise should be ordered.
2. Suggested re-order quantities of each particular item.

The computer also produces a 'level of service' report, in which details of a department's service are analysed under various categories such as types of sales, returns of merchandise and department's performance.

Each week the computer also prepares an analysis of the week's trade by department, showing units and value, sales returns, goods on order and details of order. The computer also maintains records of goods held on approval by agents and preparation of the agents' accounts. The work connected with the suppliers' accounts and the bought ledger are yet to be computerised. Freemans is setting up a central warehouse in Peterborough, from which all merchandise will be distributed. Plans are going ahead to install data transmission equipment to enable information to be transferred from London to Peterborough.

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E.D.P. & MISCELLANEOUS APPLICATIONS

EDP is nowdays a standard tool in research, in business, in industry and in government. Some computers have taken over the complete work of an establishment and some are used to provide particular services. Wherever EDP has been installed, it has given the specialised services accurately and speedily. The benefits derived from it are immense.

In this chapter we consider the following applications:

1. Solving the name and address problem.
2. Medical applications.
3. Flight reservations.
4. Library control.
5. Teaching students.
6. Updating electoral registers through tape.
7. Sales picture.
8. Production control.
9. Stock control.

Solving the name and address Problem.

This problem arises in any establishment where a large number of people are dealt with. The Reader's Digest Association faces a similar problem, namely the problem of keeping records of all who regularly receive the digests, so it has bought an IBM 1410 system to maintain subscribers of over a million. There may be 20,000 people called Smith in the U.K., 20,000 may have initials J. Smith. Moreover, a person may be called Mrs Jack Smith one time, and Mrs Linda Smith on another occasion.

The details of the subscribers are maintained on magnetic tape file.

Three files are used, (1) post office file, (2) master file, (3) index file. The post office file contains details of 30,000 towns and villages, identified by a unique 4 character code - 'post town'code. The master file contains the name, address and account number of each subscriber. The index file contains a list of subscribers' account numbers and identification codes, called match codes, each of which comprises 19 characters. Four characters represent the 'post town' code, the remaining part of each code comprises 5 characters derived from the subscriber's name, one character corresponds to the subscriber's first initial, 5 are derived from the street name, 3 from the house number or name, and one character to describe the subscriber as male or female.

When renewals, new subscriptions or changes to subscribers' addresses are received, the appropriate names and addresses are punched onto cards, which are fed into the computer. The computer eliminates the town element of each address and obtains the relevant town code from the post office file. The street and surname parts of each address, derived from the appropriate card, are then combined with the post town code. The computer checks each code against the index file to ascertain whether an identical code exists or not. If any corresponding entries are found, they are transferred into the computer's store, where they are compared with the code derived from the punched card. If one entry agrees with the new code, the entry is printed by the computer for subsequent manual verification. If the details of the code are not on the file, the subscriber is assigned a number, name and address details using 30 characters in a line are punched onto cards, which are then fed into the computer in conjunction with the master file. The information relating

to new subscribers is recorded on the master file. 52 geographical mailing areas are arranged with the master file. Up to 25,000 items are mailed at one time. The relevant name and address details are printed by the computer in four parallel rows on heat transfer paper at a rate of 600 lines per minute. Twice each week the master file is checked and details are fed into the computer to see whether any bill is to be sent or any data is to be processed. The master file is processed every month. During this run, the names of the subscribers due to receive the following month's issue of the Readers Digest are recorded, together with renewal notices of subscription.

It is needless to say that the 1410 computer is also being used, in addition to the above, for accounting work and for tasks connected with the despatch of books, anthologies and record albums.

Medical Applications.

We are aware that some regional boards have computers for pay rolls, stock control, financial control, planned maintenance and PERT programmes. But National Health services cover general practice, hospitals, and local authority services. These services are free at the point of consumption, but are paid for out of general taxation and it costs about £1,370 million a year. To contain this ever-growing bill, the Ministry of Health has to consider seriously the use of computers as a means of management efficiency in the administration and clinical spheres. Moreover, the administration of the 2,400 hospitals in the health service will be a good field for the full exploitation of modern data processing techniques.

A great number of patient notes and case histories exist in every

hospital which can be placed on a magnetic tape file in order that they can be processed and the knowledge made available. A start has been made to compile a few simple facts in order to be able to analyse by computer, in a more urgent manner, hospital records of waiting lists, in-patient records in registers, discharge data, etc. When these are collected and collated on a regional basis by each hospital, a comparative study can be made between hospitals and a management efficiency can be attained.

West Sussex County Council Public Health Department has been using a computer since 1962. The procedures adopted by the West Sussex County Council are as follows:

When a child is born, the birth is reported to the County Medical Officer of Health. His department draws up an immunisation consent form, which is given to the area health visitor, who makes a routine call on the child's parents within a few days of birth. The parents are informed that preventive medication can be administered either at the surgery of the family doctor or at the local clinic. They are invited to sign the consent form. The consent form, when returned, becomes the source document for a punched card record, which is fed into the computer to make a record for that child on magnetic tape. The computer produces two documents - one is a list for the general practitioner of children due to receive treatment in the coming month, the other is a series of postcards addressed to the parents notifying them of appointments either at the doctor's surgery or at the clinic to have a child immunised or innoculated. Some doctors are willing to set aside specific days for immunisation and to let the computer schedule their appointments within that time, others prefer to arrange the details of appointments

themselves. When immunisation is eventually done, a tick is placed against the child's name on the list by the doctor. If an appointment is broken, a record can also be made on the list. There may be unscheduled appointments, when doctors can carry out the treatment and inform the County Council by means of an unscheduled appointments list, which is integrated into the computer system. The whole operation takes a four week cycle.

I week - the County Council sends out the appointment lists and postcards.

II week - the doctor or clinic carries out the treatment.

III week - the documents are returned to the Council.

IV week - new lists or cards are produced by the computer.

West Sussex is trying to replace its IBM 1401 by County's system/360, now being installed, when time sharing and use of remote controls will be made possible. West Sussex took approximately three years to computerise 32 clinics and 191 practices.

In the medical field, other applications are:

1. By collecting obstetric records over a wide area, it can readily observe trends, i.e. a statistically significant increase in congenital abnormality that would not be recognised as such by an individual obstetrician.

At the University College Hospital, London, at the Automation Experimental Unit, data related to obstetric, orthopaedic, psychiatric and many other morbidity surveys are daily analysed and processed.

2. For sampling blood, auto-analytical methods are well developed for electrolytes, but records are kept on analogue per recorders and

have to be calculated by manual methods. Programmes have been developed for this typed data to be processed for base line drift correction, statistical quality and calibration checks, which have resulted in accuracy and speed of tests.

3. Hospital laboratories are short of laboratory technicians. Laboratories are experiencing a 15 per cent annual increase in demand for quantative chemical investigation on patients. Routine calculations take 40 per cent of their time. Moreover, manual calculations may be inaccurate. At University College Hospital, there are analogne to digital conversions of blood sampling outputs to punched tape.

4. The computer based pattern recognition will be applied in monitoring of physiological measurements such as pulse rate, blood pressure, peripheral blood flow and respiratory parameters.

5. Recording of vital functions as a routine prior to surgery and anaesthesia, the correlation of this record with the surgeon's operative procedure could produce valuable data for subsequent examination.

6. Automatic administration of immediate therapy and adjustment of these to the varying needs of the patient, e.g. blood transfusions, is another factor of the computer's work.

7. Through the Bayes Theorem procedure, the output will come as one probable disease. The doctor will be given access through a telephone to the computer matrix, where he will record his observations. The programme could output, for example, six diseases in order of probability.

8. EDP can allocate staff duties of nurses in the hospital, duties of doctors and other related duties of staff.

9. Diet control and catering can be controlled by EDP with programmes to output the nutritional assessment of any weight or volume of any of a group of foods. It may be merely done by putting into a computer file the contents of nutritional tables and building up a menu planning procedure based on minimisation of food costs.

10. Data retrieval work can be undertaken by the computer. General programmes have already been established for most types of statistical and mathematical analyses, covering means, standard deviations, tests of significance, correlations, regressions, factor analysis, analysis of variance, bio-assay, curve-fitting, acturial survival rates, solutions of equations, wave form analysis, matrix operations, and so on.

11. Staff records and patients' records can be kept through EDP.

12. Finally, teaching to students through EDP in the medical field is a real possibility. In the U.S.A., teaching to medical students has already been entrusted to EDP.

Flight Reservations by Computer.

Flights, crews and passenger lists are now controlled through EDP. BOAC (British Overseas Airways Corporation) has agents everywhere in the world. BOAC wishes to centralise all enquiries through EDP. Therefore an enquiry for a seat on a BOAC plane will be conveyed to the BOADICEA system by a typewriter keyboard unit and its reply will be flashed back on to a Ferranti display similar to a TV screen. Clear, bright letters and numerals will spell out seat availability at a rate of 333 characters per second. BOAC agents anywhere in Europe or North America will be able to communicate instantly with the BOADICEA system by means of Ferranti equipment. The system operates in conversational modes, and keeps a

complete record of passengers, their names and address, in its memory. It also works cargo distribution out in the holds so that the weight is evenly distributed. All other facets of the flight - fuel, maintenance, food, services, accounts and administration - which are affected by a booking will be kept informed and up to date by the system. No paper work is necessary. All the information is stored in the BOADICEA computer system, from where it can be obtained at will by display on cathode screens or, if needed, printed out.

Ferranti Argus micro-miniature computers and display screens will be installed in BOAC offices and stations throughout Europe and North America. They will be linked directly to the central BOADICEA system in London. The computers will be responsible for the flow of information from the stations to London and back. The screens will display both the questions and answers thereto.

In the U.S.A. some airlines have nationwide reservation systems, employing a central computer centre that is linked to the ticket office in various parts of the country by telephone lines.

Library Control.

(1) 'The library of the future may be incorporated into a vast network of computerised centres from which information is immediate. America's library system of the future will include a communication network with computer stations across the country.'

The above statement is not only true for the U.S.A. but also for the U.S. People often call on a library, ask for information which they may not get there and then, as that particular library may not have any

(1) John L. Simonds, Head of the Information Technology Laboratory of the Eastman Kodak Research Laboratories, U.S.A.

book on the subject. It is possible for the whole library system to be orientated through a computer system. An individual, looking for information on a special topic would be able to obtain it from distant sources not at present accessible to him. It also means that anyone can feed his own findings into the computer programme so that others may benefit from his research. Instead of specialized and limited edition books and documents being deposited in one isolated library, the contents of such publications will be available to any interested person who dials the network.

Each library will have a typewriter keyboard connected to a central computer. The user will simply type a request for information and the computer system will reply with typewritten answers. The user may also be referred to relevant documents obtainable from local micro-film stores. If the local micro-film library does not have the appropriate work, facsmilies of the documents will be transmitted from co-operating libraries throughout the United Kingdom and will appear on a TV-type screen from which they can be reproduced for future use. The responsibilities of the librarian will be enlarged under a computerized system.

He will:

1. Index works.
2. Provide information for the computer.
3. Direct the cataloguing and storing of information.

M.I.T. has sponsored a project called INTREX (Information transfer experiments) with the aims of determining to communicate and deposit this proliferation of information in an effective and practical way.

Teaching Students through Computers.

Computers are being used in some schools in the U.S.A. to help in school administration and to free teachers from such routine paperwork as keeping records and grading papers. They have applications in educational research, in making up class schedules and in designing standardized tests. Computers can also be teachers. (1) The examination timetables can also be prepared.

Computers are capable of a highly developed type of 'branching' programme instruction in which the materials are almost constantly reshaped to meet the students' needs. The course starts with a short reading assignment. Then the computer types out a question on a printer that operates like a teletype machine. The student types out his reply on the typewriter keyboard of his console. The computer itself may be miles away, connected to the console via long distance telephone cables. If the reply is correct, the computer types the next question. It may skip materials if the student's answers show that they do not need it. When a student makes a mistake the computer points out the mistake and by asking a series of simple questions, it leads to the right answers.

The computer can take into account the whole history of the student, his academic record, hobbies, etc., including his sex and then selects questions to be presented to him. The programme course, written by a human agent, consists of all likely patterns of responses from students of different calibres. The human agent can review the records to spot weaknesses in his presentation and add new material, if necessary, to cope with the student responses, without re-writing the whole thing.

(1) A.J. Cole, Examination Timetables.

Thereby effective programmed learning materials can be developed as a tool through the assistance of computers. If a student wishes to take personal assistance, he may merely lift a telephone beside the computer console to have connection with an instructor at the computer centre.

The computer can be equipped to project still or moving images on a screen or play tape recordings to supplement the material being presented on the printer. The computer, it is obvious, works much faster than any student. So there is a time-sharing facility, when several students can share the same computer at the same time. The computer shifts its attention from the one student console to another so rapidly that no one is aware that his response is being recorded and stored briefly while the computer deals with another student. This time sharing makes maximum use of the computer's capacity and helps to reduce costs. The computer can tell the instructors, where the student needs help by analysing the result of a short diagnostic test at intervals. The computer analyses each student's record and achievements and selects accordingly his next reading assignments, programmed learning materials, films and other self-instructional materials. As soon as a student completes one batch of material, the next list is drawn by the computer.

In the U.S.A., the cost is $4 an hour, but costs can be minimised to $1. Stanford University has taken up a project as the first large scale trial of computerised instruction in a United States elementary school with 150 graders in East Palo Alto, California.

Updating Electoral Registers through Tape.

Somerset County Council always printed their electoral registers under a contract, which came to an end in 1964. The full Somerset

register comprises 3,000 pages and only 130 copies of the publication are required each year. The main problem was updating the previous edition. Somerset could not avoid publication, as every person over 21 must be accounted for, as they are eligible to vote, and since the last register was prepared some voters in the area might have stopped residing there and new people might have moved into the area.

Creed and Company was approached to determine whether the job of updating the register could be accomplished by punched paper tape. Creed devised a system, which was based on their Creedomat equipment. The Creedomat comprises an electric typewriter to which one or more tape readers or punches are connected. All these units are mounted on a desk in which control circuits for the equipment are laid. Entries on the typewriter are punched on paper tape and data read from paper tape can actuate the typewriter. Tape editing operations can be performed and existing tapes can be copied automatically with or without simultaneous typing. Separate tapes can be combined into a single composite tape with or without a tape record. Existing tapes are revised by a combination of automatic copying and manual insertion of new data on the keyboard. Four Creedomats were installed at Taunton, Somerset. Three lists were made - A list: electors of previous year, B list: new residents and those who have attained the age of 21, C list: those who had died or moved out of the area. A list contains about 374,000 names; about 25 per cent of these names require alteration.

A list was transcribed into 7-channel punched paper tape, B list was also punched into paper tape, so was the C list. Information was merged by inserting A tape in one reader, and B and C tapes in another

reader. Previously a punched tape was produced containing B and C lists. The combined data is punched on a third tape. Each entry on the tapes is preceded by an electoral number and this is used to determine whether the entry in the previous year's list is still valid or whether it needs to be replaced. Many names are inserted or deleted in the old list A and as such A list is not numerical. The difficulty is overcome by a special serial number, which allocates new numbers to each entry and is automatically typed on the typewriter. As the new tapes are produced, rotaprint litho plates are typed simultaneously. These are then used in conjunction with 4 R30/90 Rota print machines and 2 R40/80 quick change machines in the production of the electoral registers.

Sales Picture.

This is a company where EDP helps in depicting sales in 39 seconds.(1) 'We were getting to the point where we just had to find a method of achieving more precision within our accounting department.'

The company is a meat company, called Coleman Packing Co. Ltd, London. It slaughters, packs and distributes meat to supermarkets and other adjoining retailers. They have 35 distribution routes with 350 employees. The company is a family owned affair and was established 80 years ago.

Coleman ordered the E2110 in August 1964, and took delivery the following December. It is leasing the system, valued at $23,000. The two chief functions of the computer, programmed by Burrough's senior representatives, are:

1. Checking invoices prepared by the clerical staff as orders come

(1) Mr William Bieman, Treasurer, Coleman Packing Co. Ltd.

in by telephone.

2. Processing weekly sales analysis reports for salesmen in charge of 35 routes.

The products are 80 in kind and prices vary from day to day and at least $1 a hundredweight a week in some cases.

The clerical staff produces invoices up to the point:

1. Registering the customer's name and address.
2. Products required and quantity wanted.
3. Staff records the price per pound of the item or items ordered and calculates total price.

Now comes the turn of the computer.

Invoices for each route are taken to the computer. The steps by the computer are:

1. The operator checks the invoice by keying the number of pounds and unit price indicated. This sets up the system for a simple check on the total sale for the invoice.
2. She keys in the code numbers for the products sold.
3. She presses the motor bar, (a) to give the printed-out total check, (b) to store the weight and dollars of the sale under product code number in the computer's 100 twelve-digit totals memory.

When all invoices have been received for a particular route, the operator prepares the daily sales report on which the salesmen's weekly sales analysis is based. The daily reports go to sales accounts where daily route totals are compared for accuracy.

For report preparation, the operator aligns a prepared form, showing (a) products, (b) product code numbers, in the computer. After the motor bar is pressed, the system retrieves all the product orders and prices for that route and prints out the information against the product descriptions listed on the form. The job takes only 39 seconds.

The weekly route reports, which are prepared by Monday noon the following week, are prepared from the compilation of daily product totals and print out of pounds and total dollar sales for each product on the same form as that used for the daily reports. Once this function has been done, it becomes easier to obtain the week's activity for the entire company.

The achievements of the Coleman Packing Co. Ltd:

1. An actual sales analysis is possible.
2. A check on market trends is a possibility.
3. Errors are eliminated.
4. Staff savings are made possible.

Specimen of Daily Sales Analysis

Daily Sales Analysis
Route 28 Date: October 6, 1967.

Product Description	Pounds	Dollars	Code	Totals by Classification
Bologna	1,292.9	466.79	03	
Bologna Ring	16.3	8.31	04	
⋮	⋮	⋮	⋮	
Pork Hocks	70.5	13.67	49	

Production Control.

Computers are helping many manufacturering businesses in production control. Here the case of A.E.C., the second largest manufacturers of heavy commercial vehicles in Britain is an example. A.E.C. consists of a group of companies operating under the guidance and control of a parent Board with, of course, each company having its local Board. The plant of A.E.C. at Southall produces 6,500 vehicles per year. The vehicles are of different models. In addition engines and gearboxes are produced and supplied to various firms. A.E.C. have developed a flexible production control system. An NCR 315 computer equipped with CRAM random access storage units is used for this purpose.

Control over the activities of the companies is exercised by two management committees, known as the group engineering committee and the group production and purchasing committee respectively. These committees meet alternate months and the minutes are circulated to all members of the Board and to the respective executives of each company. In each company, a management meeting is held fortnightly attended by the local managers. The Board plans the policy for five years, to be reviewed annually.

A sales forecast is obtained from the sales organisation to plan the output of the factory. On receipt of the sales forecast, the preparation of a production programme is immediately started. The production programme consists of the first 12 months of the sales forecast, starting at the current month. The production programme is issued every three months, covering a period of 12 months ahead. Having compiled a production programme based on the sales forecast, assessments are made

of the amount of material estimated to be carried over into the new programme from the current programme, of the balance of material required to meet the new programme and of the date when the material will be required in order to enable the proposed production rates to be achieved. 90 basic models with 360 types are produced. A large number of components are also used in producing such a wide range of vehicles.

Mechanised data processing facilities in the form of 80-column punch card equipment were used in 1957 but is now replaced by an NCR 315 computer, equipped with 4 CRAM random access storage units. The equipment is employed in production control work and is operated by personnel under the direction of the production control manager. The computer assisted production control system is dependent for its operation on the availability of standing information relating to vehicle specifications, customers' orders, materials orders, production schedules, etc. The information is divided into separate files or into groups of files, known as 'libraries', which are recorded on magnetic cards held in CRAM cartridges. The records thus maintained include a specification library, a sales order library, an A.E.C. order and schedule library, a material ordering library, a production schedule file, a materials disbursement file, and a machine loading library. Taking each library and relating it to the function of the library, production control system has proved successful.

Fortnightly reports are prepared to ascertain what kind of materials and what quantities are required and when. After finishing the monthly requirements of each finished part, it is necessary to schedule the delivery of rough stampings and castings to meet the machining times

required to process them. By applying the 'lead' time or duration of machining cycle to each part, the dates of rough material requirements are assessed, from which the suppliers' delivery schedules are compiled.

Two printed reports are reproduced by the computers, showing the units, assemblies, and sub-assemblies required, and the customers' special requirements. From these units assemblies and sub-assemblies are marshalled singly, by chassis number sequence, in the plant. A.E.C. will complete the final stage of the production control system shortly. This stage comprises the compilation of the machine loading library and the writing of the relevant programme in the computer. In the machine loading library will be recorded the information of operation number, machine type symbol, department, time allowed, setting time and tooling record.

The advantages claimed for the NCR 315 are:

1. Speed with which data affecting the production programme can be processed.
2. Providing the management with up to date information and thereby enabling closer control over inventory and sources of procurement of materials.
3. Changes in requirements can easily be notified to the suppliers.

Stock Control.

EDP is used to control stocks also.

We have seen from the methods of production control that purchase requirements are derived initially from sales forecasts or customer orders. A master plan is established to determine the quantity of

finished products to be produced. The master plan co-ordinates manufacturing schedules and the material schedule. The material schedule consists of material requirements to meet manufacturing requirements. The purchases of stocks of materials cumulatively are called the inventory. The costs of inventory are the combined costs of acquisition, i.e. the costs of obtaining or creating inventory, possession, i.e. the costs of maintaining the inventory, depletion, i.e. the cost of being out of inventory, when it is needed.

Inventory classification is a systematic arrangement of materials into groups or classes of usage and value for purposes of analysis and control.

The inventory must be controlled to the effect that there is no justification for buying in greater quantities than those demanded by current usage. There should be balanced inventories at a minimum total cost. An effective procurement of inventories will determine two factors:

1. When to buy.
2. What quantities to buy.

It is known that the requirement of optimum stock varies from one product to another, especially when elasticity of demand is an attribute.

However there are a few basic features of adaptive control of the inventory system.

1. A forecasting system which re-estimates future demand regularly.
2. A rational method of evaluating safety stock for each individual item and controlling them in line with specific management policy on customer service.

3. A rational method of deciding replenishment order quantities for each individual item to satisfy some criterion specified by management.

4. A means of monitoring system performance so that an unacceptable loss of forecasting efficiency is reported to management for investigation and decision.

However, there are a few formulae to calculate the economic order quantity.

The simple formula is:

$$EOQ = \sqrt{\frac{2 \times AR \times OC}{VC \times i}}$$

AR = annual requirement expressed in units

OC = order cost (purchase order cost, acquisition cost)

UC = unit cost

i = rate of inventory investment

Hence, if the annual requirement is 2,400 units, the order cost is £20 per order, the unit cost is £2, and the rate of investment is 10 per cent, thus:

$$EOQ = \sqrt{\frac{2 \times 2400 \times 20}{2 \times 10}}$$

$$= 4{,}800 \text{ units}$$

Researchers at Bablock and Wilcox showed graphically in 1915 the effect on costs of the change in the order quantity and developed a formula for the order quantity giving the lowest total cost. In its simplest form this is:

$$Q = \sqrt{\frac{2AS}{R}}$$

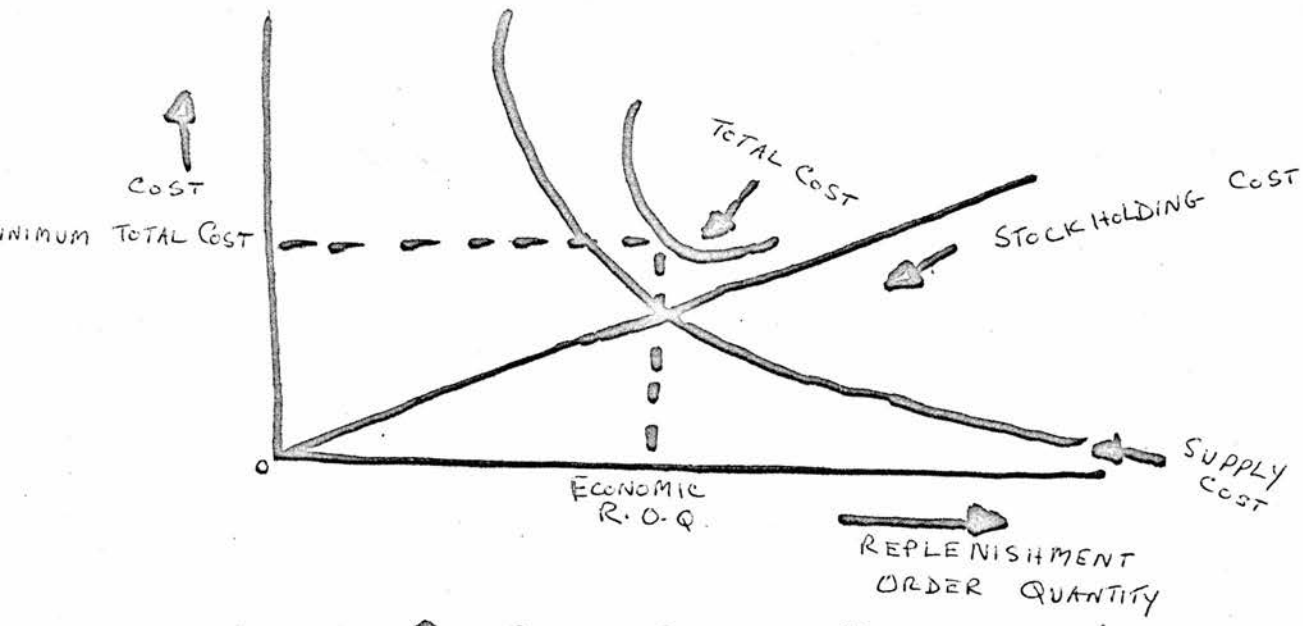
where Q = the economic order quantity .

A = purchase cost

S = annual sales by value

R = maintenance cost per cent per annum

Fig. 9:



EFFECT OF ORDER QUANTITY ON COST

There are limitations of EOQ. The use of mathematically arrived at order quantities implies a relatively stable demand and a constant demand. Where purchasing requirements fluctuate widely due to changes in the number and size of demands over a usage period, statistical order quantities can be dangerous and misleading. This problem is reduced by maintaining safety and protective stocks in quantities large enough to anticipate 'average' usage patterns. The safety stocks are those stocks available, which are no longer greater than the re-order point-fixed-stock. The stock quantity represented by the re-order point must,

therefore, attempt to satisfy all demand during the period, required to obtain further supplies. When an order is given to the supplier, time elapses from the date of order to the date of delivery; this intermediary time is called lead time. This lead time must also be taken into account.

Optimum results will not be found unless prior analysis of demand patterns of each item has been made. The computer cannot decide on changed factors that are not incorporated in the system. Therefore, periodic reports on the control operation are available to enable control decisions to be taken in the light of general policy and other external factors. The following are the possible reports which could be prepared:

(a) Inventory profile, value and analysis.

(b) Service level achieved compared with that required.

(c) Stock status report.

(d) Forecasting reports.

(e) Ordering decisions.

(f) Buyer's overriding decision.

(g) Demand models.

(h) Lead time models.

(i) Re-order quantity models.

(j) Forecast periods.

(k) Slow moving items.

(l) System performance estimation routine.

A number of ways of mathematical forecasting take place. The following are worthy of mention:

1. Trigg (1964) - A forecast is made of the mean error and the mean absolute error, using a single point box-senkins predictor.

2. The most widely known technique is exponential smoothing and most adaptive control systems currently in use are based on this technique.

3. The technique most commonly used is that developed by R.G. Brown and first described in the Harvard Business Review of August 1959. It uses a developed form of weighted moving average, known as exponential smoothing but has the disadvantage that an assumption must be made of the basic form to which the demand pattern is expected to conform. Three basic patterns are assumed: a constant pattern, a rising or falling trend, and a seasonal trend.

4. Another technique, which was first described by G.E.P. Box and G.M. Jenkins in a Royal Statistical Society paper in 1962, is an adaptive prediction technique derived from continuous, servomechanism control theory. It is claimed that the Box-Jenkins technique is simpler than exponential smoothing methods. However, whatever method is followed in calculating optimum stock, EDP can take into account all changes in demand and supply and other factors. The control of stock has been a subject of a great study in the past. A few programmes have been evolved, namely, FICS, etc. PERT also plays a part in inventory control.

There are many more applications of EDP, but those are not examined here. In all the services mentioned, the management had to invest capital in buying and installing computers. They also had difficulty in training staff, but all these problems were overcome shortly afterwards. It is estimated that the total savings in staff costs in all the above services averages 10 per cent.

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EDP AND LOCAL AUTHORITIES

EDP plays a big part in local authority administration. Before this role is discussed, let us describe local authorities and their function. Local authorities are called local governments, and are divided into corporations, county councils, urban district councils and rural district councils in England. In Scotland, the local government comprises burghs and county councils. Burghs may be large or small. The burgh of Glasgow is the largest in size and population in Scotland. The services of the local government are:

1. To maintain law and order through the police, civil defence, fire services, remand homes and probation services.

2. To provide basic services through housing, building regulations, highways, town and country planning, water supplies, general sanitation including sewerage and scavinging, clean air, burial and cremation, coastal protection, transport, market, roads, banks, etc.

3. To impart social services through child care, welfare of the aged and the handicapped, and public health.

4. To provide amenities through public parks, physical training and recreation, entertainments, provision of allotments, museums, art galleries and libraries.

5. To make regulative duties through food and drugs regulations, factory regulations, shop hours regulations, weights and measures, cinema licensing and taxicab licensing.

6. To register births, deaths and marriages.

7. To arrange for education and further education through schools and colleges and grants.

To defray expenditure, the funds come from:

1. Rates - a local tax levied on occupiers of property in proportion to their rateable value as shown on the valuation roll.

2. Government grants such as the Exchequer Equalisation grants towards the cost of particular services and, from 1959 onwards, a general grant in aid of local authority revenues.

3. Loans - the local authorities borrow from the money market and from the public works loan board. They also take deposits from institutions and the public. Borrowing is the mainspring of capital development. The cost of capital works such as housing, school buildings, road construction, drainage and water projects, office and hall buildings, is mainly met by loans. Many of the larger local authorities often finance capital expenditure from internal sources such as superannuation funds.

4. Rent from the council tenants.

Local authorities also own houses, which they rent to the public, living within the area, and build schools for education, hospitals and health centres, and arrange sanitation and sewerage.

An analysis of their expenditure shows approximately:

Education	25%
General Sanitation	17%
Roads & Lighting	16%
Police, Fire, etc.	10%
Housing	8%
Health & Welfare	8%
Water	6%

Public Parks & Playing Fields	5%
Miscellaneous	5%
	100%

The percentage varies for the services and local authorities.

Some of the local authorities have installed computers for general accounting and other purposes. In this chapter, two local authorities will be described from two angles, (1) the problems of non-computerisation (2) achievements of computerisation.

The two local authorities are:

1. Brentwood Urban District Council.
2. Glasgow Corporation.

1. Brentwood Urban District Council provides a typical instance and a case study with a successful solution. The community is growing rapidly. The growth brings the usual increase in commitments and activity - more borrowing and capital expenditure, more council houses, rent accounting, more rating assessments, more advances for house purchase. There are also complexities of new legislations - rate rebates, housing subsidies, selective employment tax, and problems arising from the wages freeze.

Naturally a computer was chosen. The computer MONROBOT XI was delivered in September 1966. The computer occupies only the space of an ordinary office desk, and stores data and instructions on a magnetic drum available in two sizes, to hold 1,024 or 2,048 computer words of information. It requires no air conditioning or special power supply, and can therefore be installed with its ancillary equipment in a corner

punched cards or ledger cards. Information is recorded on and can be read back from the Monro cards by the Monro card unit in which they are housed. They can be fed automatically into the computer through the unit or introduced singly by hand. The information, contained in each monro-card is:

1. Name.
2. Number.
3. Rate of pay.
4. Gross pay for the year to date.
5. Tax code.
6. Tax deduction.
7. Superannuation.
8. Graduated insurance.
9. National insurance contributions, etc.

Amendments to the standing information such as changes in tax codes are punched on tape and fed into the computer with the Monro cards prior to the main payroll run. Each week's variations are recorded on punched tape from the employee's time sheet. These include hours worked allowing for overtime jobs done, number of hours spent on each and adjustments for holidays and sickness. From these two sources fed simultaneously into the computer, it can produce an updated record for each person. It calculates gross pay, makes the necessary deductions to arrive at net pay, and prints out the results on continuous stationery via the electric typewriter. A pay advice and a carbon copy for the office record is provided. Income tax payments are calculated from a formula stored on the computer's magnetic drum.

of an ordinary office and plugged into a standard wall socket. The installation consists of the computer with electric typewriter, paper tape unit, and operating console. Ancillary equipment consists of an oscilloscope to assist programming, a Creed paper tape verifier to provide an additional medium for producing and verifying punched tape, and a Monro Card Unit.

Staff Training.

Members of staff were selected through aptitude tests and Lytton provided the training. Among those trained were:

1. Two seniors in programming.
2. One operator.
3. A junior assistant.

The computer system was explained to each staff and council member.

Processing.

It was thought that 270 staff's payroll processing would be easier, since there was already partial mechanisation in existence. Two broad classes of data are involved in payroll processing, (1) the standard material which remains unchanged for long periods, and (2) the details which vary from week to week and month to month. The standard data need not be produced afresh every time, but can be stored in permanent form for immediate use by the computer. For this reason, the Monrobot memory store is augmented by external storage on Monro cards. Monro cards are magnetised on one side to hold 96 computer words. They can be used again indefinitely by erasing and correcting or replacing the contents, as with magnetic tape. On the reverse non-magnetic side the cards can take written or typed reference matter for filing purposes like ordinary

Simultaneously with the pay advice, an expenditure analysis tape is provided. To obtain these figures, it divides the gross pay by the number of hours worked to give an average per hour, applies this to the hours worked on each job, and punches the remit on paper tape.

Wages are calculated to the nearest ten shillings and due adjustments are made the following week. A check in incorporated to see that no man is overpaid. The computer has everybody's pay compared with a pre-determined maximum. For any discrepancy, the case is audit checked.

A costing system was also installed in April 1967. It includes pricing out haulage, tons issue notes, producing haulage and stores analysis, labour analysis, creditors' analysis. The computer makes it possible to on-cost stores and labour automatically.

The Council is to computerise next all loans to the council, including interest payments on them. Except typing of cheques, which is handled by the computer, and the use of an addressing machine, the council pays interest twice weekly, at the end of March and of September. At the same time, personal records for house purchase advances will be transferred. Rent accounting rates, including instalment records, will be undertaken by the computer.

The Achievements of the Council.

Brentwood finds that economy of the computer is more accurately expressed not in terms of time saved but of productivity. A greater amount of work can be undertaken without an increase in staff. Already it finds one man day per week is saved on payroll accounting alone.

The computer machine time (punching and computer operations) is about the same as that of the keyboard machines, but since the computer

needs no operator while running, two to three hours a week are saved. Processing the payroll is a two and a half hour job, but it delivers an analysis tape as a by-product and this in pre-computer days used to take two and a half man days to produce.

Accuracy has been ascertained and the end of the year accounting is simplified, for example, as tax and superannuation returns are produced automatically from the Monro cards.

Costing information was not high in quality, as it was time consuming to prepare a document which was satisfactory to the engineers. Now Monrobot produces the required results automatically with little or no pressure on staff time.

The old system of three keyboard machines - one new and two of 15 years old, overdue for replacement, was handling the work of payroll, costing analysis and producing cheques. Gross pay, costing calculations, note and coin analysis were manual operations. The on-costs were added manually, as were other jobs such as loan accounting, income and expenditure analysis, debtors and periodical accounting, rating and other accounting. Now the computer has replaced the old system.

2. Now let us see what Glasgow Corporation has done towards automation.

Glasgow Corporation has been a punched card user since 1949. It was apparent by the early 1960's that the ICT 555 installation was simply not meeting the Corporation's needs. It was handling a 10,000 payroll, about a fifth of the Corporation's total strength. In 1964, a working party was set up to study all the applications that could be computerised. Eight manufacturers were invited to tender. Seven

suppliers submitted proposals and one, IBM, was selected with the assistance of consultants, Systems Consultants Ltd, of Edinburgh. IBM proposed a system 360 Model 30 (64K) with three 2311 disk drives and two magnetic tape units, using Cobol as the high level language.

Six applicants were selected to undertake training, which consisted of a week's basic course - an introduction to programming and to the System 360 - a week's Cobol course at the IBM education centre, and an additional three day's intensive course. Initial programmes were written and tested at IBM, at the General Accident Assurance installation at Perth, and at the Bank of Scotland in Edinburgh. The computer was delivered in October 1966.

Applications.

Payroll:

As usually occurs, it was operative first in payroll work. Two other applications - rate rebates and the preparation of pensioners' superannuation warrants - had to become operational at about the same time. The total corporation payroll is about 55,000, but it is planned to take only about 47,500 into the computer system. The city transport department has its own data processing section, and may become involved in a regional transport organisation. The payroll of 10,000 already being processed by the 555 was quickly transferred and work is beginning on the police payroll. The standardisation of the records of the forty departments, which have been autonomous and going their own ways for many years, was a necessary prerequisite. Only monthly, weekly and hourly rates are being calculated at present, but it is planned to build bonus nodules into existing programmes.

Creditor Accounting:

The file of 16,000 creditors is kept on tape, as is a second creditors' file sorted by department. Between 8-10,000 invoices are received each week. The master file is used to prepare cheques in payment of these once a week. The computer is also used to produce 'Committee lists' of creditors. The committee lists comprise information about transactions entered into by the corporation according to the committee with budgetary responsibility. It also produces auditors' lists, and a complete listing of the cheques prepared each week. In compiling the lists, a cash book of journal entries is merged monthly with the creditors' details to provide financial ledgers, which are stored on the disk, a process involving between 100,000 and 120,000 items a month. To compare actual expenditure with budgets, summaries are prepared.

Rating, Rents, Superannuation, etc:

The rate rebate scheme containing in the Rating Act of 1966 came into effect on 1st June 1966, when the Corporation was at the height of its pre-installation planning. Twenty thousand ratepayers applied for rebates, and the evaluation of these claims, the calculation of rebate due, the preparation of payment or credit slips, standard letters of rejection, etc., was computerised from start to finish. The embryo data processing department undertook to establish files and the basic preparation of information, testing time being obtained from another system 360 user, Babcock & Wilcox Ltd.

The collection of feu duties and similar charges and their payment where the Corporation is liable, are current applications. Cheques or

demand notices are produced by a set of programmes similar to the creditors' accounting programmes. Work for the rate assessor's and collector's departments is currently on punched cards but will eventually be transferred to the 360.

Other Applications:

1. The production of superannuation payment warrants and pensioners' records for the Corporation's pensioners. Originally, superannuation was calculated and books of monthly warrants were issued twice a year, but the use of the computer has made it possible to make direct payments monthly. The 9,000 pensioners are given the choice of receiving a monthly warrant or a credit transfer, which has resulted in a considerable saving. Superannuation and payrull share a common file of 1,500 bank names and addresses organised in index sequential.

At the moment, the Corporation is engaged in handling problems of payrull, and rate rebating, and is now considering an extension towards:

1. Health and welfare.
2. Compilation of statistics on childbirth.
3. Statistics of adult health and infant health.
4. Keeping records of school attendance.
5. Timetables for schools and meals delivery service.
6. Vehicle scheduling programme.

The Corporation did not recruit staff from outside. They are trained from within the organisation. Two members of staff were recruited from outside, who did not know system 360 Cobol. The DOS used required a 16K system. DOS 2 has now become available. A schedule of programme maintenance and revision is in progress. Savings of about 10 per cent

on core utilization are being made.

Further Applications for Local Authorities.

1. The shortage of housing is due to lack of funds and of planning. A computer can be used to provide information and forecasts of funds and requirements. It would be possible to assess the relative merits and priorities of various programmes and to provide comparative figures so that a better informed assessment could be made. It is not impossible that at some distant time the computer could itself make such an assessment.

2. Proper use of funds can be achieved in accordance with availability of funds and priority of services. The most urgent services will be met first.

3. The general location of council houses, playing fields, educational establishments can be suitably defined.

4. The percentage of rate increases can be minimised so as to give relief to the ratepayers when other sources of funds are available. The computer will show whether an increase is essential and in what amount. So arbitrary increases, causing hardship to ratepayers, will be minimised.

5. An account of government grants and their maximum use can be made through the help of EDP.

6. Roads, street lighting, traffic congestion can be assessed and the local authority may act accordingly.

7. Records of all departments can be properly kept.

8. Surveys, architectural drawings, engineering, and sanitation work can be more effectively carried out.

9. Minutes of meetings of Council and all committees and sub-committees could be prepared.

10. Notices of election, counting of ballot papers, etc., will be taken over by EDP.

11. Finally, policy planning and decision making and their execution would be improved with computer-assistance.

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PART III

THE RESULT OF THE SURVEY *

As the rate of growth in installations of computers is increasing, more and more questions are being asked as to the satisfaction of users. The position of the computer in the organisational structure is a matter of great importance. Frequent questions are:

> Who are the computer owners? Who are the Service Bureau users for commercial data processing in accounting and administrative control? What types of machines do the users own? What types of functions do these computers perform? Are the machine owners happy with hardware and software? Are those using Service Bureaus satisfied with the service provided by the Service Bureaus or Data Centres? Do the users employ systems analysts?

The survey undertaken by myself represents an attempt to find a compact answer to the above-mentioned questions. Questionnaires (appendix 1) were despatched to 300 installations selected from a list of current and future computer users in U.K. published by Computer Survey, March 1967. 250 organisations are already using computers and 50 organisations are expected to use computers within a year or two.

Table 1:

ONE OR MORE COMPUTERS BEING USED IN ONE INSTALLATION (1)

Number of questionnaires sent:	250	(100%)
Number of completed questionnaires returned:	132	(53%)

(1) An installation is defined as one or more computer systems operated by one user at one geographical location.

* Apart from all other assistance in the whole of my work, I am indebted specially to my mentor of this research, Dr A.J. Cole, for substantial guidance.

Table 2:

ONE OR MORE COMPUTERS TO BE USED IN ONE INSTALLATION

Number of questionnaires sent:	50	(100%)
Number of replies received:	40	(80%)

As seen from Table 1, 132 computer users replied out of 250. The comparative percentage of replies to forms originally sent is 53%. The organisations which are intending to install computers within a year or so, to whom the questionnaires were sent, number 50 (100%), out of which 40 organisations (80%) replied. The rise in reply percentages in the case of future users can be attributed to the fact that future users are more enthusiastic about their proposed computer system. The purpose of sending questionnaires to the future users will be shown in Table 23, relating to systems analysis and planning ahead.

The organisations which returned the completed questionairres are of various types, as Table 3, under the heading of Nature of Business can be seen. Those represented included local authorities, banks and financial concerns, insurances, wholesale and retail distribution, engineering of all types, manufacturers of all products, service bureaus, research organisations and miscellaneous trades.

Table 3:

NATURE OF BUSINESS

1.	Local Authorities & Public Boards	15	(11.25%)
2.	Nationalised Industries & Public Utilities		
	Utilities	4	
	Hospital	3	

(Table 3, Nature of Business, cont.)

	Port of London Authority	1	
	Transport Airlines	1	9 (7%)
3.	Banking & Finance		
	Banks	6	
	Building Societies	2	
	Finance Houses	1	
	Stockbrokers	2	
	Unit Trust	1	
	Discount Houses	2	14 (10.62%)
4.	Insurances		11 (8.30%)
5.	Wholesale & Retail Distribution		
	Retail	4	
	Mail Order	1	
	Cosmetics	1	
	Food Distribution	1	
	Toilet and Pharmaceutical	1	
	Warehouse	1	
	Clothing	4	
	Carpet	1	
	Photography	1	
	Bookselling	1	16 (12.12%)
6.	Engineering		
	Engineering - General	2	
	Metals	2	
	Aircraft	5	
	Electrical & Radar	1	
	Construction Eng.	2	
	Shipbuilding	1	
	Telecommunication	1	
	Electrical Eng.	6	
	Heavy Eng.	5	
	Iron & Steel Mfg. & Eng.	4	
	Civil Engineering	3	
	Earth Moving Machine Eng.	1	
	Scientific Instrument Making	1	34 (25.75%)
7.	Manufacturers of all Products		
	Paper	2	

(Table 3, Nature of Business, cont.)

	General Mfg.	1	
	Watch Mfg.	1	
	Pharmaceutical & Chemical Mfg.	4	
	Tobacco Mfg.	1	
	Textile Mfg.	1	
	Furniture Mfg.	1	
	Jute Mfg.	1	
	Sewing Machine Mfg.	1	
	Electrical Mfg.	1	
	Bearing Mfg.	1	
	Soap Mfg.	1	
	Trucks Mfg.	2	
	Food Mfg.	1	19 (14.37%)
8.	Service Bureaus & Commercial Data Centres		6 (4.54%)
9.	Research		
	Market Research	1	
	Paper Board Research	1	2 (1.51%)
10.	Miscellaneous		
	Oil	1	
	Trade Union	1	
	Football Promoter	1	
	Brewery	1	
	Television	1	
	Film Production	1	6 (4.54%)
			132 (100.00%)

The computer's position in the organisational structure can be evidenced from the designations of persons who filled in the questionnaires (Table 4). Out of 132 (100%), 65 (49.25%) have appointed managers for data processing. These managers are being named as computer manager, data processing manager, computer center manager, data processing operations manager. 18 (13.50%) of these are called head of programming, principal officer, computer to systems manager. 2 (1.50%) of the organisations call these managers mechanisation managers. So 64% are designated with data processing departments, the

Table 4:

THE DESIGNATIONS OF THE PERSONS FILLING THE QUESTIONNAIRES ON BEHALF OF ALL INSTALLATIONS.

Mechanisation Manager		2	(1.50%)
Computer Manager, Data Processing Manager, Computer Centre Manager, Data Processing Operations Manager, EDP Manager		65	(49.25%)
Head of Programming	3		
Principal Officer, Computer Development Division	1		
Accountant - Automation Department	1		
Computer Officer	1		
Manager, Automation	1		
Controller, Computer Centre	4		
Chief Systems Analyst	2		
Systems Manager	5	18	(13.50%)
Head of Operational Research	2		
Design Engineer	1		
Project Manager	1		
Manager, O & M Department	2		
Director, Systems Procedure	1		
Management Services Manager	3	10	(7.50%)
Cost Accountant	1		
Treasurer	9		
Manager	3		
Deputy Secretary	1		
Special Director	1		
General Manager	1		
Director	4		
Admin. Manager	2		
Company Secretary	2		
Asst. Company Manager	1		
Asst. Company Secretary	3		
Chief Accountant	2		
Director & Secretary	1		
Works Manager	1		
Managing Director	3		
Asst. Chief Accountant	2	37	(28.25%)
		132	(100.00%)

remaining 36 per cent are connected with computers but they are designated differently - possibly showing that the latter have limited computer applications and therefore did not find it necessary to appoint data processing managers with special duties. The duties in the latter organisations are undertaken by the existing senior management such as company secretary, director, general manager, etc.

Table 5:

USE OF COMPUTERS FOR COMMERCIAL DATA PROCESSING
THROUGH POSSESSION AND SERVICE BUREAU

	* Possessions	Service Bureau Users
Installations	123 (93%)	9 (7%)
* Possessions:		
Through Purchase	110 (83%)	
Rental	12 (9%)	
Lease	1 (1%)	

It may be fair to see at this point how many of these organisations use computers for commercial data processing. A study (Table 5) shows 110 (83%) possess computers through purchases. It was not part of the study to enquire whether these computers were purchased for cash or on hire purchase. 12 (9%) were on rental and 1 (1%) was on lease. 9 (7%) use Service Bureaus. Included in the 123 (93%) other than Service Bureau users (7%), are two research organisations.

The number of computers in use are 147 (100%) in 132 installations. Table 6 shows the number of machines in use for each manufacturer. ICT has 32% of the total machines in use and IBM has 29% of the machines. This is only to see which company has sold more machines to

Table 6:

MANUFACTURERS AND THE NUMBER OF COMPUTERS
IN USE IN ONE INSTALLATION

IBM	43	(29%)
ICT	46	(32%)
English Electric	14	(9.50%)
Burroughs	7	(4.75%)
Dela Rue Bull	3	(2%)
Honeywell	13	(8.75%)
Univac	2	(1.25%)
National Elliot	17	(11.5%)
Not mentioned	2	(1.25%)
	(1)* 147	(100%)

* Table 7 shows 10 installations use more than one computer.

(1) 123 installations and 9 installations using service bureaus left out.

Table 7:

FIRMS USING MORE THAN ONE COMPUTER

Installations	Computers
1	2 IBM
1	3 English Electric 1 NCR CRAB 2 Burroughs
1	2 IBM
1	2 IBM 2 NCR 315
1	1 Orion 1 ICT 1 Honeywell
1	1 AEI 1010 1 IBM
1	1 IBM 1 ICT
1	3 IBM
1	2 ICT
1	2 English Electric 1 KDF 8 1 KDF 6
10	30 Computers

the users under study in this survey. Table 7 shows that ten installations use more than one machine. The amount of work is more voluminous in these ten installations than the remaining 122 installations, which is obvious.

With importance in data processing, computers are being placed in a separate department (Table 8). Most installations started as a conventional organisation or a minor variation of it. Except in a few organisations like banking, or insurance, immediately a data processing department was created. Out of 123 (100%) (nine service bureau users excluded), 79 (64%) do have computers in a separate department, 32 (26%) have not situated the computer in a separate department, 6 (5%) have said the question did not apply to them, and 6 (5%) have not mentioned their location at all. Table 9 shows that when the computers are not situated in a separate department, the names of the departments are mentioned in 16 installations, and another 16 have not mentioned.

Table 8:

SITUATION OF COMPUTERS IN A SEPARATE DEPARTMENT

Installation	Yes	No	Not Applicable	Not Mentioned
123 (100%)	79 (64%)	32 (26%)	6 (5%)	6 (5%)

Table 9:

IF NOT SITUATED IN A SEPARATE DEPARTMENT THE NAME OF THE DEPARTMENT

Installations	Not Mentioned	Departments Mentioned	
32 (100%)	16 (50%)	16 (50%) *	
* Departments:	Accounts	2	
	Treasurers	45	
	Central Accounts	1	
	Data Processing	1	
	Computer Dept.	1	
	Office Services	1	
	County Treasurer	4	
	Finance Dept.	1	16

Table 10:

THE APPLICATIONS OF COMPUTERS

1.	Accounting - General	102
2.	Budgetary Control	47
3.	Cash & Credit Purchases	37
4.	Cash & Credit Sales	41
5.	Commercial Services	37
6.	Cash & Credit Control	43
7.	Costing	66
8.	Critical Path Analysis	27
9.	Dividend Warrants	33
10.	Forecasting	25
11.	Invoicing	56
12.	Income & Expenditure Analysis	55
13.	Internal Control	29
14.	Labour	39
15.	Materials	39
16.	Market Research	9
17.	Payroll	80
18.	Production Control	36
19.	Pensions	38
20.	Stock & Inventory Control	68
21.	Shareholders' Record & Share Registration Data	16
22.	Statistics	87
23.	Teaching	4

Number of installations to the above figures = 132, which includes 9 Service Bureau users.

OTHER SERVICES MENTIONED

Other Services	4
Despatch documentation of orders	1
Sales analysis	2
Estimating & designing	1
Nominal ledger	1
Statements for customers	3
Rating & Valuation	6
Customer's mailing list	2
Service Bureau	1
Adjust Booking	1
Personal Records	1
Trial Balance	1
Insurance policies	3
Engineering & Scientific Calculations	9
Structural design	1
Mailing	3
Technical design	3

(Table 10, Applications of Computers, cont.)

Order handling	1
Health records	4
Register of Electors	2
Medical Survey	1
Football pool checking	1
Customers' accounts	2
Plant Register	2
Pert	2
Membership records	1

The Applications of the Computers (Table 10):

The computer is performing many tasks from scientific calculations to commercial record keeping. It appears from the table that accounting general has the highest application, next comes statistics, payroll, stock inventory control, costing, etc. It must be said that large concerns find a greater variety of uses for their equipment than the smaller concerns. In engineering firms and in hospitals, fullest exploitation of computer services have been made. In the case of local authorities, the start was from payroll, but services are now extended to rate demands, electoral register amendment, etc. This is perhaps because a local authority has much scope in its functions to be computerised.

Table 11:

SATISFACTION IN THE USE OF HARDWARE

Installations	Satisfied	Dissatisfied
123	75 (61%)	48 (39%)

Table 12:

REASONS FOR DISSATISFACTION IN USE OF HARDWARE

Reasons	Installations
a. The wrong machine was bought initially	1
b. The machine did not come up to the manufacturer's specification	2
c. The organisation has outgrown the original computer	26
d. Any other reasons	7
Joint Reasons	
The wrong machine bought initially and organisation has outgrown the original computer	3
The wrong machine bought initially, although it was right at first, and insufficient computer capacity	1
The wrong machine bought initially for some applications, as it cannot handle all applications	1
The machine did not come up to the manufacturer's specifications and the organisation has outgrown the computer requirement	2
The machine did not come up to the manufacturer's specifications and real time processing is needed	1
Where the Organisation has outgrown the original Computer, the following:-	
1. Original size of core store too small	1
2. More sophisticated techniques are needed in management information	1
3. More demand with computer capacity	1
4. Insufficient software with inability to increase size of core store	1

Satisfaction in Use of Hardware (Table 11).

Out of 123 (100%), 75 (61%) are satisfied with the computer, 48 (39%) are dissatisfied. Table 12 shows the reasons for dissatisfaction. One organisation states that a wrong machine was bought

initially. This is a very tragic situation. This may have been due to the failure of management to seek independent advice from a consultant or due to ignorance of non-appointment of systems analysts. Two organisations state that the machines did not come up to the manufacturer's specifications. This position can simply be remedied by return of the machines or suing the manufacturers for breach (1) of contract or even for warranty. Regarding the organisations that have outgrown the computer, this is a reason for which neither party is blameworthy. The scope of the computer in applications is increasing, so when a computer is bought for a few applications, some more applications come in. A prudent buyer will always look into this factor when buying his machine.

There are other joint reasons for dissatisfaction. Three state that they were wold wrong machines with the following additional reasons. Organisation has outgrown, insufficient computer capacity, and it does not handle all applications. The answers to these have been given by one organisation that, although it was right at first when it was bought, it is no longer right. All these allegations can be simply said to be due to the lack of planning for applications and due consultations. 'The machines did not come up to the manufacturer's specifications and the organisation has outgrown, real time processing required' - all these can be sorted out with manufacturers, but manufacturers will not be able to cope with the outgrowth of the organisation. There are a few more reasons mainly connected with outgrowth.

Classification of other reasons (Table 13) show additional capital

(1) This depends upon the Contract between the user and supplier.

expenditure to remove dissatisfaction.

On the whole, dissatisfaction by the users of hardware is very low. Conversely, satisfaction has been obtained by many users. This to us was a surprising result.

Table 13:

CLASSIFICATION OF ANY OTHER REASONS

Reasons	Installation
1. Re-organisation of companies by merging other companies after the installation of a computer	1
2. Financial reasons prevent more disk storage being used, which restricts application development	1
3. Certain scientific applications require large core	1
4. Disc system was not sufficiently tested	1
5. Random access storage device, real time terminals are lagging relative to CPU	1
6. Printing run is slow, as no line printer is possessed	1
7. Multi-processing, faster input and output disks needed, which are not with the present computer	1
	7

Table 14:

SATISFACTION WITH SOFTWARE

Installations	Not Answered	Question not clear	Satisfied	Dissatisfied
123 (100%)	4 (3.25%)	1 (1%)	94 (76.25%)	24 (19.5%)

Satisfaction of Software (Table 14).

Out of 123 (100%), 94 (76.25%) are satisfied, 24 (19.50%) are dissatisfied, 4 (3.25%) have not answered, and 1 (1%) has stated that the question is not clear. The rate of satisfaction among the users is very high. Table 15 shows the reasons for dissatisfaction and the remedies. 24 organisations are not satisfied with software, 3 are not weeking any remedy, others are remedying the situation mostly by rewriting software. The software, supplied by the manufacturer as a package deal, can fit only those circumstances foreseen by the manufacturers. So most software needs rewriting to fit the circumstances. Some of the dissatisfied users in software have given reasons which are illogical. However, these reasons show that users wish to have more utility from the use of computers, which may not be connected with software. Also the illogical answers show the unthoughtful attitudes of the users in answering questions on software.

Table 15:

REASONS FOR DISSATISFACTION AND REMEDIES

Reasons	Steps Being Taken
1. Inadequate debugging aids; use of Executive Programme very restrictive so set up time is excessive	None
2. Too much time taken to analyse and programme an assignment	Increasing O. & M. staff for analysis work
3. Manufacturer's software is inflexible	Tailoring to own needs by rewriting
4. Complete lack of high level language computer in the present computer	Being replaced by another computer

(Table 15, Reasons for Dissatisfaction and Remedies, cont.)

Reasons	Steps Being Taken
5. Software are virtually non-existent	Changing the computer for another
6. Not paper oriented - worked with punched cards but not with paper tape	Chasing manufacturer where possible
7. Too clumsy	None; not so serious
8. Require too much operator's decision and intervention	Training own software team
9. Insufficient file security; compiling system poor; tape sort generator very poor	Taking own security measures; amending tape sort; getting a new machine
10. Rapid write compiler slow and inefficient	Programmes are no longer written in rapid-write
11. Insufficient library routines; poor variable length sort; insufficient in Cobol	Taken delivery of a machine to handle all work
12. Machine specification has been too small	Increased core size of present computer being replaced by another computer
13. Insufficient facilities provided	Some software being written by own programmer
14. Range of software limited	Pestering the manufacturer
15. Translating of large programmes in the highest level languages takes too long	Preparation of a 'Direct Amend' Routine for test purposes only. Thus original translated programme will be loaded into store and machine code amendments effected prior to start

(Table 15, Reasons for Dissatisfaction and Remedies, cont.)

Reasons	Steps Being Taken
16. Software restrictive in use	Enhance the available package; kick the manufacturer
17. No job stacking, random access on disk	Waiting for release of IBM software
18. File handling techniques and automatic restart facilities	Further development within the organisation of the manufacturer's software
19. Minor restrictions in manufacturer's software specification. 95% satisfied	Re-organising software
20. Inadequate checks, logical errors, inadequate alternative given to accounting controls	Not answered
21. Inefficient basic software from manufacturer, too slow. Inefficient software, prepared by staff	Rewrite basic software closer supervision of staff with clearer statement of objectives
22. Difficulty in amending existing programme	None
23. Software packages inefficient to cope with advanced language	Own writing
24. Not debugged properly	Writing own programmes

Table 16 shows the suppliers of software in these dissatisfied 24 organisations. 18 (75%) were supplied by the computer manufacturer, 3 (12.50%) from computer manufacturers and own programming staff, 1 (4.25%) was from computer manufacturer and programme agency, 2 (8.25%) were from computer manufacturers, own programming staff and programme agency. The three suppliers - own staff, programme agency and the

manufacturer, the latter supplied 75 per cent.

Table 16:

Suppliers of Software not Meeting with Users' Requirements	No. of Installations	
Computer Manufacturer	(75%)	18
Computer Manufacturer and own programming staff	(12.50%)	3
Computer Manufacturer and programme agency	(4.25%)	1
Computer Manufacturer, own programming staff and programme agency	(8.25%)	2
	(100%)	24

Table 17:

SATISFACTION ON USE OF SERVICE BUREAU OR DATA CENTRE

Installations	Satisfied	Not Answered	Dissatisfied
9 (100%)	5 (55.5%)	2 (22.25%)	2 (22.25%)

Table 18:

REASONS FOR DISSATISFACTION AND REMEDIES

Installation	Reasons	Remedies
1	Machine reliability Software Processing unreasonable Time	Kick the Manufacturer
1	Hardware failures of Service Bureau Work returned late Inflexibility in our present system in amendment procedures	Ordered own computer and recruited staff
2 = Total Installation		

Use of Service Bureau (Table 17).

Nine (100%) installations use a service bureau completely. Five (55.50%) are satisfied with use, two (22.25%) are not satisfied, and two (22.25%) have not answered.

Table 18 shows the reasons for dissatisfaction and the remedies. One of the two dissatisfied users is buying a computer system and the other is dependant on the service bureau. Both of them complain about hardware failures, unreasonable processing time, and inflexibility of amendment procedures. These defects of service bureaux can be removed if the service bureaux act efficiently to cater for the needs of their clients. In this connection it is interesting to see Table 22, where three installations possessing computers partly use service bureaux. Their satisfaction is 100 per cent. It is quite certain that these three only use service bureaux for very limited applications.

Systems Analysis

This is a job for specialists. Therefore due and thorough studies are required. Out of 132 (100%) which include nine service bureau users, expected to install their computers very soon, 109 (82.5%) employ systems analysts, 17 (13%) do not employ any, 4 (3%) have stated that the questions do not apply, 2 (1.5%) have not answered.

Table 19:

EMPLOYMENT OF SYSTEMS ANALYSTS

Total	Inside	Outside
* 586 (100%)	362 (61.75%)	224 (38.25%)

* Includes 9 service bureau users who are contemplating installing own computers within a short time.

Table 19 shows that 586 (100%) systems analysts are employed in 109 organisations. 362 (61.75%) came from inside staff to train and take over as systems analysts, and 224 (38.25%) are recruited from outside.

Table 20 shows the main sources of training for systems analysts. Out of 132 (100%), 35 (26.50%) trained their staff from machine manufacturers' courses, 11 (8.25%) received internal training in the machine user's department, 10 (7.50%) trained their staff in machine manufacturers' courses and other training. 6 (4.50%) trained their staff internally and sent them to courses other than those of manufacturers. The training other than from manufacturers' courses and internal courses is derived from -

1. Technical Colleges
2. Management Consultants' Courses
3. Data Processing Consultants' Courses
4. Ashmorehill Training College
5. Professional Institutes such as Steel Industry Management Centre, Institute of Chartered Accountants' Courses, and Institute of Management Courses.

10 (7.50%) of the organisations did not answer the question. 17 (13%) stated that nobody was employed as a systems analyst. In these 17 organisations, senior management took control of the computers and, while retaining their own departmental positions, they acted as systems analysts.

Table 20:

MAIN SOURCES OF TRAINING FOR SYSTEMS ANALYSTS

Sources of Training	No. of Installations
Machine Manufacturers	35 (26.50%)
Computer Users	11 (8.25%)
Machine Manufacturer and Computer User	6 (4.75%)
* Machine Manufacturer and other Training	10 (7.50%)
Computer User and other Training	6 (4.50%)
Other Training	7 (5.25%)
None	30 (22.75%)
Nobody Employed	17 (13.00%)
Not Answered	10 (7.50%)
	ø 132 (100%)

ø Includes 9 service bureau users.

* Other Training: Steel Industry Management Centre,
Urwick Diebold,
O.M.T.C.,
Ashornehill Training College,
Institute of Office Management,
Data Processing Consultants,
Local College O.M.O.R. Course.

Table 21:

WHEN SYSTEMS ANALYSTS ARE ENGAGED FROM OUTSIDE THE FIRM, THEIR FAMILIARITY OF WORK OF THE ORGANISATION

None	39	(29.50%)
Yes	24	(18.25%)
Partially	12	(9.00%)
None from outside	29	(22.00%)
None employed	12	(9.00%)
Not applicable	2	(1.50%)
Not answered	14	(10.75%)
	132	(100%) *

* Includes 9 service bureau users.

Table 21 shows whether or not systems analysts engaged from outside the firm are familiar with the work of the organisation engaging them. It is usually expected that systems analysts from outside will know their jobs. But this is not the case. 39 (29.10%) out of 132 (100%) stated that none were familiar. Only 24 (18.25%) stated that systems analysts they recruited were familiar with the work of the organisations. 12 (9%) said that their staff were partially familiar. 29 (22%) said that all were recruited from outside staff. 12 (9%) said that none were employed as systems analysts. 2 (1.50%) stated that these questions were not applicable. 14 (10.75%) installations did not answer the question.

Table 22:

SATISFACTION ON PART USE OF SERVICE BUREAU BY INSTALLATIONS HAVING THEIR OWN COMPUTERS

Installations	Yes	No
3	3 (100%)	Nil

The organisations which are expecting to install computers in a year or less than a year have already devised plans for installations of computers. 21 organisations have simply replied to us by letter and another 20 have filled up the questionnaires showing that most of them have already appointed systems analysts. Tables 23A,B,C and D show that out of 19 organisations (100%), 12 (63%) have already employed systems analysts, 4 (21%) have not mentioned, 3 (16%) have stated that they have not employed any. These 12 firms have employed 35 (100%) systems analysts, internal recruitment has been 13 (37%) and from outside the

Table 23A:

ORGANISATIONS WHICH ARE EXPECTED TO INSTALL COMPUTERS WITHIN A SHORT TIME

Total number of organisations	19	(100%)
Employed systems analysts	12	(63%)
Not employed any systems analyst	3	(16%)
Not mentioned	4	(21%)

Table 23B:

SHOWING TOTAL NUMBER OF SYSTEMS ANALYSTS FROM INSIDE THE ORGANISATIONS OR FROM OUTSIDE THE ORGANISATIONS CONTEMPLATING INSTALLING COMPUTERS SHORTLY

Total number employed	35	(100%)
Inside recruitment	13	(37%)
Outside the organisation recruitment	22	(63%)

Table 23C:

MAIN SOURCE OF TRAINING OF THE SYSTEMS ANALYSTS

Manufacturers' Courses	8	(67%)
Manufacturers' & Consultants' Courses	1	(8.25%)
Other Training	1	(8.25%)
Not Mentioned	2	(16.5%)
	12	(100%)

Table 23D:

FAMILIARITY WITH THE WORK OF THE ORGANISATIONS WHICH RECRUITED FROM OUTSIDE SYSTEMS ANALYSTS CONTEMPLATING TO INSTALL COMPUTERS SHORTLY

Familiar	4	(40%)
Not at all	4	(40%)
Not answered	2	(20%)
	10	(100%)

organisations, recruitment has been 22 (63%). The training of systems analysts has been mostly from the manufacturers (67%). Nobody received any internal training. It appears here that after a few staff - whether recruited inside the organisation or outside - these staff are trained to be systems analysts, unless they have previous training and then only further staff are recruited again from either of the two sources to train them internally under the supervision of the trained staff. Some of the organisations give them training internally as well as externally - the latter meaning technical colleges, consultants' or manufacturers' courses. In this context, it is worthy of mention that only 4 (40%) out of 10 (100%) who are recruited from outside the organisations are familiar with the types of work the recruiting organisations do.

In conclusion, it could be said that responses to our questionnaires were high and very satisfactory, specially when compared with two other surveys already undertaken, where the response rates were 28.2%(1) and 55%(2) in different spheres of EDP. The original intention of our survey was to find out the reasons for dissatisfaction with hardware and software to a large extent, but after the survey was completed, it was found that dissatisfaction was not so widespread as we had believed. Whatever dissatisfaction has been shown, a little

(1) Peter Lister - Computer Uses in Britain. Report on a recent BS & E Survey. Questionnaires sent to 1,120 business systems and equipment readers. Completed questionnaires returned numbered 317, of which 282 were usable. Business Systems and Equipment - Computerscope Special, page 43.

(2) D.W. Hooper - The Place of the Computer in the Management Structure and its Operating Efficiency.
Questionnaires sent to 442 installations. 240 completed questionnaires were used for sample analysis.

careful study on the part of users and manufacturers will solve the problems. To sum up, to quote one computer manager, 'When the computer came in, it was fit for the purposes; then senior management demanded too much from the computer by applications which were not originally planned; so now the machine is no longer suitable.'

With all the limitations in computer applications, senior management ought to take an interest from the earliest stages and make their minds up as to what they should get from the machines and what the machine could give in return. There should be an increasing realisation of the development of proper integrated systems in the application of computer systems. It is clear that by putting the computer in a separate department, under a specially commissioned manager, the management is aiming to achieve the integrated system.

CONCLUSION & FUTURE OF AUTOMATION THROUGH E.D.P.

Great Britain is a country which must accept the slogan, 'Export or die'. To increase exports, industrial productivity must increase, and the growth rate must be higher year after year, after taking into account population explosion and other factors such as her position as one of the international leaders in trade and world politics. Her pricing policy, her marketing of products through competition in a free world market will depend much on research and development. She cannot forego the automatic methods of production. Here electronic data processing will play a very important role. The industries must be automated as far as possible. Automatic operation of machines, processes, control and organisation - all will be assisted by E.D.P. Home consumption and consumption abroad will both be calculated and production may be modified accordingly. The availability of raw materials and its purposes could be improved by cybernation. Thereby human supervision will be reduced. This trend of development has already been described by Norbert Weiner in his book, 'The Human use of Human Beings', in its revised edition of 1954.

> 'In the first place, the sequence of operations will be controlled by something like a modern high-speed computing machine ... The computing machine represents the centre of the automatic factory, but it will never be the whole factory ... Some of them (machines) will have to be invented, to duplicate more nearly the functions of the human hand as supplemented by the human eye.'

Weiner's viewpoints cannot be dismissed too lightly as seen in the gradual development of computer applications. The dream of Weiner is coming true, as the use of computers in the process control system becomes a reality.

It seems that workers at first may fear that they will lose their jobs. As study shows, for white collar workers these fears are unfounded in the long run, since technological change and increased productivity contribute to economic growth and expansion of employment opportunities, at least for higher grade workers. Automation produces new jobs. There may be some displacement at the outset, but sooner or later they will be absorbed.

(1) Mr Donald N. Michaels in his book, Cybernation: the Silent Conquest, writes:

> 'In twenty years, other things being equal, most of the routine blue collar tasks that can be done by cybernation will be taken over by it. Our schools will probably be turning out a larger proportion of the population better educated than they are today, but most of our citizens will be unable to understand the cybernated world in which they live ... Besides, most people will have had to recognise that, when it comes to logic, the machines by and large can think better than they, for in that time reasonably good thinking computers should be operating on a large scale.'

It is obvious that the great mass of citizens did not understand the jargon, or the mechinations, of such developments in automatic

(1) Director of Planning and Programming at the Peace Research Institute, Washington, D.C.

development. There will be some special people specialised in EDP. Automation through EDP will give human beings more leisure to develop their thinking towards the good of their fellow human beings. Mr Ian Travis of the Burroughs Corporation in his speech at the seventh annual conference on Industrial Electronics, Detroit, Michigan, on 25th September 1958, said, 'The year 1946 may be taken as the initial year in which the companion tools, systems engineering and electronic data processing, had their influence on modern automation. Thus it appears that in 1976 we may be able to celebrate both the bi-centennial of this country and the full benefits which automation will provide for its people.'

The benefits are being felt in every quarter, as more and more computers are being installed.

Electronic computers are very recent additions to man's kit of tools and many of their applications remain almost entirely unexplored. Let us look at various developments which have already taken place.

The central processor of a computer has been reduced considerably in size through the use of miniaturization techniques, but this does not mean that the capacity for storing information has been decreased. It is indeed true that the storing capacity in such cases is increased. Previously a medium size computer had 16,000 - 32,000 character positions. Now the character positions may have increased to 256,000 or more. In the larger models, it is possible to have computers with storage in excess of 8 million characters.

Modular construction techniques have been adopted whereby sections of the machine are constructed separately and jointed together at a

later date, providing greater flexibility to increase the capacity of a computer which is already installed, to meet an expansion in the work load. Modular construction techniques have also given reliability to all component parts of the machine.

The capabilities of the latest machines have allowed the central processor to work on a number of problems simultaneously. The machine itself arranges and divides up the work in the most economical way, which the programmer lays down as an overall priority scheme. It is possible to interrogate the computer with single question problems without interrupting any calculations that are being carried out already. This is called multiprogramming. This type of performance of several tasks at the same time is also called 'time sharing'. 'Time sharing' and 'time shared' are widely used to refer to computer systems that can serve multiple users in real time. A 'time shared' system is able to serve multiple users in an organisation, and it is equally able to serve users in multiple organisations, each receiving service in real time. Applications of real time systems are very important, as each user thinks that the computer is his own, doing his job only. Since each of his demands receives immediate service, it is as if he is provided with a machine of his own.

Faster speeds have been attained. Now magnetic tape units can read or write characters at speeds of up to 340,000 per second, and printers can print out 1,000 to 1,400 lines per minute. There are other methods of output, mentioned earlier. Among these random access storage devices are important. Although costs are high, 50 thousand million characters can be stored in such a device in one computer and

access to any of the information within 60ths of a second is possible. Information can be amended either serially or at random. This device is expensive relative to magnetic tape or other forms of storage devices.

Data capture has been secured early in some cases. A lot of time and energy is wasted if a document is first typed and sent to the computer centre for punching in tape or card form. More and more documents are produced in a form suitable for a computer. The methods are M.I.C.R., employed by the British banks, C.M.C.7 and optical scanning of documents. On the output side, the use of television screens for display is used for giving quick information. Furthermore, the micro-filming of information is now a possible means of reducing the volume of paper handled. Information stored in the computer may be micro-filmed direct, without the need first to record data in printed form. Automatic retrieval is also available. It can be shown on a screen or on a sheet of paper. Data reduction in the output is always demanded, as this reduces the vast paper work. For example, what can be given in rows and columns can be shown in graphical form.

Data transmission is being made through the telephone and telegraph line links. Data output by one computer is input to another, even when the latter is situated a long distance away or even in a completely different country. A large company with many branches in various parts of the world can maintain overall control by means of a central computer linked to satellite machines in each of the branches.

There has been a lot of software development to suit the requirements of the computer users. Programmes like PERT are of great

value to the users. Programming languages, operating systems and other aids are simplified from the users' viewpoints.

The above-mentioned have already been achieved. It will not be out of place to examine what other achievements can be made on further developments in hardware, software, systems applications, manpower requirements and in alteration of the static or slow-change attitudes of the management.

Future Developments:

Hardware

The developments in hardware come about in two ways.

(1) Through further technical developments.

(2) By reasonable cost within reasonable reach of users.

1. Further technical developments include the following:

(a) Size of the machine, the peripherals.

Input, output and storage equipment should be made smaller, otherwise there is no gain in reducing the size of consoles (central processing unit) to a smaller size.

(b) More speed and larger memories are needed. Reduction, therefore, in the physical size of memory with larger storage is expected.

(c) Different sizes of machines should be introduced with limited and unlimited applications. A firm can start with a smaller size of machine, using a few selected applications, and gradually extend its range.

(d) Devices that read documents optically are urgently needed. Also needed are readers that can recognise human handwriting. Research

is going on for development in character recognition. When optical readers are perfected, they will eliminate the burdensome cost of input preparation, as they will reduce considerably the labour of transcribing source documents, such as invoices, onto punched cards or tape.

2. Cost:

Machines must become cheaper so as to come within easy reach of users. The cost must be fixed in accordance with services rendered. If a firm buys a machine for invoicing only, it has to pay the full cost, as the machine can give other services. Manufacturers should develop machines with lower costs for limited applications. The present day system of putting the burden of research on the users should be minimised, when a considerable advancement in research has been reached.

Table H shows the total annual cost of a computer system.

Table H:

ANNUAL COST

Can you estimate the total annual cost of your computer? (including interest on capital, depreciation, rent of office space, wages and salaries, ancillary equipment, software and maintenance)?

	Total 100% = 282	Under 1,000 Employees (46)	Over 1,000 Employees (236)
Under £10,000	2 (1%)	0 (-)	2 (1%)
£10,000 to £20,000	23 (8%)	5 (11%)	18 (8%)
£20,000 to £30,000	32 (11%)	8 (17%)	24 (10%)
£30,000 to £50,000	42 (15%)	8 (17%)	34 (14%)
Over £50,000	153 (54%)	15 (33%)	138 (59%)
Cannot estimate	30 (11%)	10 (22%)	20 (8%)

(Source: Peter Lister, Computer Users in Britain, Report on a recent British Systems & Equipment Survey, Compescope Special, Table IV, page 45).

Here the firm is divided into two categories - one under 1,000 employees, and another over 1,000 employees. 65 per cent spent more then £50,000, which was the annual spending, including interest on capital, rent of office space, wages and salaries, ancillary equipment, software and maintenance. 1 per cent only spent less than £10,000. This 1 per cent comprises two firms of over 1,000 employees each. These large sums of money can only be spent annually by firms of this size. But what of the small firm, which wishes to have the benefit of electronic data processing. These costs must be brought within the easy reach of users of different sizes.

Such heavy spending of money as annual costs for computerisation may bring dissatisfaction among the users. So let us see from table I, what the users say about their installations of computers and runningscosts. The users are asked one question: Has the installation 'paid its way'?

51 per cent of the total sample consider that their installations have already paid their way; a further 30 per cent consider that they will do so when their installations are more developed; and 3 per cent say that they never will or have not meant to pay their way. 16 per cent have given no definite replies. Perhaps the latter firms have not yet developed integrated systems. When they do, machines willpay their way. But savings are not only based on cash savings, but also on efficiency and improved services. So many firms evaluated the questionnaires without measuring in terms of cash but in terms of efficiency, improved service and information.

Table I:

HAS THE INSTALLATION 'PAID ITS WAY'?

	Sample used for analysis	Yes	No	But will do so 1966	1967	1968	1969	1970 or later	Never will and/or no need to	No definite reply
Government Departments and Research Organisations, services and other research establishments	20	15	1	-	1	-	-	-	-	14
Local Authorities & Public Boards	16	6	8	-	3	3	1	-	1	2
Universities, Colleges, Schools and other educational establishments	15	1	1	-	-	-	-	-	1	13
Nationalised Industries and Public Utilities	25	19	4	-	2	1	-	1	-	2
Banking	10	5	2	1	-	1	-	-	-	2
Insurance	13	5	7	1	1	1	1	2	1	1
Manufacturers (all products)	105	56	40	3	16	8	4	5	4	9
Contractors	4	3	1	-	-	1	-	-	-	-
Wholesale & Retail Distribution, and agencies	25	9	12	2	5	2	-	3	-	4
Miscellaneous	7	4	2	-	-	1	-	1	-	1
TOTAL %	240	123	78	7	28	18	6	12	7	39
PER CENT		51%	33%	3%	12%	8%	2%	5%	3%	16%

Source: D.W. Hooper, 'The Place of the Computer in the Management Structure, and its Operating Efficiency' - Accountancy, October 1966, page 694.

Future Developments in Software & Programming Languages:

Manufacturers often supply package programmes but most of these need to be amended to suit the requirements of users. But in fact, most of these package deals meet only partial needs. These programmes are re-written by the users' own programming staff, which is an inconvenient and costly process. In the future, these package programmes will be part of the deal and the manufacturers will have not only to meet their specifications in hardware but also in software.

Programming languages have made a rapid change. The languages have been simplified in such a way that the same programme technique can be used on different types of computer. It is unlikely that there will be only one universal programming language but some common features will emerge.

Future Systems Applications:

Here information retrieval will play a great part. Thousands of publications or documents can be abstracted or stored in the memory banks of computers or other electronic devices subject to instantaneous recall. This is very important in the case of U.K. and U.S.A. especially, where thousands of technical journals with 'knowhow' are published annually. U.S.S.R. has already adopted this system of information retrieval.

Future Alteration in the Attitudes of Management:

The management must be more realistic and will leave EDP to help them make decisions. The EDP's routine operations might not have impressed management at the moment. But management will soon realise that the ultimate benefits will accrue to them, having executed their

policy through EDP, the use of which is flexible. Then the suspicion of management, which is common at the moment, will be removed and they will trust the computer to do many tasks accurately and speedily; tasks which could not be attempted otherwise. Because of the management's attitude, a new profession has emerged, namely, the profession of computer consultant, and the management will turn to these professional people for independent and reliable advice. It is sad to note that some management are not prepared to learn about EDP, as they think they are traditional in outlook and do not want any change in conventional methods, which are used on a hereditary basis. This idea may hold back the full development of EDP.

There are other points of psychological reaction in the minds of management. As in the location of industries, one management follows the other. The time will soon come when they will learn about the efficiency and savings of computers (Table 26) from other management.

Table J shows that 77 per cent of 240 (100%) say that computers are mechanically efficient, 78 per cent say that outputs are to their expectations. 31 per cent say that they have made significant savings, 69 per cent do not know yet. But sooner or later they will derive the benefits of significant savings, and improved management information.

The standard of benefits can be a guide from one industry to another, from one institution to another, when considering the installation of EDP. The static management will now be dynamic in its attitude. After all, they all wish to produce better products and better service at lower costs. Now they will turn to the manufacturer

Table J:

EFFICIENCY & SAVINGS

	Sample used for analysis	Mechanically Efficient			Output to Expectations			Significant Savings		
		Yes	No	No definite reply or too early	Yes	No or not yet	No definite reply or to early	Yes	No	Not intended or indefinite
Government Departments & Research Organisations, services & other research establishments	20	14	4	2	16	-	4	6	1	13
Local Authority & Public Boards	16	13	2	1	11	-	5	7	3	6
Universities, Colleges, Schools & other educational establishments	15	8	5	2	4	-	11	1	1	13
Nationalised Industries & Public Utilities	25	20	4	1	21	1	13	11	2	12
Banking	10	6	2	2	8	-	2	6	-	4
Insurance	13	8	3	2	11	-	2	3	5	5
Manufacturers (all products)	105	85	16	4	86	13	6	32	20	53
Contractors	4	3	1	-	4	-	-	2	2	-
Wholesale & Retail Distribution & Agencies	25	21	3	1	21	2	2	7	7	11
Miscellaneous	7	6	-	1	6	-	1	-	4	3
TOTAL	240	184	40	16	188	16	36	75	45	120
PER CENT		77%	17%	6%	78%	7%	15%	31%	19%	50%

Source: D.W. Hooper, 'The Place of the Computer in the Management Structure, and its Operating Efficiency' - Accountancy, October 1966, page 693.

and other consultants for EDP.

Moreover, the management will learn from the standard of service given by the manufacturers to users. Many times their lack of knowledge in these directions prevents them from adopting EDP.

Table K:

STANDARD OF SERVICE

Are you satisfied with each of the following aspects of service received from the computer manufacturer?

Total (100% = 282)

	Satisfied	Not Satisfied	Cannot Say
Pre-installation	210 (75%)	40 (14%)	32 (11%)
Installation	239 (85%)	13 (4%)	30 (11%)
Reliability of Hardware	224 (79%)	39 (14%)	19 (7%)
Availability of Software	165 (59%)	95 (33%)	22 (8%)
Education of Computer Staff	210 (75%)	48 (17%)	24 (8%)
Help with Programming	147 (52%)	91 (32%)	44 (16%)
Maintenance	223 (79%)	29 (10%)	30 (11%)

Source: Peter Lister, 'Computer Users in Britain'- Report on a recent British Systems and Equipment Survey - Computer/scope special, Table VI, page 45.

From an examination of the table, it reveals that users have derived satisfaction with installation and initial running costs. Those who cannot say now, and those who are not satisfied at the moment, will certainly be satisfied as time passes, in the not too distant future.

Due to good standards of service, some manufacturers have established goodwill. The management always looks into the goodwill factor with whoever they deal.

The management will be conscious about manpower shortage. Population is expected, in ten years time, to rise by about 8 per cent[1] and the working population by 1½ per cent[2]. In the same period of ten years, office work, if past trends continue, might rise by as much as 30 per cent[3]. There would be a shortage of office workers. But this could be relieved by, among other economies, the use of EDP.

One main difficulty which could hold up the speed with which EDP can be introduced, in the short term, is the shortage of experienced systems analysts and programmers. Since the formation of programming teams precedes the operation of the computer by a year[4] or so, the demand for these staff over the next few years is to be influenced by orders of equipment yet to be placed. It is estimated that there is a shortage of systems analysts and programmers in 1967 numbering 11,000. So to remedy this situation of lack of trained staff in EDP, more training should be imparted in schools, colleges, manufacturers' courses, and management consultants' courses. The management must release their staff on a part time basis to train themselves, or grant a few weeks off to become full time students. The second course in solving the shortage problem is to offer a higher salary to attract trained staff. Table I shows that management has already realised this fact but the solution is

(1) Ministry of Labour - Computers in Offices - Manpower Studies.
(2) Ministry of Labour - Computers in Offices - Manpower Studies.
(3) Ministry of Labour - Computers in Offices - Manpower Studies.
(4) Table

in any case only a temporary one and the management who attract staff in this way may well subsequently lose them to a higher bidder.

* A note on growth of population in the United Kingdom in the recent years will not be out of place.

	U.K. de facto population (mid-year estimate) 000's	Approximate average growth rate between indicated year and 1967 (compounded annually)
1957	51,430	0.69
1962	53,341	0.64
1966	54,744	0.59
1967	55,068	-

* The author is grateful to Professor Sir Alec Cairncross, Head of the Government Economic Service and Master-elect, St. Peter's College, University of Oxford, and to Professor C.A. Moser, Director of the Central Statistical Office, London, S.W.1, for their kind assistance.

Sources: Annual Abstract of Statistics,
Monthly Digest of Statistics.

Table L:

Category	Age	Experience	Average old Salary	Average new Salary	% Increase
Programmers	22.5	2.0	£1,060	£1,235	22
Senior/Chief Programmers	27.7	3.7	£1,656	£1,981	19
Senior/Chief Analyst	31.5	6.5	£2,430	£2,720	12
Systems Analysts	27.6	3.7	£1,861	£2,050	10
D.P. Managers and Consultants	36.0	8.6	£2,980	£3,390	14

Sources of Table L: Personnel - The Wages of Computer Workers:
Table 2 - from 'The Times', 25.7.67.
A survey by ASAP Ltd.

Conclusion:

So in conclusion, it can be said that the effects noted in this chapter will make computers more powerful, more versatile and more economical. The expanding uses of computers in organisations, industry, commerce and local government will not be in the machines, but in the ability of management to surmount the difficulties and become realistic in their attitude towards electronic data processing. The British Government's role to teach management can be seen by means of investment grants and tax benefits to the users when they install machines. The establishment of a National Computing Centre is a step forward towards teaching management about computers. More and more fields will be marked out, where EDP will be applied. Sir Leon Bragitt, in his series of Leith Lectures on 'The Age of Automation', predicts that by 1974 the normal computer will be as small as a packet of cigarettes. If the cost of that packet of cigarettes is within the reach of every householder, it will be bought by every householder to guide housewives in household affairs.

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APPENDIX I:

A SURVEY OF COMMERCIAL INDUSTRIAL ORGANISATIONS USING COMMERCIAL DATA PROCESSING IN ACCOUNTING AND ADMINISTRATIVE CONTROL

The information given in this questionnaire will be treated with strict confidence and no mention will be made of names of individuals or of firms in the survey report.

1. Name:

2. Company:

3. (i) Address of the Company:

   (ii) Nature of business:

4. Position in the Company:

5. Do you use Computers for commercial data processing?

6. If answer to Q. 5 is yes,

   (i) Does the Company possess a Computer?

   (ii) Does the Company use a service bureau or commercial data centre?

7. If answer to Q. 6 (i) is yes,

   (i) What is the make of the Computer?

   (ii) Is the Computer situated in a separate department? If not, in what department of the firm is the Computer situated?

8. What is the type of work the computer does, if the Company possesses one?

Please tick all the services rendered by the Computer or service bureau.

Accounting-general, Budgetary control, Cash credit purchases, Cash and Credit Sales, Commercial Services, Cash and Credit Control, Costing, Critical Path Analysis, Dividend Warrant, Forecasting, Invoicing, Income and Expenditure Analysis, Internal Control, Labour, Materials, Market Research, Payroll, Production Control, Pension, Stock and Inventory Control, Shareholders Record and Share Registration Work, Statistics, Teaching.

What other services, if any, does the Computer provide?

9. If you do own your own Computer, please answer this question.

Does the hardware configuration you own meet all your requirements satisfactorily?

If the answer is no, do you believe that this is -

(a) Because the wrong machine was bought initially:

(b) Because the machine did not come up to the manufacturer's specification:

(c) Because your organisation has outgrown your original computer:

(d) Any other reason. Please specify.

10. If you do own your own Computer, please answer this question.

(i) Does the software (i.e. the Programs provided) meet your requirements satisfactorily?

If the answer is no, were these programs provided by -

(a) The Computer manufacturer:

(b) A programming agency:

(c) Your own programming staff:

(ii) Please comment on the type of inadequacy of the software provided.

(iii) What steps are you taking to remedy the situation?

11. If you do not own your own computer, but make use of a service bureau or data centre, please answer this question.

Does the service provided meet your requirements satisfactorily?

If the answer is no, please state the reasons for your dissatisfaction.

What steps are you taking to remedy the situation?

12. Do you employ any systems analysts?

If the answer is yes -

(a) How many do you employ?

(b) Approximately how many were previously employed within your own organisation in some other capacity?

(c) What formal training in systems analysis have they received?

(d) If any system analysts were engaged from outside the firm, were they already familiar with the type of work that you do?

Thank you for your assistance.

Note: If your organisation does not use a Computer, please return this form to the sender. A stamped envelope is enclosed.

If you are not concerned personally with the use of a computer, please pass it over to someone who is.

For any further comments you have to make, please use the blank space below.

APPENDIX II

A LIST OF CENTRAL PROCESSORS AND PERIPHERALS

WITH NAMES OF THEIR MANUFACTURERS.

ENTRAL PROCESSORS: *

	Bull-G.E.	Burroughs	Control Data	English Electric	Honeywell	IBM	ICT	NCR	Univac
	115	B500	1700	4/10	120	360/20	1901		9300
Average Price	£35,000	£70,000	£68,000	£85,000	£50,000	£73,000	£63,000		£53,000
Maximum Memory	16,384 bys	9,200 chs	32,768 words	32,768 bys	32,768 chs	16,384 bys	16,384 wds		32,768 bys
Data unit size	8 bits	6 bits	18 bits	8 bits	6 bits	8 bits	24 bits		8 bits
Cycle time	6.5uS	5.7uS	1.1uS	1.5uS	3 uS	3.6 uS	6 uS		600 ns
Add time	114 uS	414 uS	6.6 uS	24 uS	66 uS	493 uS	34 uS		57.5 uS
Multiply time	1.1 ms	3 ms	11.4 uS	225 uS	3.5 ms	7.432 ms	6 ms		1.322 ms
Divide time		3.45 ms	18 uS	290 uS	3.5 ms		5.75 ms		
	415	B2500	3150	4/30	200	360/30	1902	315	(9500)
Average Price	£115,000	£95,000	£131,500	£115,000	£88,000	£119,000	£84,000	£90,000	(£100,000)
Maximum Memory	32,768 words	60,000 bys	32,768 words	65,536 bys	65,536 chs	65,536 bys	32,768 wds	40,000 sls	
Data unit size	24 bits	8 bits	24 bits	8 bits	6 bits	8 bits	24 bits	12 bits	
Cycle time	5.8 uS	2 uS	1.75 uS	1.5 uS	2 uS	1.5 uS	6 uS	6 uS	
Add time	29 uS	64 uS	7 uS	22.5 uS	48 uS	50 uS	18 uS	48 uS	
Multiply time	364 uS	412 uS	18 uS	225 uS	374 uS	155 uS	1.5 ms	294 uS	
Divide time		600 uS	24 uS	285 uS	475 uS		2.236ms	1.146ms	
	425	B3500	3300	4/50	1200	360/40	1904	315RMC	418
Average Price	£153,000	£130,000	£300,000	£190,000	£140,000	£200,000	£180,000	£175,000	£150,000
Maximum Memory	131,021 words	500,000 bys	262,144 words	262,144 bys	131,072 chs	262,144 bys	32,768 wds	80,000 sls	65,536 words
Data unit size	24 bits	8 bits	24 bits	8 bits	6 bits	8 bits	24 bits	12 bits	18 bits
Cycle time	3.9 uS	1 uS	2.1 uS	1.4 uS	1.5 uS	2 uS	2 uS	800 ns	2 uS
Add time	19.5 uS	32 uS	2.75 uS	21.9 uS	36 uS	40 uS	7 uS	7.5 uS	
Multiply time	270.6 uS	206 uS	9 uS	65 uS	301 uS	62.8 uS	40 uS	97 uS	
Divide time		300 uS	11.6 uS	95 uS	356 uS		44 uS	445 uS	

ENTRAL PROCESSORS (cont.): *

	Bull-G.E.	Burroughs	Control Data	English Electric	Honeywell	IBM	ICT	Univac
	435	B5500	3800	4/70	2200	360/50	1904F	491/492
Average Price	£186,000	£300,000	£500,000	£300,000	£200,000	£350,000	£300,000	£200,000
Maximum Memory	131,072 words	32,768 words	262,144 words	1,048,576 bys	262,144 chs	262,144 bys	262,144 words	65,536 words
Data unit size	24 bits	49 bits	48 bits	8 bits	6 bits	8 bits	24 bits	30 bits
Cycle time	2.7 uS	4 uS	880 ns	1 uS	1 uS	2 uS	750 ns	
Add time	14.2 uS	7 uS	1.6 uS	2.1 uS	24 uS	20 uS	4 uS	
Multiply time	219.6 uS	34 uS	6.1 uS	6.6 uS	191 uS	31.7 uS	20.9 uS	
Divide time			14.5 uS	11.6 uS	272 uS		27.7 uS	
		B6500 core	6400	4/75	4200	360/65	1906F	494
Average Price		£550,000	£750,000	£600,000	£300,000	£850,000	£500,000	£500,000
Maximum Memory			131,072 words	1.048.576 bys	524,288 chs	1,048576 bys	262,144 words	131,072 words
Data unit size		52 bits	60 bits	8 bits	6 bits	8 bits	24 bits	30 bits
Cycle time		[illegible]	100 ns	700 ns	188 ns	750 ns	750 ns	750 ns
Add time		[illegible]	1.1 uS	1.57 uS	9.4 uS		3 uS	
Multiply time			5.7 uS	5.65 uS	48.4 uS		16½ uS	
Divide time			5.6 uS	10.51 uS	68.4 uS		22 uS	
		B6500 thin film	6500		8200	360/67		
Average Price		£800,000	£850,000		£600,000	£1 million		
Maximum Memory			262,144 words		1,048,576 chs			
Data unit size		52 bits	60 bits		6 bits			
Cycle time			100 ns		750ns (8chs)			
Add time			1.1 uS		3 uS			
Multiply time			5.7 uS		5.25 uS			
Divide time			5.6 uS		14.25 uS			

CENTRAL PROCESSORS (cont.): *

	Burroughs	Control Data	Univac
	B8500	6600	1108-2
Average Price	£4 million	£1.3 million	£1½ million
Maximum Memory	262,144 words	262,144 words	262,144 words
Data unit size	52 bits	60 bits	36 bits
No. of processors	15	11	5
Cycle time	100 ns.	100 ns	375 ns
Add time	600 ns	400 ns	750 ns
Multiply time		1 uS	750 ns
Divide time		2.9 uS	

NOTES TO CENTRAL PROCESSORS TABLE:

BULL: All the Compatibles 400 can be equipped with a floating point arithmetic unit which reduces the add times by 50% and the multiply times by 90%. The commercial software for these machines assumes fixed point arithmetic. The floating point unit adds about 5% to the prices quoted in the table.

IBM: The 360/44 has been omitted from the tables because it is a scientific machine and does not represent a step in the normal commercial ladder.
The 360/67 is similar to the /65 but possesses time sharing logic enabling two central processors to use the same core store simultaneously.

UNIVAC: The 9500 has not yet been released, and the figure in brackets is pure conjecture.
System 4 and the Univac 9300 both claim to be program compatible with the IBM 360 family.

CONTROL DATA: The 3150 cannot have magnetic tape units, and the price given in the table is for a configuration with two changeable diskdrives. The CDC 6500 has two central processors.

ENGLISH ELECTRIC: The System 4/75 can have up to six central processors.

ICT: The 1903, 1905 and 1907 have been omitted from the tables as they are simply 1902's, 1904's and 1906's with floating point arithmetic. The 1904F and the 1906F have two central processors.

ABBREVIATIONS:
ms = millisecond
uS = microsecond
ns = nanosecond

A second contains 1,000 milliseconds, 1,000,000 microseconds, or 1,000,000,000 nanoseconds.

* SPECIAL NOTES ON CENTRAL PROCESSORS:

This is not an exhaustive survey of Central Processors, as to prepare this is thought pointless because of the following:

(a) A significant proportion of the machines would be obsolete.

(b) New computers are being introduced very frequently.

* SPECIAL NOTES ON PERIPHERALS:

Many computer suppliers offer their peripherals for use with other suppliers' equipment, so many of them are interchangeable.

ERIPHERALS: *

	Bull-GE	Burroughs	Control Data	English Electric	Honeywell	IBM	ICT	NCR	Univac	OEM
Paper tape readers	500 cps	1,000 cps	350 cps 1,000 cps	1,500 cps	600 cps 1,000 cps	1,000 cps	300 cps 1,000 cps	1,000 cps	300 cps 1,000 cps	Regnecentralen 2,000 cps Facit 1,000 cps
Paper tape punches	100 cps 150 cps	110 cps	110 cps	150 cps	120 cps	not available	110 cps	110 cps	110 cps	Facit 150 cps
Card readers	300 cpm 600 cpm 900 cpm	200 cpm 800 cpm 1,400 cpm	100 cpm 1,200 cpm	800 cpm 1,400 cpm	400 cpm 600 cpm 800 cpm	400 cpm 600 cpm 1,000 cpm	300 cpm 900 cpm	400 cpm 2,000 cpm	400 cpm 600 cpm	Uptime 1,400cpm
Card punches	100 cpm 200 cpm 300 cpm	100 cpm 300 cpm	250 cpm	100 cpm 300 cpm	100 - 400 cpm	160 cpm 300 cpm 500 cpm	100 cpm 350 cpm	100 cpm	200 cpm	
MICR sorter/ reader	1,200 dpm	1,560 dpm	1,560 dpm	1,560 dpm	1,620 dpm	1,620 dpm	1,200 dpm	1,200 dpm	not available	Crosfields 1,200 dpm
Optical readers	No	No	page reader	Lector	Bar code	Bar code Tally roll Doc reader OCR A	Bar code OCR B	Tallyroll	No	Farrington S.E.Lorenz Crosfields Slemag Control Data
Printer skip rates	16 or 64 ips	75 ips	25 ips	75 ips	55 ips	75 ips	31 ips	15 and 75 ips		

ERIPHERALS (cont.): ≠

	Bull-GE	Burroughs	Control Data	English Electric	Honeywell	IBM	ICT	NCR	Univac	OEM
ine printers	300 Ipm 600 Ipm 1,200 Ipm	720 Ipm 1,040 Ipm	750 Ipm 1,350 Ipm	450 Ipm 650 Ipm 950 Ipm	350 Ipm 600 Ipm 1,100 Ipm	300 Ipm 600 Ipm 1,100 Ipm	300 Ipm 600 Ipm 1,350 Ipm	300 Ipm 600 Ipm 1,000 Ipm 1,250 Ipm	600 Ipm 1,000 Ipm	Xeronic 3,000 Ipm ContrdData Regnecen-tralen
agnetic tape units	21 - 160 kc	9,18,25,36, 50,72 & 144 kb	20,60, and 120 kc	30,60, and 120 kb	13,28,44, 66 & 83 kc	15,30,60, & 90 kb	20,41,60, & 96 kc	12,33,66, & 120 kc	34 kb or 133 kc	Plessey, ControlData Potter, Ampex
ead backwards	No	Yes	all except 20 kc	Yes	Yes	all except 15 kb	96 kc only	120 kc only	Yes	

NOTES ON PERIPHERALS TABLE:

cps = characters per second
cpm = cards per minute
dpm = documents per minute
ips = inches per second
kc = thousands of characters per second
kb = thousands of bytes per second. A byte is one letter or two numbers.

RECT ACCESS PERIPHERALS: ≠

	Bull-GE	Burroughs	Control Data	English Electric	Honeywell	IBM	ICT	NCR	Univac
hangeable disc packs: ingle units	not	not available						not available	not available
Access time	95 ms		97½ ms	117½ ms	97½ ms	97½ ms	97½ ms		
Transfer rate	260 kc		208 kc	156 kb	208 kc	156 kb	208 kc		
Capacity	7.8mill chs		8 mill chs	7½mill bys	9.6mill chs	7½mill bys	8 mill chs		
hangeable disc packs: ultiple units	not available	not available	not available	not available	not available		not available	not available	
Access time						87.5 ms			135 ms
Transfer rate						312 kb			
Pack capacity						25mill chs			1 mill chs
Unit capacity						8 packs			2 packs
agnetic card units	not available	not available	not available	not available	not available				not available
Access time						300 ms	324 ms	235 ms	
Transfer rate						55 kb	80 kb	38 kc	
Pack capacity						40mill bys	42.8mill chs	16mill chs	
Unit capacity						10 packs	8 packs	1 pack	
ixed disc units								not available	not available
Access time	26 ms	20 ms	65 ms	85 ms	100 ms	165 ms	150 ms		
Transfer rate	333 kc	377 kb	196 kc	550 kb	197 kc	156 ib	150 kc		
Capacity	15.36mill chs	10mill bys/mod up to 500 modules	201mill chs	600mill bys	300mill chs	224mill bys	419mill chs		
agnetic drums		not available						not available	
ccess time	17 ms		17 ms	10 ms	27½ ms	8.6 ms	20 ms		92 ms
Transfer rate	370 kc		2,000 kc	820 kb	102 kc	1,200 kb	100 kc		160 kc
Capacity	4.7mill chs		4 mill chs	1 mill bys	2.6mill chs	4.1mill bys	2 mill chs		132mill chs

NOTES ON MANUFACTURERS:

1. Elliot-Automation has been subject to a duly accepted take over bid by English Electric. The Elliott 4100 range directly conflicts with English Electric's system 4 in commercial data processing. The Elliott 4100 range is currently being marketed by both Elliott and NCR. Due to some doubt over the future of the 4100, it has been omitted from the table.

2. GEC sells the scientific data systems range and, as Appendix II is restricted to systems suitable for commercial data processing, GEC is omitted from the list.

3. NCR is expected to launch a new system called the 615.

4. English Electric's System 4/30 at present has not met their specifications in terms of speed. It is expected that the subsequent 4/305 will come up to the specification as shown in the table. There are expected improvements in the core requirements of System 4 software, which are currently larger than was expected, early next year (1968).

(Source: David Shirley, 'Choosing a Computer' Part 4B, Magnetic File Computers, Data Systems, August 1967, pp. 16-25).

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G L O S S A R Y

ACCESS TIME: The period elapsing before the desired record can be selected in some sequential or random access storage device.

ACCUMULATOR: Part of the computer's central processor, which acts electronically, rather as a register in an accounting machine acts mechanically, for the performance of additions or subtractions and storage of the result. Arithmetic registers are much the same as accumulators.

ADDRESS: The identification of a place, where data may be held in computer storage.

ALPHA: Contraction of alphabet.

ASSEMBLER: Programming aid (software) which a computer uses to convert a source programme into the machine code.

AUTO CODE: A form of expressing computer instructions in mnemonic terms, for example, DV for divide.

AUTO POLLING: An arrangement whereby peripheral devices sharing a party line are connected in turn to the central processor.

BACK UP STORE: A computer store of larger capacity than the working (or immediate access) store, but of slower access. The backing store generally takes the form of magnetic tape or a drum or disc, or a combination of these.

BIT: Contraction of 'binary digit'. Each component of a binary number (that is, each 0 and each 1) is known as a bit, so 1001 is a 4-bit number.

BOOTSTRAP: A short key programme which instructs a computer to feed in more detailed instructions from some convenient input device.

BUFFER: A form of subsidiary storage designed to provide a flexible link between devices working at very different speeds.

BYTE: A sequence of adjacent binary digits, which are used as a unit; generally longer than a single character but shorter than a word. For instance, some computers operate with a byte of eight bits.

CHANNEL: A path along which signals can be sent, i.e. a telephone wire.

COLLATOR: A punched card machine which interleaves cards from two packs when information punched in one or more coincides.

COMPILER: The computer programme (the manufacturers' software) whereby a computer can convert a source programme into an object programme, expressed in machine language which the computer can recognise.

CONSOLE: The piece of equipment provided with most computers from which all the apparatus can be controlled, and in which any requirement for attention is normally made evident.

DEBUG: To trace and correct the inevitable errors in a programme newly written.

DUMMY: Computer instruction or data superficially similar to the real thing but not capable of being operated upon.

DUMP:
(1) To cut off all power supplies to a computer system.
(2) To copy stored data onto some other storage medium, for example, a programme in core store may be dumped onto a magnetic disc to make room for other programme instructions in core store.

EDIT:
(1) To amend data before printing so as to improve clarity.
(2) To prepare data in suitable format and remove obvious errors before input to an EDP system.

EQUIVALENT ELEMENT: A circuit which produces a signal if, and only if, two items of input are identical.

EXECUTIVE PROGRAMME: A programme of instructions maintained permanently in the working store of time-sharing computers. Its use includes switching control between the various programmes that may be in use (together with the peripheral devices assigned to each) according to some predetermined order.

FATHER & SON: A system of updating records which retains a copy of the original record as well as providing an amended version. The technique is particularly applicable to files held on magnetic media such as tape, disc or drum. For example, Tape A (father tape) + some information - both marking Tape B (son tape).

FIRST GENERATION: Early computers, which used thermionic valves for necessary electronic switching are called by this term.

GIGO: Garbage in garbage out.
A reminder that computers do not think and can produce nonsence on a massive scale, if fed with wrong data.

GRANDFATHER: Father-Son.
An extension of the father-son technique. Each tape or other record is kept for an extra generation before its data is destroyed. Example: Payroll for week 20 (father tape) + information of pay of week 21 (son tape), making father and son, and then information for week 22, altogether making grandfather-father-son.

HARDWARE: All parts of computer and its equipment - central processor, memory units and peripheral devices.

HASH TOTAL: A total of the various numbers involved in some piece of data transfer. A comparison of hash totals before and after processing reveals any loss of data.

HOUSEKEEPING: Instructions in a computer programme, which are necessary for its processing but which do not form a constructive part of any worker programme, for example, insturctions to pack or re-arrange data in some form to suit the peripheral devices which happen to be attached.

INDEX REGISTER: An electronic register, sometimes held in part of a computer's working store, designed to hold a number for address modification. Synonymous with B-register and modifier register.

MASTER FILE: A file containing information, which is relatively permanent, for example, names and addresses as distinct from day-to-day transactions.

M.I.C.R: Magnetic Ink Character Recognition (abbreviation). A system of printing specially styled characters in magnetic ink so that they can be identified by the computer.

MICRO-SECOND: One millionth of a second.

MILLI-SECOND: One thousandth of a second.

MODE:
(1) A computer system of data representation, for example, binary mode.
(2) A selected method of computer operation, for example, real time mode.
(3) A method of card reading and punching, for example, the Hollerith mode.

MODULE: A part of computer circuitry or a peripheral device which has been manufactured as a subunit so that it may easily be detached from, or attached to, the system as a whole without seriously affecting the operation of that system.

MONITOR: A type of programme (manufacturers' software) used to supervise and verify the correct operation of a programme during its execution.

MULTI-CHANNEL: A communications link which can carry several independent messages simultaneously. This can be arranged on an ordinary pair of telephone wires.

MULTIPLEXER: An interconnecting device between a central processor and two or more similar peripheral devices (for example, enquiry teleprinters) so that they can effectively operate simultaneously on a single channel.

MULTIPROGRAMMING: The inter-leaving, or apparently simultaneous working, of two or more different worker programmes in a single computer.

NANO-SECOND: One-thousandth of a micro-second (10^{-9} seconds) - in American parlance, a billionth of a second.

OBJECT PROGRAMME: The final machine language programme for performing data processing produced by means of a compiler.

OPERAND: That which is operated upon; a number brought into a computer store to suffer some arithmetic or logical modification.

OVERFLOW: The production of a number beyond the capacity of a register to receive it.

PARAMETER: Loosely equivalent to limit. A computer cannot reason, so it is necessary for all its instructions to be precisely defined.

PASS: One complete transit of a group of data through a process.

PERT: Production evaluation and review technique (abbreviation).
A form of critical path analysis, for which a software package is frequently offered by a computer manufacturer.

PICO-SECOND: One millionth of a micro-second; one thousandth of a nano-second; 10^{-12} seconds.

POST MORTEM ROUTINE:
A service routine used to locate the cause of a failure.

PSEUDOCODE: A code which expresses programmes symbolically, for example, in mnemonic terms as opposed to machine language codes. Synonymous with symbolic code.

SECOND GENERATION: Description of computers, whose circuitry is based on transistors and other solid-state electronic devices to the exclusion of gas-filled or vacuum valves, which are more prone to failure.

SOFTWARE: Programmes and routines required to adapt the hardware of computers to useful work.

SOURCE PROGRAMME: A computer programme written in mnemonic, assembly or compiler language, from which a machine or object programme can be produced by a compiling process.

SUPERVISORY ROUTINE:
A routine designed to organise and regulate the overall work in an EDP system. A supervisory routine may change control automatically from one programme to another and this is done extensively in multi-programming or time sharing operations. Synonymous with executive routine.

TABULATOR: A printing machine, which can read and tabulate information from punched cards or other media.

TELEPRINTER: A form of electric typewriter, capable of connection by telegraph line to similar devices so that what is keyed in at one teleprinter will be printed out at the other terminal.

TELEX: An international telegraph system in which subscribers communicate by means of teleprinters instead of telephones.

THIRD GENERATION: A term applied to computer hardware held to be significantly in advance of the transistor circuitry which identified the second generation solid state computers from the original first generation of computers with their thermionic valves, etc. Present thinking identifies third generation with micro-miniaturisation and integrated circuits.

TIME-SHARING: The use of a computer or related device for two or more purposes simultaneously, achieved by interspersing component actions. The most common example is in multi-programming.

TRACK: A single data-holding path in a magnetic drum or disc.

UTILITY ROUTINE: A standard routine normally made available by computer manufacturers as part of their software package, for example, for code conversion.

VERIFIER: A mechanical device to confirm the accuracy of data punched into cards or paper tape.

XEROGRAPHY: A printing process in which the desired characters are formed by the operation of an electrical charge.

Source: Reynolds - A Computer ABC, Gee & Co., London, 1966.