

UNITED NATIONS
ECONOMIC
AND
SOCIAL COUNCIL



5-6-68
Distr.
LIMITED



E/CN.14/UAP/160
21 June 1968

Original: ENGLISH

ECONOMIC COMMISSION FOR AFRICA
Seminar on the Methods and Procedures
to improve Personnel Administration
Addis Ababa, 20-28 June 1968

THE USE OF MECHANICAL PROCESSES AND MACHINES^{1/}

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M68-899

PART I

THE BALANCING OF ADVANTAGES

1. The mechanization of some of the procedures involved in Personnel Administration work can lead to economies and improvements in effectiveness similar to those obtained in other areas of administration. But here as elsewhere it must not be blindly assumed that mechanization is a panacea for all ills or that the immediately apparent advantages of using a machine are the only factors to be considered.

2. The approach of the Manager towards mechanization should be as objective as in the consideration of any other managerial problem. Care should be taken to avoid questions of prestige entering the reckoning; although machine carry an aura of efficiency in themselves, a high degree of mechanization in an organization is not necessarily a reflection of a high degree of overall efficiency or indeed of the efficiency of the manager. The average manager may not be very well equipped to judge the relative merits of mechanical and manual methods, or of different machines available for similar purposes; and he may well rush too easily into treating a symptom of malaise by a quick dose of mechanization when what may be really needed is a major surgery on organization and procedures. Every proposal to mechanize ought therefore to be examined on its merits and an unbiased assessment made as to whether a mechanized system is needed at all and then as to the most suitable equipment available for the job. In short mechanization should only be introduced where it has clear advantages which cannot be obtained by other means.

3. The assessment required to determine the balance of advantage calls for quite a high degree of expertise, and it is beyond the scope of this paper to attempt to cover all the skills required. There are nevertheless a number of broad considerations of which a manager should be aware, and these are introduced below and then expanded in Part II and III of this paper.

4. Let us first consider the broader advantages and disadvantages of mechanization which need to be compared in arriving at a balanced assessment. They may be listed as follows:

Advantages

- (1) Greater speed with increased output and less effort and drudgery;
- (2) Greater accuracy;
- (3) Improved management information;
- (4) Better supervision and control over the work and procedures;
- (5) Improved legibility of records.

Disadvantages

- (1) Loss of flexibility for dealing with sudden changes;
- (2) Rigidity of organization by centralization of mechanical services adherence to tight time schedules;
- (3) Specialization calling for skilled specialist staff;
- (4) Special requirements for machine installations e.g., accommodation, power, floor loading, ventilation, acoustical treatment, storage of consumables etc.;
- (5) Problems of maintenance and breakdowns, e.g. maintenance time, lost time, arrears, location of repair agents, effects of climate etc.;
- (6) Staff resistance to "radical" new methods.

5. In weighing the balance of advantage, the relative improvements and difficulties listed above must also be considered against the background of cost, which may indeed be the most important factor. The ultimate case in justifying mechanization is, with few exceptions, based on savings expressed in monetary terms and arising in the main from savings in staff and salaries. It is important, therefore, that in costing a proposed mechanized system its costs should be compared with the costs of the most efficient manual system that can be devised; the latter is not necessarily the one already in existence. Some of the factors to be taken into account in making this comparative costing are discussed in Part III. In Part II, which follows, the field of machine application is first described.

PART II
THE FIELD OF MACHINE APPLICATION

A. General

6. It is of assistance in thinking about mechanization to consider the seven basic clerical operations for which there are machine equivalents. They are as follows:

<u>Operation</u>	<u>Machines</u>
(1) Communicating	(a) Preparation: Dictators, transcribers, teleprinters; (b) Handling: Letter openers, collators, folders, inserters, sealers, and document lifts.
(2) Writing	(a) Variable: Typewriters; (b) Static: Addressers; (c) Mixed: Printers (franking, numbering, cheque writers) and automatic typewriters.
(3) Sorting	Punched cards and computers.*
(4) Copying	Duplicating offset litho, dyeline, xerographic, microcopying.
(5) Checking	Punched cards and computers.*
(6) Calculating	(a) Printed results - add-listers, keyboard calculators, accounting; (b) Visible dials - plus adders, lever calculators.
(7) Filing	Punched cards and computers,* micro-copying.

* Note: Punched cards and computers can of course also perform the other operations.

Appendix I to this paper shows all the above in greater detail in chart form and illustrates the interplay of the machines in mechanical office systems.

7. It is perhaps useful at this point to draw some distinction between machine "aids" and machine "systems". Aids may be described as those machines which assist certain aspects of clerical work, or certain members of the staff, without affecting the work flow or the organization. Examples are calculators, dictating machines, copying machines, typewriters. A machine system, on the other hand, is one in which the work flow and organization are geared to enable the machines and their operators to work at optimum rates. Examples are accounting machine systems, addressing/issuing systems, punched card and computer installations. While it may be easier to introduce a machine aid because of its smaller disturbance factor in the work as a whole, justification for its introduction in terms of monetary savings must still be sought. Old fashioned aids like carbon paper and ready reckoners are much cheaper than copying machines and calculating machines and may still be the right answer in certain applications. Consideration of all the possible methods available, manual and mechanical, should always be given.

8. The term 'mechanical processing' can conveniently be extended in interpretation to cover those special items of equipment which while not perhaps machines in themselves are useful modern aids in facilitating some clerical processes, particularly in the fields of records and their sorting, filing and retrieval, and in progressing operations. It is in this field that we make use of modern devices such as flap sorters; filing equipment of all sorts; visi-edged index cards, rota indexes and other indexing systems; item cards and feature cards and the use of symbols and colours for the selection and retrieval of information; peg boards and wall charts for the display of information and progressing of operations.

B. Machine applications in personnel administration

9. All the seven main clerical operations are obviously used, in varying degrees, in personnel administration work, so the general considerations for mechanization in the preceding paragraphs will apply. It is perhaps more convenient, however, to think of personnel administration in terms of three functions for machine purposes:

- | | |
|------------------------|--|
| (1) Record maintenance | (a) staff - appointments, absences, career, complements, promotion; |
| | (b) services - accommodation, furniture, equipment, stationery, etc. |
| (2) Accounting | Estimates, budget, pay, travel, subsistence, removals, stores, etc. |
| (3) Staff training | |

10. The records maintained in personnel work are extensive and are listed in greater detail in the paper dealing with personnel files and forms. It is in this function that there may well be scope for indexing systems, retrieval systems (e.g., feature cards) filing systems, sorting systems and progressing systems (e.g., wall charts). It is here too that the size and complexity of the statistics and returns needed in large departments may begin to give justification for the introduction of punched card installations, or even, in conjunction with other requirements, for a computer.

11. It is perhaps in the accounting function that most organizations are already mechanized to a large extent. It is here that we see the progression, again according to size and complexity, from semi-mechanized peg board "three in one" payroll systems to calculating machines and accounting machines, including electronic machines of both types, and then through to punched card installations and computers for the largest and most complex applications.

12. The separation out of the staff training function may cause some surprise, but it is here that the use of some special mechanical and visual aids can be of value. They include such things as projectors for slides, films, translucencies; tape recorders; and programmed learning devices. Staff training courses also depend very much upon the efficiency of the office copying systems for the production of briefs, charts and handouts.

13. It is beyond the scope of this paper to go into technical descriptions of all the various types of machines available for personnel administration work. Appendices II and III, however, contain some information concerning calculating and accounting machines and feature card retrieval systems which may be of interest and value.

PART III
CONTROL AND COSTING

A. Control

14. The importance of centralized control and of building up a body of expertise in mechanization considerations should be apparent from the preceding paragraphs. It is customary for control to be centralized in the establishments department, where it is usually delegated to a machines specialist who should preferably be trained in the techniques of management services and O & M.

15. This organizational device has four main advantages:

- (1) It ensures that all proposals for mechanization throughout an organization receive expert and unbiased consideration before decision;
- (2) It ensures that the ordinary clerical operations for which mechanization are proposed are examined by O & M techniques so that necessary improvements (with or without mechanization) can be made;
- (3) It ensures that the necessary specialist expertise in machines, in dealing with manufacturers or their agents, in organizing purchase, installation, maintenance and repairs of machines can be built up and held centrally for the benefit of the whole organization;
- (4) It enables adequate central control to be exercised over expenditure and costs, and in the pooling of machine resources to the best advantage of the whole organization.

16. The machines specialist, even if not O & M trained, should be able to make a challenging approach to the problems of work simplification either with or without mechanization. Some of the considerations to be applied in the simpler field of machine and equipment "aids" are contained in Appendix IV. In the more complex fields of machine "systems" involving accounting machines, punched cards and computers it would be unwise, however, to embark upon such a system without a full scale feasibility study by an O & M expert; in this field of high capital costs great care needs to be taken to ensure that all the consequences of reorganization are fully appreciated and costed. These consequences arise from the need to centralize work, to integrate processes, to consider shift working, to engage and train staff, to write-off existing equipment, to obtain accommodation and plan lay-out, to arrange stationery requirements, to plan organize control and co-ordinate the new system, and so on. These are major managerial questions in addition to the refined costing techniques to be applied.

17. The decision to mechanize can be affected at all stages of the consideration by a knowledge of what machines are available for different applications, and, where there are competitive machines for the same process, which is the best machine for the particular application. A starting knowledge of machine applications can be built up by the machines specialist from a wide bibliography, training courses, and papers such as this. Decision as to the best machine among competitors, however, nearly always demands some local market research with manufacturers or their agents direct. In considering the relative merits of the machines that are locally available or obtainable, the following factors are the most important:

- (1) Price;
- (2) Simplicity and ease of operation;
- (3) Relative machine speeds;
- (4) Durability and freedom from breakdown;
- (5) Availability of local maintenance, spares and repair facilities;
- (6) Cost of operators and consumables (e.g. stationery).

18. There are a number of other useful factors which derive from central control, as follows:

(1) Standardization of machines

This gives easier maintenance; a spreading of peak loading; simpler staff training; and standardization of consumables. But the benefits of developments in other types of machine may be lost if taken too far.

(2) Pooling of machines

This gives greater machine utilization; easier cover for absences or breakdowns; greater variety for operator interest; better use of supervision and skills; possible savings in accommodation and equipment; possible justification (because of volume) for more sophisticated machines. But work has to be sent to and from the pool and local control over it is lessened.

(3) Location, accommodation and layout

These all need careful planning in order to give the best service; minimum transport or rehandling; proper work flow through the process and good staff working conditions. Factors involved are floor loading; electrical facilities; ventilation; noise reduction; storage of consumables; fire precautions; natural and artificial lighting; functional furniture; adequate cabinets and storage racking.

(4) Staffing and training

Recruitment and training of operators and supervisors; training manuals; training of other staff in use of "aids" e.g., dictating machines; utilization of operators, control of performance.

(5) Other planning

What needs to be done in advance e.g., forms design; is parallel working necessary during the changeover period?; will standby systems be necessary? etc.

(6) Prevention of abuse

Unauthorized private use of machines e.g., copying; unnecessary copying; copying by uneconomic machine processes where there are alternatives; control of use of consumables; care of machines; control of planned maintenance, etc.

B. Costing

19. There may be some exceptional instances in which it may not be necessary to justify mechanization on economic grounds. Examples are processes which cannot be performed manually e.g., photography, or instances in which staff of the right calibre and skills to do a job manually cannot be found and it becomes necessary to mechanize in order to achieve an objective. Normally, however, any proposal to mechanize should be justified by distinct monetary savings, not merely marginal, over the most efficient clerical system that mechanization would replace. A corollary from this is that one would expect the more expensive machines to be in use most of the day if they are to justify themselves; on the other hand smaller and cheaper machines may sometimes produce overall savings even if they are used only periodically.

20. To enable the monetary savings inherent in mechanization to be demonstrated, the costing to be carried out needs to be extensive and thorough. Both capital costs - amortized over a period of years - and annual running costs need to be carefully calculated, and applied to both the mechanized proposals and the equivalent clerical procedures. The following costing factors will all be involved:

- (1) Capital cost (or rental);
- (2) Interest on capital;
- (3) Depreciation/amortization;
- (4) Staff costs - salaries, training etc.;
- (5) Accommodation costs - including all the special requirements;

- (6) Maintenance costs (including operator time);
- (7) Contingencies - for breakdowns and alternative arrangements;
- (8) Consumable costs - these may be special proprietary and costly;
- (9) Parallel working during changeover period;
- (10) The cost of investigating, planning and installing a new system.

21. When one considers that it may be necessary to do this comparative costing for not just one machine system but for a number of competitive but alternative proprietary systems, it will be realized that the costing can become highly complex. Variables arising from different machine speeds, outputs and functions, and different operator costs will all need to be considered. In some cases also it will be necessary to cost out the alternative advantages of hiring and outright purchase; here a number of judgment factors will be brought to bear, such as the possible rate of machine obsolescence according to the rate of new developments in a particular field, or the degree of after sales service available, or the prospective life of the particular piece of administration etc.

22. The very largest schemes - accounting machine systems, punched card installations and computers - usually require the application of discounted cash flow techniques to the costings in view of the large capital costs involved. It is considered beyond the scope of this paper to expand on this technique, because the feasibility studies for the installation of these large and costly systems are best handled by O & M specialists who will themselves be well versed in d.c.f. methods.

APPENDIX II

NOTE ON ADDING, KEYBOARD ACCOUNTING AND CALCULATING MACHINES

Introduction

This note gives a broad description of adding, adding-listing, keyboard accounting machines and calculators. There are probably few departments of government today where adding, keyboard accounting or calculating machines are not used at all; in a number of places they are used extensively. The application of these machines is often thought to be confined to the arithmetic and accounting processes in the office; this may be so for keyboard accounting machines but it is not so for adding machines and calculators. Calculating machines are used by scientific, professional and technical people as aids to their calculations in precisely the same way as clerks in offices use them for working out routine calculations. Whatever the nature of the work the same techniques of operation are used.

Calculating machines (using the word 'calculating' in its broadest sense) merely perform mechanically the four basic processes of arithmetic, viz.: addition, subtraction, multiplication and division. There is a wide range of machines, some capable of performing only one or more of these processes whilst others are equipped to carry out not only these processes but other operations as well.

Although there are certain techniques to be learned about the operation of calculating machines, the machines themselves will do nothing that cannot be done using pencil, paper and mental effort. Part of the advantage of using calculating machines lies in the reduction of drudgery, thereby raising the output of the operator, improving the accuracy of the work and facilitating the production of legible printed records. On the other hand there may be some disadvantages in using machines for carrying out calculations. Mechanization of the work may be costly; it may require the employment of specially trained staff and may impose a certain rigidity on the organization.

General

A wide variety of types and makes of machine is available, ranging from simple manual to fully automatic electrically operated machines. This paper does not deal with all these machines in detail but describes the salient features which distinguish one group of machines from another.

There is, however, one feature common to all calculating machines, viz., the computing mechanism. This is a device for the accumulation of numbers, commonly known as a register. A register may add or subtract numbers, although in the smaller machines subtraction is not always a straightforward operation and is only achieved by the process of complementary addition.

The choice of machine depends on the kind of work being carried out, i.e., whether the work involves addition and/or subtraction only, or whether multiplication and division processes are also involved: the need for printed records: the size of the numbers being handled. Other factors to be taken into account include the extent of machine usage (an electric machine might be chosen in preference to a manually operated one, so as to reduce fatigue) and the need for some degree of portability of the machines between the users.

Adding machines

There are two types of adding machines:

- (1) Those which show the total of the figures in a visible register but do not produce a printed record (non-listing), and
- (2) Those which produce a printed record.

Non-listing adding machines

These machines are the simplest calculating machines and are used extensively where the arithmetical processes consist mainly of addition. These machines provide a rapid means of obtaining the required result and they have the advantage that models working in any system of units are available. Basically a non-listing adding machine consists of one register for storing the numbers entered into the machine.

The keyboard consists of rows of keys numbered 1-5. This shortened keyboard is used because it is found in practice that for addition only it is easier for a trained operator to depress two keys successively in the 1-5 range than to use the whole 1-9 range. To enter figures greater than 5 the operator uses two keys successively. The machines are known as "key-driven", i.e., when the selected keys are depressed, the figures are entered directly into the register on the automatic upward stroke of the keys.

Adding-listing machines

Two types of keyboard are available:

- (i) The full keyboard consisting of rows of keys numbered 1-9 for each column of figures within the register capacity of the machine;
 - (ii) The 10 or 12 keyboard (also known as the simplified keyboard); this consists of 10 keys numbered 0-9 for working in decimal, or 12 keys, i.e., two extra keys for 10d. and 11d. for working in sterling.
-

With both types of adding-listing machine the figures are first set up on the keyboard but are not printed or recorded in the register until the handle or motor bar is operated; these machines are known as "key-set". Errors made in setting up the keys can be corrected before the handle or motor bar is actuated, i.e., before the amount is printed or recorded in the register.

Adding-listing machines are fitted with additional keys enabling subtraction to be carried out and for the figures set up on the keyboard to be held for as many times as they are required without re-entering them into the keyboard each time the calculation is carried out. Other features include special keys for recording the date, reference or code numbers and for taking sub-totals etc.

Most of these machines also have what is known as a credit balance feature. This enables a true balance to be obtained if the amount for subtraction is greater than the amount from which it is to be subtracted. (On machines not fitted with this feature the complement of the figures is shown, i.e., the difference between the correct answer and the totalising capacity of the machine).

Although some of these machines have only one register there are adding-listing machines which have two registers (known as duplex machines) for the accumulation of individual figures in groups which may be entered in either or both registers; totals may be obtained from each separately.

Adding-listing machines also possess one other very useful feature: as the figures are entered into the machine they are also printed on a roll of paper (usually referred to as a 'tally roll') attached to the machine by a fixed narrow carriage. In this way a list of the figures contributing to the total appears in printed form. Similarly by pressing a 'totals key' the result or total is also printed on the paper. Some models of adding-listing machines may be fitted with a shuttle or a wide movable carriage for tabulating information.

Keyboard accounting machines

In addition to the keyboard from which their name is derived, all keyboard accounting machines have computing and printing mechanisms, i.e., the registers. A register may add or subtract amounts entered into the machine; for accounting operations the machine is fitted with one or more registers which add and subtract horizontally to produce a balance. These special registers are known as 'cross-footing registers' or 'cross-footers'. The registers used for vertical addition or subtraction of figures are usually known as accumulative registers.

There are two types of accounting machine:

- (1) Machines which have been developed from the typewriter; these have a special built-in mechanism whereby the figure keys, as well as printing the figures, operate an adding mechanism. These registers may be either fixed to the carriage or built into the machine itself.
- (2) Those which have been developed from a keyset adding machine; these machines are fitted with a wide tabulating carriage and may have a number of other special features.

(a) Typewriter based accounting machines

In these machines the vertical adding registers are removable, thus giving some flexibility over the range of work which may be carried out, although the number of registers is limited to the length of the carriage. In these machines there can be one or two cross footers.

(b) Adding machine based accounting machines

In these machines the vertical and cross footing registers are built into the machine itself.

The operations of accounting machines (viz., addition, subtraction of amounts in registers, line operation, carriage return etc.) are controlled by the operation of the keys in conjunction with control bars or plates, known as form bars or programme bars; these may be fixed to the front or at the rear of the machine according to the model. The control bars or plates are constructed in a number of different ways according to the make of machine; with some machines they are engineered by the makers of the machines according to the job requirements but there are models available having control bars or plates which the operator may set up according to the requirements of the job. Essentially the control bars or plates, however constructed, achieve the same purpose, viz., controlling the machine operations.

The printing mechanism on accounting machines is similar to a typewriter but the carriage always provides for back and front feeding of forms so that a number of related but separate documents can be prepared simultaneously. Some adding machine based accounting machines are also equipped with a typewriter keyboard for typing descriptive information onto the documents.

Other features include:

Special keys or controls for printing the date, reference and/or code numbers.

Facilities for repeat printing, non-printing.

Printing a zero proof for each line entry.

Accounting machines are used for a wide variety of accounting and statistical work such as:

- (i) Posting ledger accounts of various kinds (vote, sales, bill paying and stock records);
- (ii) Recording, analyzing and summarizing statistical information;
- (iii) Cheques, posting slips, cash sheets, receipts;
- (iv) Pay lists, wages and tax record cards, pay advice slips and pay envelopes.

The operator of an accounting machine enters each item of data in a pre-arranged order to complete one row of information; the machine proceeds automatically from column to column as each entry is made. During these operations the necessary additions and subtractions are carried out in the registers to produce the end results; during these operations the results may be printed if so desired. At the same time the figures of each column or of selected columns, according to the job being carried out, are accumulated in separate registers to give the complete result.

Calculators

Calculators are used primarily for multiplication and division. Although these machines may also be used for addition and subtraction some calculators are less versatile than others in carrying out these processes.

Calculators are grouped, according to type, as follows:

- (i) Key driven calculators;
- (ii) Crank-operated calculators which may be either lever-set or key-set; this group of machines may be fitted with full or simplified keyboards;
- (iii) Printing calculators;
- (iv) Electronic calculators.

Key driven calculators

The key driven calculator is basically an adding machine with a full keyboard. Both hand-operated and electrically driven models are available. These machines are available with sterling keyboards for carrying out addition and subtraction direct in pounds, shillings and pence, but for multiplication and division sterling amounts must first be converted to decimals. Although these machines normally have only one register, some models are fitted with a second register so that amounts accumulated in one register as intermediate or group totals can be transferred to the second register for aggregation into grand totals.

The results of the calculations are recorded on visible dials but the component factors used in the calculations are not shown. There is, therefore, no visible means of checking the accuracy of the calculations. Results may be checked by comparison with predetermined figures or by carrying out the calculation a second time.

Crank operated machines

In crank operated calculators the figures used in the calculation are pre-set by positioning levers (lever-set) or depressing keys (key-set). The figures are entered in the machine when the crank handle is rotated (the handle may be rotated in either direction according to the calculations being performed, e.g., in a clockwise direction for addition and multiplication; anticlockwise for subtraction and division).

In multiplication the number of revolutions of the crank handle (determined by the multiplier) are counted separately by what is usually known as the revolution counter register. The machines are fitted with a movable carriage or other device for multiplication by tens, hundreds and thousands etc., so that the amount being multiplied is shifted the required number of places to the right according to the calculation being carried out. The factors used in multiplication are retained at the end of the calculation, which assists the operator to check the calculation.

In division the factors used in the calculation are entered into the machine commencing at the left hand or most significant, end of the register. The crank handle is then rotated in an anticlockwise direction, each revolution subtracts the divisor from the dividend until it will divide no more or until there is a remainder. During these operations the carriage is shifted to the left.

Some models have a facility enabling the transfer of a product i.e., the result of a calculation, from the result register back to the setting levers or the keyboard for multiplication by a third factor (this is usually known as the back transfer feature).

There is a wide range of electrically operated models of the key-set type of calculator. They can be divided into three main groups:

- (i) Motorized versions of the hand-operated machines;
- (ii) Semi-automatic machines in which division proceeds automatically once the dividend and divisor have been set up and the 'divide key' pressed. In these machines multiplication is a motorized version of the hand operated machine operation;
- (iii) Fully automatic machines in which both multiplication and division proceed automatically after setting up the component figures.

Additional facilities offered with these machines make possible:

The accumulation of products, the subtraction of products and the accumulation of quotients;

The locking of constant factors into the machine;

The entry of figures directly into the product or revolution counting registers;

Full tens transmission i.e., whereby the tens carry over is effective over the whole capacity of all registers in the machine; on some machines the tens carry over on the product register is only effective on the movable carriage directly over the body of the machine and this is sometimes a disadvantage where large numbers are being accumulated;

The squaring of a number after it has been entered only once.

Printing calculators

These machines have a built-in printing mechanism enabling the factors and the results of calculations to be printed on a tally-roll. The printing mechanism causes these machines to operate more slowly than the non-printing calculators, especially in carrying out the division process.

Some printing calculators are fitted with a device for holding the factor(s) which are being used repeatedly during a sequence of calculations.

Electronic machines

These machines are a development of the key-driven calculator, and have most of the facilities offered by the fully-automatic machine. Depression of the keys transfers the figures electronically into the register(s) where they may be seen on an illuminated display panel.

Display panels may take the form of a collection of individual tubes in each of which digits from 0-9 are wired; or a screen similar in some respects to that of a television. Some models will show at a glance all factors entered, others show only one factor at a time.

Models are available with a full keyboard - others with a simplified keyboard.

Quietness and speed of operation are the main features of these machines. Other features available are:

- (1) Correct positioning of a decimal point;
- (2) Up to three storage or memory registers;
- (3) The use of up to four satellite keyboards and other peripheral equipment. Note Only one model has these features at the moment.

CLASSIFICATION AND RETRIEVAL OF INFORMATION

Among the duties of the office worker are the compilation, checking, duplicating, sorting and analysing of records. Even in the one-man business, some clerical work must be carried out to satisfy legal requirement or to save the memory the work of storing facts and figures. In larger concerns, the processing and distribution of information is an essential part of the communication process designed to establish understanding of goals among employees, to help them take action and to help management, plan, co-ordinate, motivate and control. Expectations of the office, such as these, demands an ability to handle pieces of information in large quantities

e.g., Library extracts
Quality Control—returns from tests
Personnel—features and attributes of people.

Problems of Classification

Why classify? Aslib suggests that classification is needed to give a thing a name. This has the implication that the name must be not only specific but must signify the relationship between the item named and other items. The purpose of classification may be to give every item a discrete identity, by describing the features it possesses.

e.g., Pivot - pin - spigot - bar - rod, describe the same item with its alternative uses. A common description, which would reduce these five items to one, could be 'Metal having a given diameter and a certain length.'

It is not unusual to have an item identified by several names, and as a consequence one of them could be neglected in a search. In order to reduce this possibility it is necessary to develop a dictionary of terms to show synonyms and alternative meanings.

e.g., In looking for rod, the dictionary would also show spigot, etc.

Fast would have the alternative meanings: rapid and stuck; abstain from eating.

Glossaries are generally developed within organisations and societies for scientific, industrial or common usage purposes.

The way in which an item or subject is initially described can have a significant influence on the number of sources from which information relating to that subject is thought to be available.

e.g., Describing typewriters as writing machines opens up more channels of information, than if a precise mechanical description were given.

Describing electric cables as 'rope-like conveying electricity', directs that ropes, cables, wire, rod and all possible electrical conductors should be explored.

Some systems, such as the decimal classification system, do not take into account grammar, but show only key words.

e.g., Exports from England to Germany, could also be found under Imports into Germany from England.

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Stages in Classification and Retrieval

GLOSSARY—List of items, synonyms and alternative meanings.

CLASSIFY—according to the type of questions to be asked.

CHOOSE THE SYSTEM—Analytic or synthetic.

CHOOSE DATA VEHICLE—according to the system selected.

Item or Feature Question?

In any classification system the information contained in the system should be arranged according to the sort of questions that are most likely to be asked. These questions can be of two kinds:

ITEM QUESTIONS: What are the characteristics of a certain thing?

FEATURE QUESTIONS: How many, or which particular things have a certain characteristic.

These two groups can be further divided according to the type of question to be asked, quantitative or qualitative.

Unit, or single, questions can be readily answered by either the Feature or the Item system whereas multiple questions, embracing both feature and item information, can require intensive searching into one or other of the systems.

e.g., How many employees are there between 25 and 35 years of age? This can be answered directly with a feature card system, whilst, every employee record card would have to be scanned in an item system.

It is fortunate therefore that the systems are distinct, since some methods are inherently better than others for certain types of question.

The Arrangement of Information

To facilitate visualisation, information can be arranged in the form of a matrix. In the information matrix shown, the numbers represent items and the letters represent features.

		ITEMS						
FEATURES		0	1	2	3	4	5	6
a				0	0			
b		0		0				
c						0		
d		0	0	0	0	0	0	0
e			0	0		0		0
f					0			
g		0	0					

Information Matrix

Development of Matrix

Classification systems using numbers should start at zero, rather than number one to give ten divisions between 0-9.

- i. Places on the matrix can be described as:
 - a. Bearer - coded, i.e., one particular square filled with symbol, letter or figure.
 - b. Blank - negative coding, i.e., signifying no known relationship between that item and a particular feature.
 - c. Spare unused spaces - features or items within the universe or population so far unallocated.
- ii. Attributes can be signified by:
 - a. Making a mark - positive coding
 - b. Leaving blank - negative coding.
- iii. The universe or population (all the things under consideration) cannot be considered adequately classified until:—
 - a. The total bits of information collectively exhaust the universe.
 - b. Each bit is mutually exclusive.

e.g., People living to the age of 100 years can be divided into ten groups:

 - i. Under 10
 - ii. 10 but less than 20
 - iii. 20 but less than 30
 - etc. to -
 - x. 90 - 100

Everyone has some age - collectively exhaustive (COLLEX)
If one age then not another - mutually exclusive (MUTEX)

Classification Systems

There are two main systems, analytic and synthetic.

ANALYTIC

Analytical classification systems make use of the 'family tree' idea - the whole being divided into sections and each section being sub-divided. A typical analytical system (with intended errors), is shown later under item classification.

In both analytical and synthetic classification systems the order of features is rarely of significance, critical single features rarely being called for.

- e.g., Item 1. French medieval tapestry
Item 2. German medieval tapestry.

Few concerns would be interested in French as a subject, but this is available in one location, on the other hand, tapestry is available in two places. There is a greater likelihood that tapestry, medieval and French, would be required.

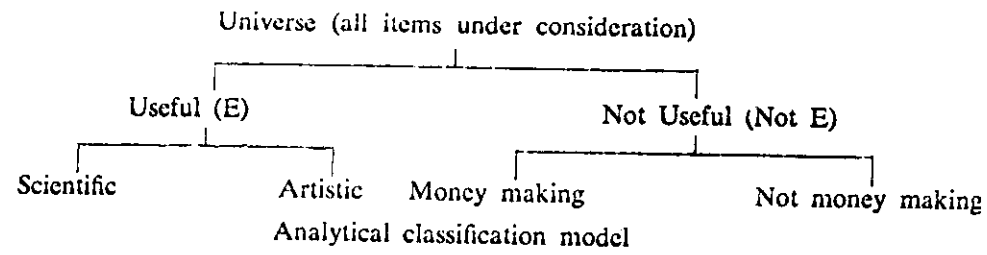
Index Cards

In this system one card is prepared for each item. This card carries all the details relating to that item. No provision is made for selection other than by visually scanning each card in turn. Index systems are often used with synthetic systems to provide complete item information.

TYPICAL ITEM CARD FOR PERSONNEL RECORD SYSTEM

First name	Sex
Surname	Date of Birth
Marital Status	Occupation
Address	Department

Item Classification

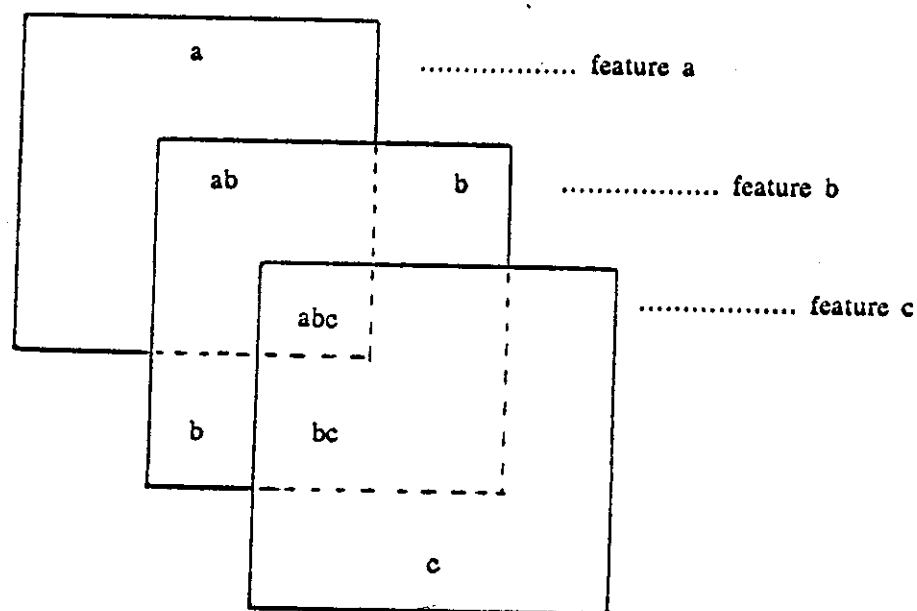


Item classifications should be both mutex and collex. The breakdown, 'useful' and 'not useful', meets these criteria. But in the case of the items under 'useful' this is not so. 'Useful' items can be other than 'scientific' or 'artistic', and could even be both. The universe should be classified on the E and Not E principle, items would then be mutex and collex.

Generally analytical systems are the easiest to understand and lend themselves to 'open shelf classification'. For instance, all books of the same subject are collected together. This facilitates the general location of a subject and permits browsing.

Synthetic Systems

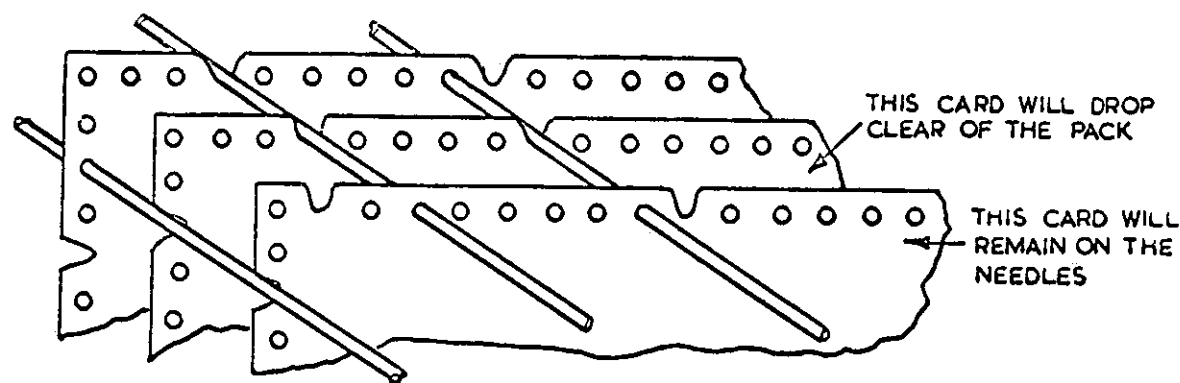
In synthetic systems the qualities, or characteristics of an item are built up by overlapping features.



This example of a synthetic system illustrates a universe classified as having three features a, b and c. Such an arrangement is impracticable because no item could be both b and c, or a, b and c. The example is equivalent to saying that a person could be both male and female.

Marginally Punched Cards

This system uses one card for each item, e.g., Machine, Animal, Component, Person, etc. Each card has a series of holes punched around its perimeter. Any one hole can represent a single feature or alternatively a code embracing several features. A feature can be embodied in the item card by notching out the hole to form a vee slot with the edge of that card as illustrated.

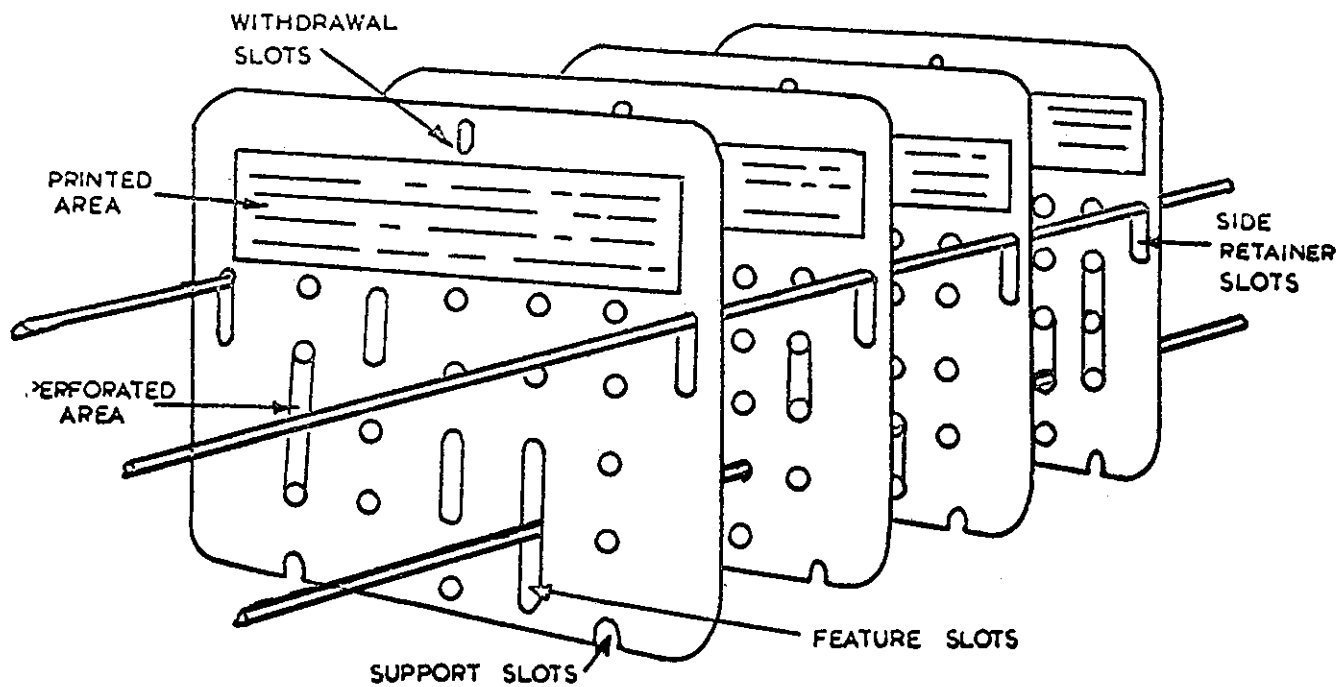


In searching for items possessing certain desired features the procedure is a simple matter of squaring the pack of item cards, passing a needle through each of the selected feature holes and gently shaking the needles. The item cards with all the selected features will not be supported by any needle because the holes have been cut away and will consequently fall away from the stack.

Centre Slotted Cards (Findex)

This is an alternative system to marginally punched cards in that there is still one card per item. However, the holes are prepunched in the body of the card rather than the periphery, and the method of allocating a feature to the card is to join a selected pair of holes by a slot. The proportion of printed data area to hole perforated area per item card can be varied according to user requirements. Sometimes the selection of a limited number of slotted features is all that is required to locate a card from which much more detailed printed information can then be read.

Findex Cards

INDEX CARDS

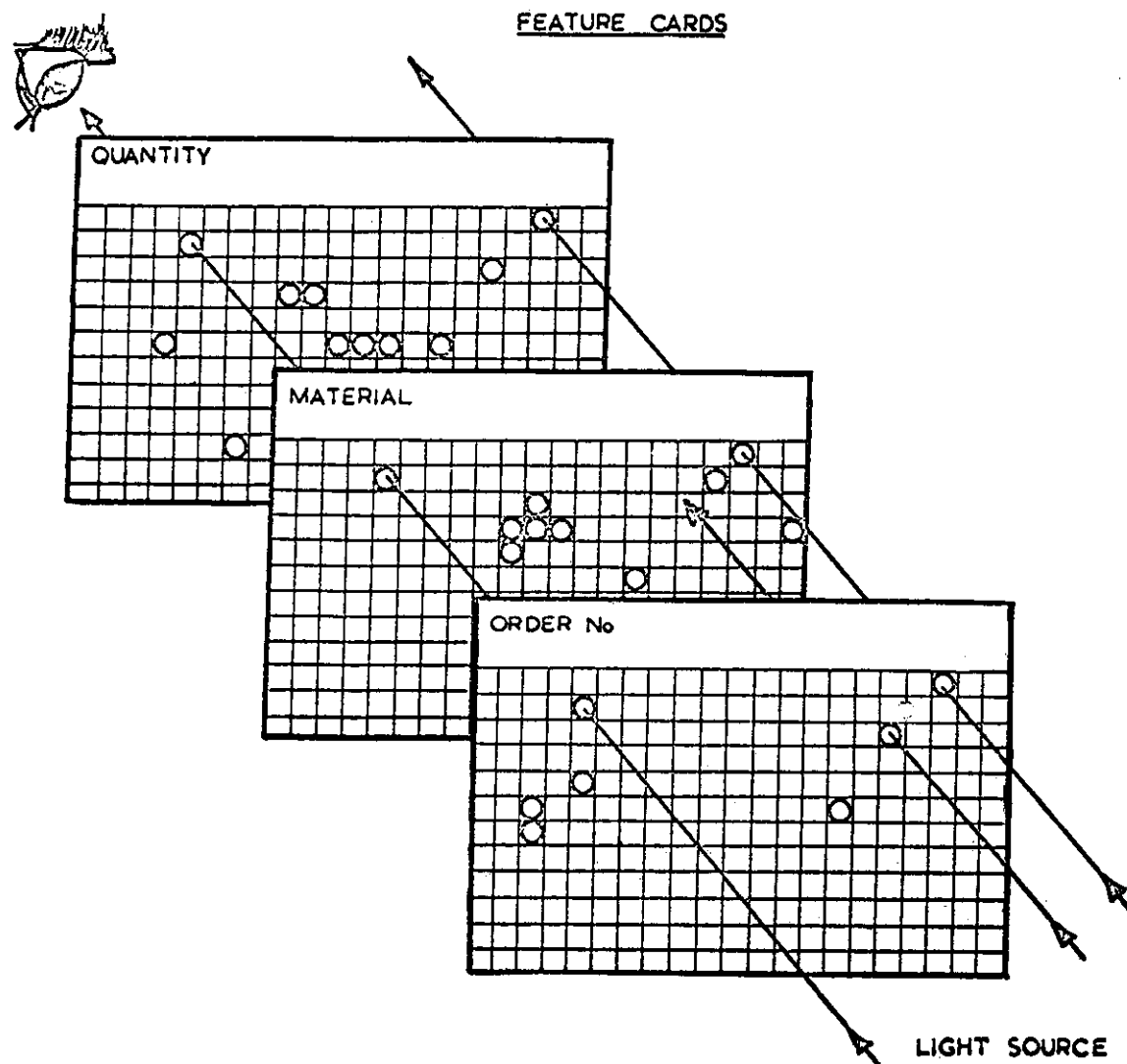
The cards are housed in a selector tray fitted with an end metal plate suitably perforated and coded to align with holes in the cards. To select appropriate item cards metal rods are slid through the two side retainer slots and also into any of the hole positions representing the features required. The complete selector tray is then swivelled 180° so that there is a tendency for all the cards to drop $\frac{1}{2}$ inch, i.e., the maximum allowed by the side retainer slots. However, the central selector needles will hold firm all those cards that do not possess slots in those positions (since the circular rods are passing through circular holes), and so only the slotted cards will drop $\frac{1}{2}$ inch. Before returning the selector tray to the upright position, two more rods are slid into the support slot positions to ensure that the projected slotted cards do not drop back into the pack. These selected cards can then be counted insitu, read insitu or removed completely from the file by firstly sliding another rod through the withdrawal slot position and then removing all other rods. The system can be faster than even a machine punched card sorter which requires several separate runs per column to select several features compared with one sorting operation using centre slotted cards.

Feature Cards

Feature cards use the reverse principle of marginally punched cards and centre slotted cards in that there is a separate card for every feature, and every item possessing that feature is identified on that card. The feature card is gridded into numbered squares and each item allocated a number, e.g., an employee could be allocated square position No. 459 and would occupy that position on every one of the feature cards in the system.

If the item possesses the feature represented by the card then that position is punched out with a circular hole. In this way a feature card gives both the identity and also the total quantity of items having and conversely not having that particular feature.

Usually there is a need to know which and how many items possess a set of features or characteristics. The method, often termed peck-a-boo, is to stack the pertinent feature cards and offer them to a light source so that items possessing all features allow the light to pass through as illustrated in the diagram. Reshuffling and subtracting cards is a way of determining which items possess only a few of the features.



CAPACITIES OF FEATURE CARDS

The number of spaces available for items varies according to the dimension of the punched hole and the size of the card.

No. of Spaces	Size of Card	Dimension of hole
1,000	11" x 6"	3/32" see Fig. 8
5,000	12" x 10"	3/32"
10,000	12" x 10"	1/12"

Interpretation and Uses of Feature Cards

ARRIVAL PATTERNS

When items are allocated numbers according to their arrival sequence, then the pattern developed by punching the feature card can be of considerable interest. The holes can show a growth in the number of items having a certain feature, and also any fluctuations.

RANDOM INDICATORS

Cards can be obtained ready punched according to random number tables, each feature card having a different frequency of occurrence. In use a random punched card is placed over a single or stack of feature cards. Moving the random punched through a square of four adjacent holes should show no significant change in the number of visible holes, if in fact the items of the feature cards occur by chance.

LOGICAL OPERATORS

It is sometimes desirable to know which items possess all the features, and those that possess some of the features.

e.g., How many employees have lost time through illness, and how many are apprentices?

The answers to both questions can be obtained simultaneously with the aid of transparent sheets of coloured plastic inserted between the feature cards in question. The feature card for 'lost time through illness' answers the first question directly. If a coloured sheet is placed behind this feature card and then the feature card for 'Apprentices' placed behind that, the light will shine through all the positions of apprentices who had lost time through illness. The plastic sheet will cause a solid colour to show through those employees' positions, other than apprentices who have lost time through illness. A series of cards and transparent sheets, commonly termed logical operators, can be used to highlight more complex situations. Opaque logical operators with pre-determined punched holes are used when only certain pieces of information need to be passed.

MEASEL CARDS

To eliminate the need to correct feature cards, where several items are temporarily changed from positive (i.e., punched) to negative, and also as a guide to the total number of items affected by this temporary situation (e.g., a group of employees working in a different department for agreed reasons and time span), it is advisable to use measel cards. These are made of transparent material and held in position over the particular feature card whilst opaque stickers are adhered to the item positions affected. The spotted transparency then becomes part of the pack.

SUB CARDS

This is a system that permits a large number of features, say 15,000 to be contained in 26 cards provided all characteristics are mutually exclusive. If 26 feature cards are viewed separately they can represent 26 features, but these cards can be stacked together. The total arrangement for four cards selected from 26 and stacked is 14,950, thus permitting the number of features to be put easily into 26 cards.

SUMMARISING

Not all organisations or systems can justify a punched card or computer system yet may need some assistance in selecting information of a diverse nature from a large volume of comprehensive data. They may well find the solution to their problem in the form of manual punched cards. The total cost of the most expensive equipment is less than one month's hire charge for a power sorted punched card system.

APPENDIX IV

CLERICAL METHODS AND OFFICE AIDS

Challenging approach

The need for a challenging approach towards the purpose of the whole, or any part, of an activity which is being investigated, and the painstaking analysis which takes place both during and after the fact-finding stage, are preliminaries to the elimination of unnecessary tasks and the reduction of necessary work to a minimum.

Work simplification

After this work of elimination has been carried out consideration should be given to the possibility of simplification of the remaining work by using alternative methods and procedures. To tackle this aspect of O and M successfully demands some practical experience of office methods and a general knowledge of the capabilities of the extensive range of machines and office aids available today. This Appendix covers some of the office aids and short cuts in clerical procedures which may be used in the streamlining of work; for this purpose, therefore, the term "office aid" is restricted to equipment of a simple character and is not concerned with the more sophisticated equipment such as accounting machines, punched card equipment or computers.

Critical examination of machine systems

The benefits of an improved service and greater efficiency are often quoted as axiomatic when new machines are introduced. It is, however, necessary to show that the advantages claimed for machines are inherent in the machine itself, and that an improved manual system could not achieve the same results at less cost. A further apparent attraction of machine methods is that additional processing can often be performed without any extra effort or cost. The prospect of something for nothing is tempting, but the snag is that the use made of the machine by-products may require staff effort which is out of proportion to the value obtained. These tests should be applied before commitment even in the case of simple devices, but a number of other factors must also be considered when substantial capital expenditure is involved and these are mentioned in the body of the main paper.

The division of clerical functions

One approach to the process of generating ideas to improve existing methods and procedures is to establish quite clearly the essential characteristic of the clerical task and to use this as an index of possible ways and means of simplification and improvement. To recognize the basic functions of a procedure is not always easy; the multiplicity of operations and the scale on which they are carried out may confuse the

issue. It sometimes helps to identify the process if one visualizes the job being done on a very small scale, say, by a one man concern. Examination may then reveal that what at first sight appeared to be a process of analysis, is, in fact, a simple resorting of data into an order different from that in which it was received, which could be achieved more economically by pre-sorting at an earlier stage and summarizing the results. A suggested broad division of clerical functions is:

- | | |
|---------------------|----------------------------|
| Reading and writing | Analysing |
| Recording | Checking |
| Copying | Filing and indexing |
| Calculating | Sorting and selecting |
| Summarizing | Handling and transporting. |

Examples of ways and means under these headings are:

Reading

- Assisted by good forms design;
- 'Blown-up' documents e.g., machine room tax tables;
- Copy holders and line indicators to assist typist or machine operators;
- Good environment conditions;
- Proof reading can be saved by copying the original.

Writing

- Forms design can save writing by using pre-printed entries;
- Use codes and symbols;
- Standard letters save drafting;
- Standard letters of a 'personal' character can be produced by auto-typing.
- Dictating machines save drafting and cost less than shorthand typing;
- Pre-cut stencils can be prepared that require little addition for completion;
- Register machines provide multiple copies on continuous stationery.

Recording

- Is the data recorded at its place of origin and could this record serve more than one purpose?

Recording (contd.)

Can the original document be used to save recording e.g., invoices in firms order may save the need for personal accounts;

Sorting the documents into order may speed recording;

Limit recording to details of exceptions from an agreed standard - introduce management by exception;

Forms design - layout can facilitate extraction or transcription of data for recording;

Addressing equipment is economic where the master is used on a number of occasions - simple spirit addressing equipment is cheap - masters can be stored with the record to which they refer.

Copying

Avoid copying by making the original serve several purposes, e.g., an application form that is serially processed can record action taken in the successive stages of the procedure.

A 'shuttle card' system can repeatedly convey information between branches without copying;

Choose the system best suited to produce the minimum number of copies needed at the cheapest cost consistent with the acceptable standard of quality:

by (i) Carbon copying (where the original is written or typed)

- (a) Carbon papers (various types);
- (b) Strip carbon backing on original;
- (c) Patch carbon on original;
- (d) No carbon required (NCR) paper;
- (e) One-time carbon, pre-inserted in made-up sets of stationery.

(ii) Reprographic equipment

- (a) Photographic processes - various;
- (b) Electrostatic process;
- (c) Duplicating equipment

Spirit duplicating;

Stencil duplicating;

Offset lithography.

Original documents as translucent forms can be used in conjunction with transparent masks to produce a variety of different forms (at different stages in the procedure) from the same original.

Use Multipart sets, where all the documents used at different stages in the procedure are raised simultaneously - omitting the uncommon information from copies by carbon patching etc., where necessary.

Calculating

Use approximations when practicable, e.g., round pound accounting.

Avoid spurious accuracy;

Save calculation when possible, e.g., maintain records of 'low value' stores in quantity only;

Use ready reckoners - proprietary or "home-made"
(tables, charts, slide rules, etc.)

Templates designed to mask unwanted figures simplify calculation.

Numerous machines for adding, subtracting, multiplying and dividing.

Summarizing

Devise documents that permit summarization without rewriting, e.g., so that forms can be overlapped and the relevant figures easily extracted.

Use summary boards (Feg Boards, Magnet Boards, Plastic Boards) to assist in the alignment of documents being summarized.

Templates can be used to mask figures not needed in the summary.

Various machines can accumulate summary totals.

Analysing

Can analysis be performed by pre-sorting of documents before posting - so that a carbon backed posting strip serves the dual purpose of analysis roll and control total slip.

Classification of items by codes, symbols etc., may speed the process of analysis.

Document layout - correct use of columns, boxes, shading.

Templates to mask unwanted data.

Checking

Evaluate checks to show cost versus savings; in general checks should not cost more than they save.

Introduce sample checks, inspections, comparisons etc., in place of 100 per cent examination.

Good Forms Design can assist e.g., by allowing figures to be compared to be placed side by side.

Check bulk calculations instead of individual calculations if compensating errors are self detecting.

Use proof sheets as carbons of original entries and compare totals with pre-lists.

Examine the possible causes of errors to eliminate or reduce the need for quality control e.g.,

Method of staff selection and quality of staff employed.

Training - introductory and continuing - departmental and local - background training and job instruction.

Staff instructions - written or unwritten - rigid or flexible.

Is there good communications within the section/branch?

Quantity checks, such as those applied to determining stock levels or reordering levels, may be achieved automatically by visual means rather than comparison of actual and control figures.

Filing and Indexing

Is the classification system adequate - does it permit files to be found by any of the staff or only the filing clerk.

Are both numerical and alphabetical indices employed - are both needed or can the files themselves serve as one index.

Do the papers need to be stored in files at all - are they sufficiently important to be retained?

SECRET
UNCLASSIFIED

Various types of indexes

- (i) Blind Index Cards - where the detail on the card is not visible without handling.
 - high density storage (about 2000 cards per tray).
 - need to extract cards if entries required.
- (ii) Cards or Sheets held in binders
 - high density storage
 - sectional breakdown of record permits a number of staff to refer to the record.
- (iii) Visible Edge Cards
 - where the cards are held in trays so that the lower edge of the card can be scanned.
 - low density storage (about 200 cards per tray).
 - permits entries without extraction.
 - need to allow space for expansion, in each tray or filing section, otherwise frequent re-shuffling of the collection may be necessary.
- (iv) Strip Index
 - strips of card, in a variety of widths, held in metal frames or mounted on sheets in binders.
 - permits use of different colours to aid analysis.

Filing and indexing (contd.)

(iv) (contd.)

Strip index

- strips easily extracted and inserted on amendment.

- photographic reproduction

- need to allow for expansion.

Card wheels

- blind index cards mounted on a wheel (various sizes) which revolves to speed access.

- manuscript entries can be made without extracting cards.

Suspended filing

- pockets of stiff card mounted in conventional filing cabinets.

- convenient for storage of loose papers when subdivision by subject, firm etc., required.

Lateral filing

- cabinets (various dimensions) with system of pockets suspended laterally.

- by increasing height of cabinets maximizes storage per square foot.

Sorting and Selecting

Can unnecessary sorting be eliminated by, say, leaving documents in receipt order and batching by date of receipt?

Use simple aids to sorting viz:

- symbols to aid recognition
- colour to distinguish similar documents
- convenient size of documents for handling
- pigeon hole racks
- tiered compartments
- flap sorters

Sorting and selecting (contd.)

Aids to selecting include:

Edged punched and body punched card systems - each card is an item record and has features or characteristics of that item recorded as punched holes in predetermined positions

- selection by needling.

Coincident hole systems - each card represents a feature and items possessing that feature are allocated a unique number which is recorded on the card by a punched hole in the position relating to that number. Selection of items possessing two or more features is by alignment of the appropriate cards.

Handling of papers

Bring cards, files, books etc., nearer to users or vice versa.

Use collators, folding, inserting, sealing, opening machines.

Pneumatic systems and mechanical transport systems.