Method Study

A MANAGEMENT GUIDE

4

NATIONAL PRODUCTIVITY COUNCIL

ABOUT NPC

The National Productivity Council is an autonomous organization registered as a Society. It is tripartite in its constitution and representatives of Government, employers, workers and various other interests participate in its working. Established in 1958, the Council conducts its activities in collaboration with institutions and organizations interested in the Productivity Drive. Besides its headquarters at New Delhi, NPC operates through eight Regional Directorates. In addition, there are 49 Local Productivity Councils.

The purpose of NPC is to stimulate productivity consciousness in the country and to provide service with a view to maximizing the utilization of available resources of men, machines, materials and power ; to wage war against waste ; and to help secure for the people of the country a better and higher standard of living. To this end, NPC collects and disseminates information about techniques and procedures of productivity. In collaboration with Local Productivity Councils and various institutions and organizations, it organizes and conducts training programmes for various levels of Management in the subjects of productivity. It has also organized an advisory service for industries to facilitate the introduction of productivity techniques.

Recognizing that for a more intensive productivity effort, the training and other activities of NPC, designed to acquaint management with productivity techniques, should be supported by demonstration of their validity and value in application, NPC offers a Productivity Survey and Implementation Service (PSIS) to industry. The demand for this service has been rapidly growing. This service is intended to assist industry adopt techniques of higher management and operational efficiency consistent with the economic and social aspirations of the community. PSIS is a highly competent consultancy service concerned with the investigation of management and operational practices and problems, and recommendation of measures of improvement and their implementation. NPC has established a special Fuel Efficiency Service. It has set up cells for servicing small scale industries. It has introduced a National Scheme of Supervisory Development under which an examination is held and certificates awarded to successful candidates. NPC also conducts a two-year practice-oriented programme for training in Industrial Engineering for first class graduates in Engineering disciplines.

NPC publications include pamphlets, manuals, and Reports of Productivity Teams. NPC utilizes audio-visual media of films, radio and exhibitions for propagating the concept and techniques of productivity. Through these media NPC seeks to carry the message of productivity and create an appropriate climate for increasing national productivity.

MANAGEMENT GUIDE

METHOD STUDY

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PREFACE

The experience of the National Productivity Council (NPC) over the last ten years has shown that development of supervisory skills contributes significantly to the productivity of an organisation. In view of the rapid industrial developments that have taken place and are expected to take place in the ensuing years, the present arrangements for the supervisory training in India are altogether inadequate. NPC has launched a nation-wide Supervisory Development Scheme through self-study and enterprise level guidance which will prepare the candidates for a professional qualifying examination leading to the award of National Certificate in Supervision.

Apart from making the necessary arrangements for holding the above examination, and providing the specialist services for supervisory training under the usual terms, NPC is also preparing a number of guides covering the main body of the syllabus to be read along with standard textbooks on the subjects. The main purpose of thes eguides is to give the supervisors and foremen a basic understanding of the topics in a simple and concise manner so as to provide the basic foundations and promote future studies. A list of such guides and other booklets which are being brought out could be seen on the last page of the cover of this publication.

This guide on Method Study has been prepared by Mr. N. V. Krishna, Regional Director, NPC, Kanpur.

The list of reference books for further studies has been given in the prospectus of the National Certificate Examination in Supervision. It must be stressed here that all these guides are not intended as a substitute for enterprise level assistance for supervisory development in the way of training, demonstrations, seminars, etc., but mainly as an aid to these. It goes without saying that these publications will not only help the candidates preparing for the National Certificate Examinations but also others who wish to have some basic understanding of the subjects. It is hoped that managers of all forward looking enterprises will make an all-out effort towards training their supervisors and skilled workers.

(G. R. DALVI)
Executive Director
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New Delhi-3.

CONTENTS

METHOD STUDY

Introduction

Method Study and Work Measurement are the two basic techniques of work study. While method study aims to improve the existing methods of operations and procedures, work measurement helps to assess the human effectiveness. Though these two are distinctly separate techniques, they are very much interdependent. The application of both these techniques in adequate proportions based on the nature and type of problems would result in maximum benefits to the organization. In this guide, however, only the topic of method study is covered.

Method study is essentially concerned with finding better ways of doing work. It is a technique of cost reduction. The philosophy of method study is that "there is always a better way" and the tools of method study are designed to systematically arrive at this "better way of doing a job." Method study can be applied to almost all types of work, whether it be a factory, clerical or any other type of activity. The scope of method study is not restricted to manufacturing industries alone, but extends to all other spheres. Methods improvement has been very successfully adopted in banks, hospitals, offices, and retailing, in addition to defence, agriculture and all types of industries. There are various techniques which are suitable for tackling method study problems on all scales and for all types of work. There is no limit to the types of work which can be profitably studied. Another important aspect of method study is that often with limited capital expenditure it would be possible to obtain considerable economies in the use of resources and achieve large monetary savings.

Method study can be defined as "the systematic analysis of existing or proposed methods and the development of improvements through critical examination." The techniques of method study aim (a) to expose and analyse all the facts concerning the situation, (b) to critically examine these facts, and (c) to develop the best methods under the circumstances.

Objectives

The objectives of method study are:

(i) improve basic processes

(ii) improve the design of plant and equipment

(iii) improve factory, office and workplace layouts and handling of materials

(iv) improve the use of material, plant, equipment and manpower

(v) improve the working procedures

(vi) improve the working environment

(vii) improve quality.

Method Study Procedure

The analysis of problems for method study consists of an ordered and a systematic procedure. This procedure involves six basic steps as follows:

SELECT	the work to be studied
RECORD	all relevant facts
EXAMINE	these facts critically
DEVELOP	the most effective, economical and practical method
INSTALL	the method as standard practice
MAINTAIN	the standard practice by regular checks.

The above procedure is a logical one and is easy to follow in any type of work. Each of the steps is equally important and clearly defined. A faithful adherence to the basic procedure would result in achieving maximum results.

Selection of the work for method study is the first step. The field of choice for method study is quite wide and every job is amenable to improvement. But the selection of the job should be based on scope and need for improvement, resulting economy, priority, objective and similar other considerations. Once the job has been selected, the next step is to record all the pertinent facts relating to the present or proposed method. There are a variety of recording techniques suitable for different types of situations. A proper recording is necessary since it forms the basis for further investigation. Critical examination is the crux of method study. All the recorded facts are subjected to a thorough examination. Nothing is taken for granted and each activity is challenged with a view to get as many alternative and improved methods as possible. All the alternative proposals thus obtained are evaluated and the most practical and economical method is developed. Considerable planning and preparation is necessary before the proposed method is installed. Full co-operation and participation from the management, supervisors and workers, is essential for the implementation of the new method. Number of difficulties may crop up when the proposed method is under operation. There is also a tendency on the people to get back to the old methods with the slightest of excuses. Proper

maintenance through routine and regular checks is an important factor in the method study procedure.

There is nothing new about method study. Man has always been on the look out for improvements which is essential for progress and success. The procedure outlined above is a systematic and an orderly approach to method study problems. It has been proved that the adoption of such a procedure ensures that no significant point has been overlooked and helps in achieving maximum possible results. Each of these basic steps have been dealt in detail in the following chapters.

SELECTION

Almost any type of work of any magnitude is capable of study and improvement. The problem could be as big as the study of an organization, its structure, objectives, policies and products or as small as a small assembly or a clerical job. The scope for improvement and potential savings, may be unlimited for some jobs and very much restricted for some other jobs. On the other hand there may be certain jobs offering intangible and indirect benefits without any direct monetary gains. Thus the field of choice for method study is very wide and if method study is to be efficient, the subject of the study should be carefully chosen. The selection should be a methodical process, rather than on an *ad hoc* basis.

In certain cases the management may be very well aware of the problems and may themselves select the specific project to be studied. But it may also happen that the management only recognises the problem in its broader perspective and may ask the work study practitioner to diagnose the specific problems and study those which are important and significant. In a situation where the real problem may be the one involving aspects of management, its policies and procedures, studying and improving small jobs do not bring about great benefits. Thus it is necessary to diagnose the problem, its causes and effects and select those which are of primary importance.

Economic considerations such as the cost of conducting a study, limitation of finance on proposed methods and the expected monetary benefits should also be the guiding factors in the selection of jobs. Human reactions play an important role in method study. Method study means a change for the better. Any change is normally resisted by people. This resistance may be from all levels right from the top. It is necessary to convince the employee and get their whole hearted co-operation if method study is to succeed. The effectiveness of method study can be proved by improving some of those jobs which are hard, unsafe, dirty or inconvenient from the point of view of employees. Jobs where the scope for improvement is obvious may not necessarily be a profitable starting point for method study. The job under study should be viewed in perspective with its related components. Thus there are a number of factors involved in selecting a problem and the considerations demanding attention may vary between different situations and organizations.

Field of Choice

As indicated earlier, since method study can be applied to almost any situation, there is a very wide and varied field for selection of method study projects.

Cost of raw materials forms a major portion of the total cost of the end product. In most of the Indian industries about 60 to 70 per cent of the total cost is taken away by materials. Hence materials area offers very good scope for method study. The following may be some of the subjects under materials:

(*i*) Quality, Quantity or cost of raw materials

(*ii*) Substitution of cheaper or better materials

(*iii*) Reduction of waste or use of waste

(*iv*) Materials Handling

(*v*) Control of Inventories

(*vi*) Marketing, Advertising or Selling etc.

Method study may pertain to plant, equipment and machinery and may include,

(*i*) design and modification of equipment

(*ii*) machine utilisation

(*iii*) maintenance of machines

(*iv*) layout of plant and machinery, etc.

Method study may be applied to the process either to eliminate, combine or simplify certain operations. Reduction of process or operational time, cutting down of delays, increased output, improved quality and similar factors may prompt method study investigation.

Apart from the above, human factors such as satisfaction, motivation, improved working conditions and safety consideration, etc., offer considerable scope for method study.

Certain factors indicating the need for method study.

The need for improvement is not always apparent. However following are some of the pointers which may indicate the areas for study:

(*i*) Operating costs—running higher than normal or gradually increasing

(*ii*) High wastage—poor use of materials, machinery, labour, space and services

(*iii*) Excessive movement and backtracking of materials and men

(*iv*) Existence of production bottlenecks

(*v*) Excessive overtime

(*vi*) Excessive rejections and reworks

(*vii*) Complaints about quality

(*viii*) Complaints from workers—poor working conditions, handling of heavy jobs etc.

(ix) Increasing number of accidents—poor safety conditions.

Objective of the Study

Before undertaking a study it is necessary to decide the objective of the study. Although the aim of any method study is to effect improvements, the specific objectives of improvements should be clarified wherever possible. The objectives may be quite obvious, as in the case of increased output or reduced costs. But there may be other less obvious objectives like improved quality, improved safety, better working condition, etc. It is also possible that the study may have more than one objective. In certain cases it may be necessary to undertake a preliminary investigation in order to clearly determine the objective and also recognise the channels of improvement. A clear understanding of the objective is necessary to determine the method of investigation, the extent of detail, techniques to be adopted, and to assess the achievement of the objective.

Terms of Reference

After deciding the objective it is necessary to ascertain the limitations and the terms of reference of the study. There may be various conditions imposed on the conduct of the study by the management, within the framework of which the investigation will have to be carried out. Some of these terms of reference may be as follows:

(i) Capital expenditure for the implementation of the new method should not exceed Rs....

(*ii*) Certain aspects of the manufacturing process should not be challenged.

(*iii*) The location of certain machinery will not be changed.

(*iv*) There should not be any labour retrenchment as a result of the study.

(*v*) The study should be completed within.....months and so on.

Preparation for Study

When the objective of the study has been defined and the terms of reference

have been drawn up, the subsequent steps like deciding the personnel for conducting the study, getting management's approval and support and getting the participation from the workers can follow.

Method study to be effective should have the full support and the active co-operation from the management, employees, trade unions and associations. Co-operation would be obtained easily if every one is kept properly informed, especially those who are likely to be affected. Before the commencement of the studies, a circular may be issued by the management to keep everyone concerned informed about the study. Such a circular may include the purpose and scope of the study, composition of the team, liaison and assistance required to be extended. This, apart from serving as an information, will also provide an authorisation for the team to obtain all necessary data and make the required investigation.

Finally it may be worthwhile to make a time schedule in order to see that the project is completed on time. Allocation of specific tasks to different members of the team and drawing up a programme of work will help in an organized conduct of the project.

RECORDING TECHNIQUES

When the job has been selected for Method Study, the next step is to collect and record all the relevant data. The facts collected about the existing method are subsequently subjected to a thorough examination with a view to evolving improved methods. Hence a clear and precise record is necessary if method study is to be effective.

The common way of recording any information is to write it down. But writing down all the details of a complicated process in an industrial situation is not an easy task. Besides, reading through this information and visualising the same, is an equally tough job. In order to avoid these difficulties, certain graphical forms of representations are adopted. The advantages of such a form of recording are (i) it helps in presenting the necessary information in a precise and clear manner and facilitates further analysis, (ii) it is easily understandable and can be clearly visualised and (iii) often presentation of the existing method or procedure, in a graphic form itself pinpoints obvious improvements.

Recording the Background Information

In order to become familiar with the job and the various inter-relationships, it would be worthwhile to collect a certain amount of background information about the situation under question. Such information may be in respect of organization structure, history of the jobs, the future trends, details with regard to the use of resources such as materials, labour, capital and equipment, etc. The type and details of background information required would depend upon the problem on hand. However such information would be useful at the analysis stage.

Process Charts

Charting is a method by which the nature and sequence of the activities involved in a process are recorded. A process chart is a pictorial representation of the activities that occur in the work method or procedure, in which suitable symbols are used to represent the various activities. The construction and interpretation of process charts are simplified by the use of these symbols, which are so designated as to be easily distinguishable and to represent standard activities in a short hand form.

Charting Symbols

All activities can be broken down into five basic types of events and each is represented by a symbol. Following are the five standard symbols used in process charting:


- OPERATION – PRODUCES OR ACCOMPLISHES


- INSPECTION – VERIFIES


- TRANSPORT – MOVES


- DELAY – DELAYS OR INTERFERS


- STORAGE – HOLDS OR KEEPS

(a) An operation—○—occurs, when there is a change in the physical or chemical characteristics of an object or material. Assembling and dis-assembling, making ready for one activity or putting away after another activity are also classified as operation. Mental activities such as giving or receiving information or calculating, etc., are included in operation.

Example: Turning a rod on a lathe, joining two components by welding posting in a ledger, a chemical reaction, dismantling of a steam pipe.

(b) An inspection—□—occurs when an object is checked for either quantity or quality.

Example: Checking by counting, dimensional check, visual inspection of welding, checking a letter.

(c) A Transport— → —occurs whenever there is any movement either by the material or the man.

Example: Movement of material on a trolly, man walking.

(d) A delay—D—occurs when conditions do not permit the performance of the next activity immediately. Various delays and interruptions are denoted by this symbol.

Example: Material waiting near a machine for an operation, an operator waiting for a tool near the tool crib.

(e A storage—▽—occurs when an object is kept and protected against unauthorised removal.

Example: Materials in store, a letter in a file.

Some Principles and Conventions

The process chart is drawn by denoting the activities by relevant symbols and placing them one below the other according to sequence. These are joined by a vertical line. A brief description of the activity is given on the right of the symbol. Any other details such as distance, time, etc., can be given on the left of the symbol.

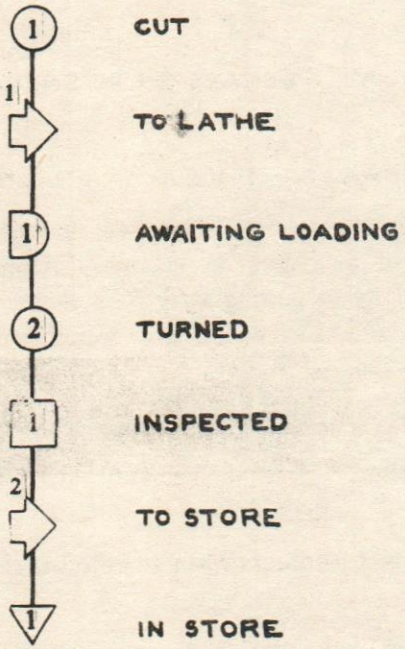


Fig. 1

Subject of the Chart

The activities of only one subject can be recorded on each chart. The subject chosen need not be a single unit and may consist of a group of parts. It is useful to select one typical member or unit of each group, which plays an active part throughout the process. The activity charted should relate to the same subject, throughout the chart. The activities of men and material should not be mixed up.

Scale of the Chart

The degree of detail charted will vary according to the requirement. Adequate amount of detail should be given without being elaborate. After depicting the broad details of the process, if necessary, particular activity can be amplified further and a detailed chart can be drawn. The consistency must be maintained with regard to the scale adopted as far as a particular chart is concerned.

Numbering the Activities

The symbols in a process chart are numbered to facilitate easy reference and comparison. The like symbols are numbered serially from beginning till end as shown in Fig. 1.

Combined Activities

Whenever two activities are performed simultaneously they can be devoted by combined symbols.

For Example 

indicates a combined inspection and operation. The more predominant activity is denoted by the outer symbol. The first number indicates the outer symbol and the second the inner symbol.

Change of State

When there is a very significant change in the subject charged during the process, it is shown as below:

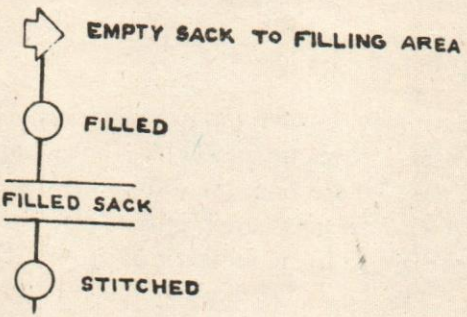


Fig. 2

Rejects and Reprocessing

When the material is rejected, it is shown by taking out an arrow at the appropriate stage. If after inspection they are to be reworked it can be shown by taking and joining an arrow suitably as shown in Figs. 3 & 4

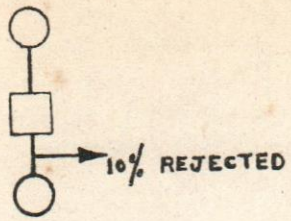


Fig. 3

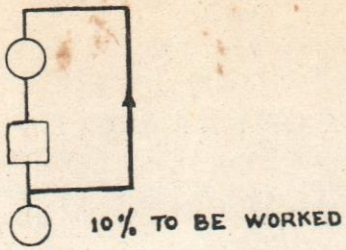


Fig. 4

Repetition

If a series of activities have to be repeated in a process they can be shown as given below:

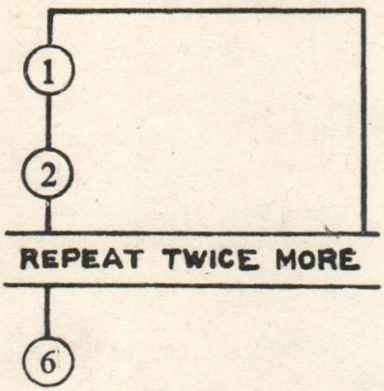


Fig. 5

Introduction of Materials

Sometimes the chart may involve various materials, components and sub-assemblies. In such cases the main subject is shown on the right extreme and the components and material are introduced from the right. The introduction of materials is shown by horizontal lines at appropriate places in the chart. Numbering also proceeds from the right to left in sequence as shown in Fig. 6.

Types of Recording Techniques

The following recording techniques are generally used .

(*a*) The operation process chart

(*b*) The flow process chart—material and man

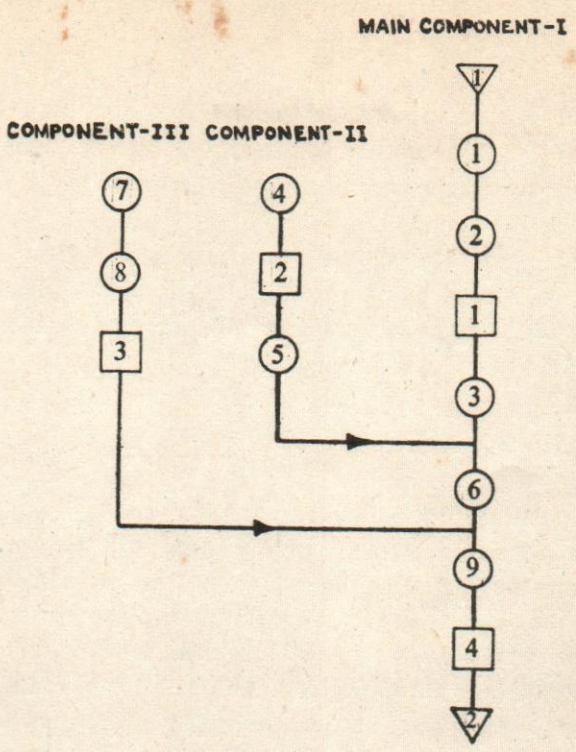


Fig. 6

(*c*) The multiple activity chart

(*d*) The two handed process chart

(*e*) The flow diagram

(*f*) The string diagram

Basic Information

In order to maintain the value of process charts and diagrams, for future reference and make them easily understandable and recognisable, the following information should be given as a heading:

(*a*) Name of the chart or diagram

(*b*) Nature of process or job being recorded

(*c*) Whether the present or proposed method is shown

(*d*) Subject being recorded

(*e*) A clear indication as to where the chart begins and where it ends

(*f*) The time and distance scales used where applicable

(g) The date of construction of the chart/diagram, reference number and name of the observer.

At the end of each chart a summary is prepared in a tabular form giving the total number of each activity, distance moved and the time taken. This also helps in comparing between the present and proposed methods.

It should be remembered that these charts and diagrams are only a means to an end. They provide a graphic picture of the facts which facilitate further analysis. Thus these recording techniques can be adopted by the individual depending upon the situation to suit the purpose.

The Operation Process Chart

At the initial stage it is valuable to get an overall view of the process. This will indicate how detailed further recording need to be. An operation process chart provides a bird's-eye-view of the whole process or activity. In an operation process chart all the operations and inspections involved are recorded. The chart does not indicate where the work takes place or who performs it. The delays, transports and storages are not indicated. An operation process chart is a graphic representation of the sequence of all operations and inspections involved in a process or procedure. The entry points of materials are also indicated.

Such a chart will serve as a starting point for the critical examination. This is a very useful chart for initial analysis. Where the process is long and complicated, this chart provides an overall picture and gives adequate information for critical examination. This chart is particularly useful for recording maintenance and other indirect work.

An example of the operation process chart is given in Fig. 7.

Sometimes at the initial stages of the study an overall view of the job under study can be obtained by recording only the key operations and inspections without going into all the operations and inspections and other activities like delays, movements and storages. Such a chart is known as an Outline Process Chart. This chart is particularly useful for large projects for getting a broad outline. Further amplification and analysis can be gone into if necessary, through an operation process chart or a flow process chart.

An example of the outline process chart of plywood manufacture is given in Fig. 8.

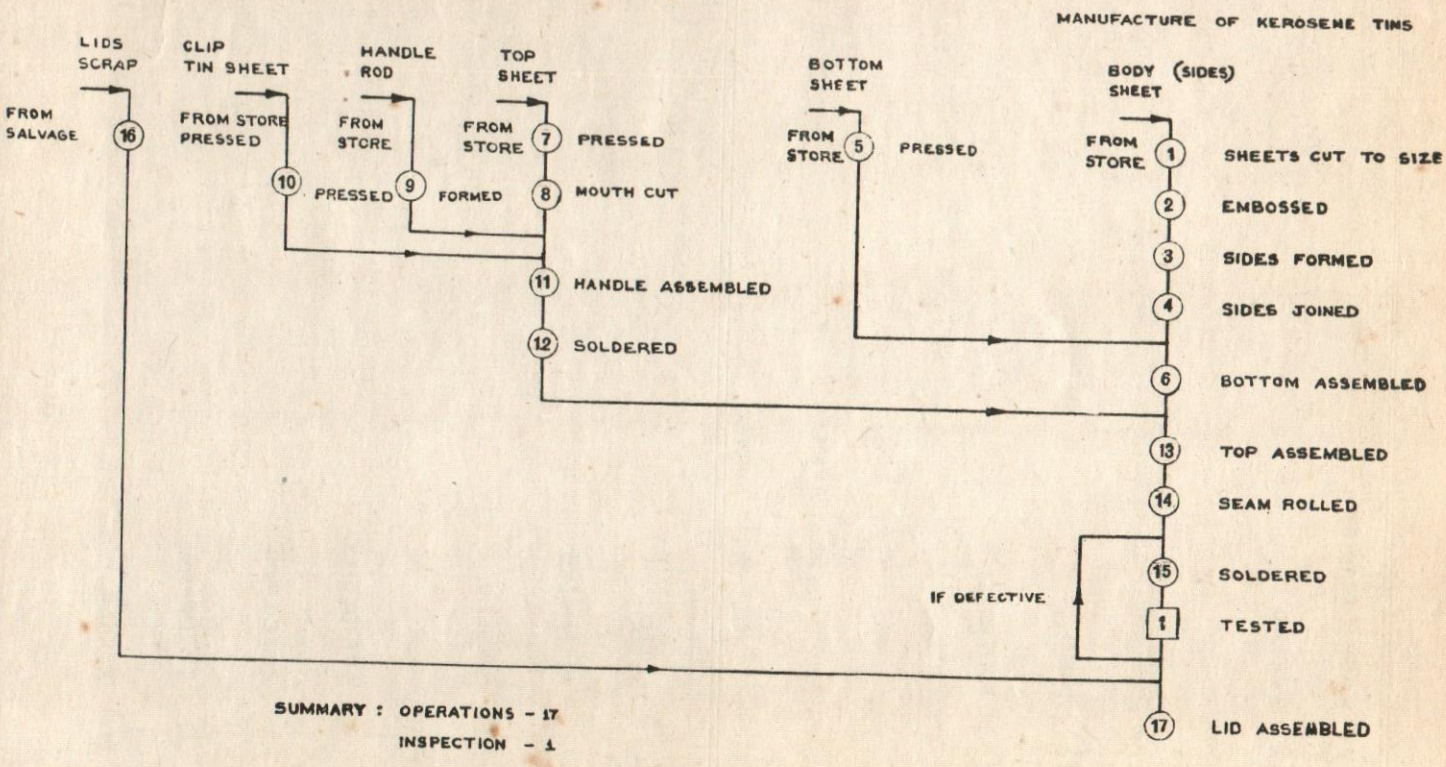

MANUFACTURE OF KEROSENE TINS
LIDS SCRAP
FROM SALVAGE
16
CLIP TIN SHEET
FROM STORE PRESSED
10
PRESSED
HANDLE ROD
FROM STORE
9
FORMED
TOP SHEET
FROM STORE
7
PRESSED
8
MOUTH CUT
11
HANDLE ASSEMBLED
12
SOLDERED
BOTTOM SHEET
FROM STORE
5
PRESSED
BODY (SIDES) SHEET
FROM STORE
1
SHEETS CUT TO SIZE
2
EMBOSSED
3
SIDES FORMED
4
SIDES JOINED
6
BOTTOM ASSEMBLED
13
TOP ASSEMBLED
14
SEAM ROLLED
15
SOLDERED
IF DEFECTIVE
1
TESTED
17
LID ASSEMBLED
SUMMARY : OPERATIONS - 17
INSPECTION - 1

Fig. 7

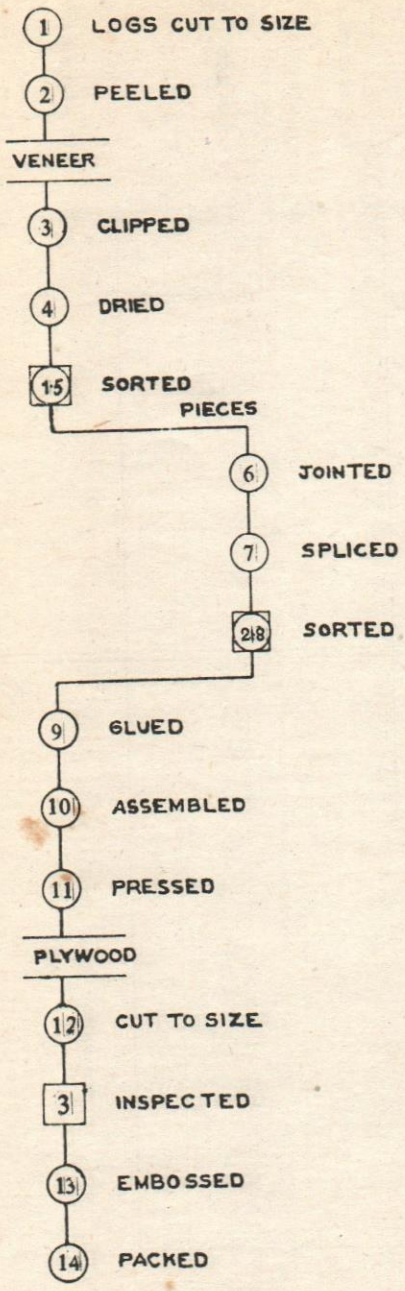

1
LOGS CUT TO SIZE
2
PEELED
VENEER
3
CLIPPED
4
DRIED
15
SORTED
PIECES
6
JOINTED
7
SPLICED
28
SORTED
9
GLUED
10
ASSEMBLED
11
PRESSED
PLYWOOD
12
CUT TO SIZE
3
INSPECTED
13
EMBOSSED
14
PACKED

Fig. 8

The Flow Process Chart (Material)

When once an overall picture of the process has been obtained, it may become necessary to go into a certain amount of detail. A flow process chart (material) is a detailed chart, indicating all the activities involved in a process.

A flow process chart (material) is a process chart setting out the sequence of the flow of a product or a procedure by recording all events under review in terms of the material being processed, using the appropriate symbols.

In a flow process chart (material), the subject of the chart is material. Since all the activities, operations, inspections, movements, delays and storages are recorded all the five symbols are used. The subject selected for recording should be one that provides continuity throughout the process. A suitable unit or a grouping of material should be selected.

A flow process chart (material) is more detailed than the operation process chart. All the factors contributing to the process must be recorded. Though the degree of detail would depend on the problem under consideration for method study, the chart should not be oversimplified.

In order to ensure that there is no confusion between material and operator while recording, the activity description given at the side of the symbol should be in passive voice. The distance and time values are also recorded whenever appropriate.

Since all the movements are recorded very clearly, the flow process chart along with the flow diagram is a very useful chart for analysing and improving layout and handling problems.

For recording and analysing a process a flow process chart (material) is a very useful chart. It gives a very clear account of events. This chart is also a useful medium for presenting new proposals to the management. Fig. 9 gives an example of the flow process chart (material).

The Flow Process Chart (Man)

There are various types of charts that are used to record the method depending on the degree of detail required. The flow process chart (man), is one of the basic charts to record the method. It is used to record the work of individual operators. It gives a graphic representation of all the activities performed by the operators in the sequence in which they occur.

A flow process chart (man) is a chart setting out the sequence of the flow of a product or a procedure by recording all events under review in terms of the worker using the appropriate process chart symbols.

The term storage ▽ is not usually applicable to an operator and hence this symbol is not used. The subject of the chart will be an operator/worker performing the job. The description of the activity is written in active voice to avoid confusion.

Flow Process Chart (Material)—Present Method

Job: Packing empty "Hair Oil" bottles in carton

Subject charted: One typical bottle

Chart Begins: Bottles on storage table

Chart Ends: Bottles in closed carton on storage bench

The above points are shown in Fig. 9.

Flow process chart (man) is a useful recording technique to chart the method of performance rather that the process. When once the process has been examined and all possible improvements have been made, further analysis and improvements in methods would be necessary. Existing methods when clearly recorded through this chart, would be helpful in developing new methods. This chart can also be used as an operating instruction for use by supervisors and workers. An example of the flow process chart (man) is shown in Fig. 10.

Flow Process Chart (Man)—Present Method

Job: Collection of materials from store

Subject charted: Machine Helper

Chart Begins: Helper awaiting for preparation of requisition

Chart Ends: Helper at the machine

The above points are shown in Fig. 10.

The Multiple Activity Chart

There will be various situations wherein the combined and inter-related efforts of a group of workers and machines would be necessary for the performance of the job. The charts described so far can be used to record only one subject in any one particular chart. Whenever a process involves the co-ordination of various activities it may be required to study the relationship between these activities. Such an inter-relationship is provided by the multiple activity chart. A multiple activity chart is used to record the activities of one subject in relation to others.

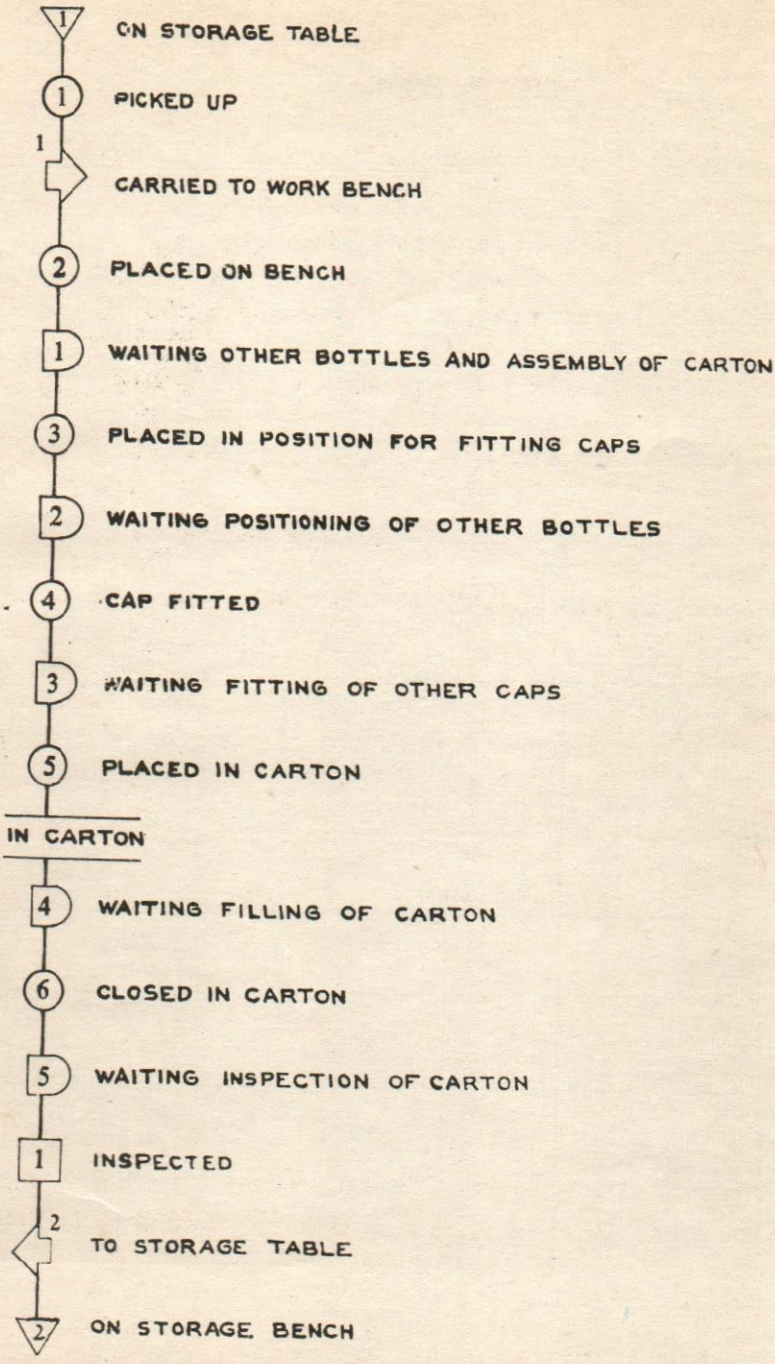
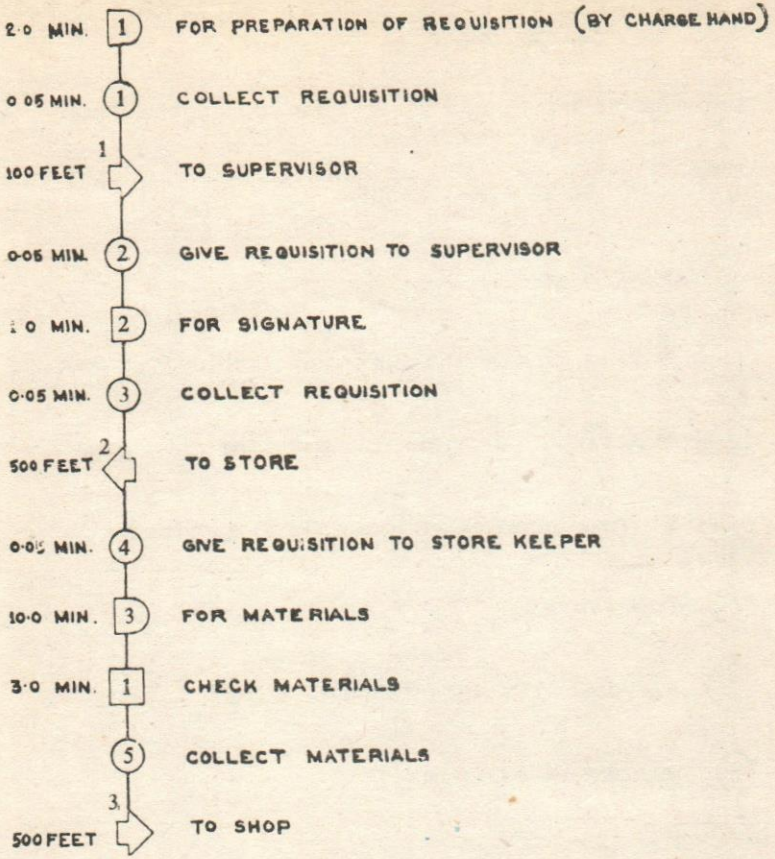

1
ON STORAGE TABLE
1
PICKED UP
1
CARRIED TO WORK BENCH
2
PLACED ON BENCH
1
WAITING OTHER BOTTLES AND ASSEMBLY OF CARTON
3
PLACED IN POSITION FOR FITTING CAPS
2
WAITING POSITIONING OF OTHER BOTTLES
4
CAP FITTED
3
WAITING FITTING OF OTHER CAPS
5
PLACED IN CARTON
IN CARTON
4
WAITING FILLING OF CARTON
6
CLOSED IN CARTON
5
WAITING INSPECTION OF CARTON
1
INSPECTED
2
TO STORAGE TABLE
2
ON STORAGE BENCH

Fig. 9



SUMMARY

	NO	TIME (M.T.S)	DISTANCE (FEET)
○	5	4·0	-
□	1	3·0	-
⇨	3	-	1100
D	3	13·0	-

Fig. 10

A multiple activity chart is a form of process chart recording the related sequence of work of a number of operators and/or machines on a common time scale.

Separate vertical bars are attached to each worker and/or machine to be charted. A time scale is entered along side in a convenient place, usually on the left hand side. The activities are then plotted in sequence against the time scale within their own particular bar in the chart. A brief description of the activities are also given along side. In getting the time for activities very fine accuracy may not be needed. But it may become necessary sometimes to obtain the time values by one of the work measurement techniques. The contract between working and non-working is brought out by suitable hatching of the respective boxes. A summary showing the times and percentage use of all the subjects is made at the end of the chart. Similar summary for the proposed method provides a comparison.

Multiple activity chart brings out the comparative utilisation of men and machine very clearly and helps to synchronise the various activities and improve the situation. It is a useful tool for planning team work and determining the staffing pattern.

When the activities of the machine or machines are recorded in relation to that of the operater, the chart is sometimes called as the man machine chart. This is only a special variant of the multiple activity chart.

Figure 11 gives the multiple activity chart of one operator operating two machine .

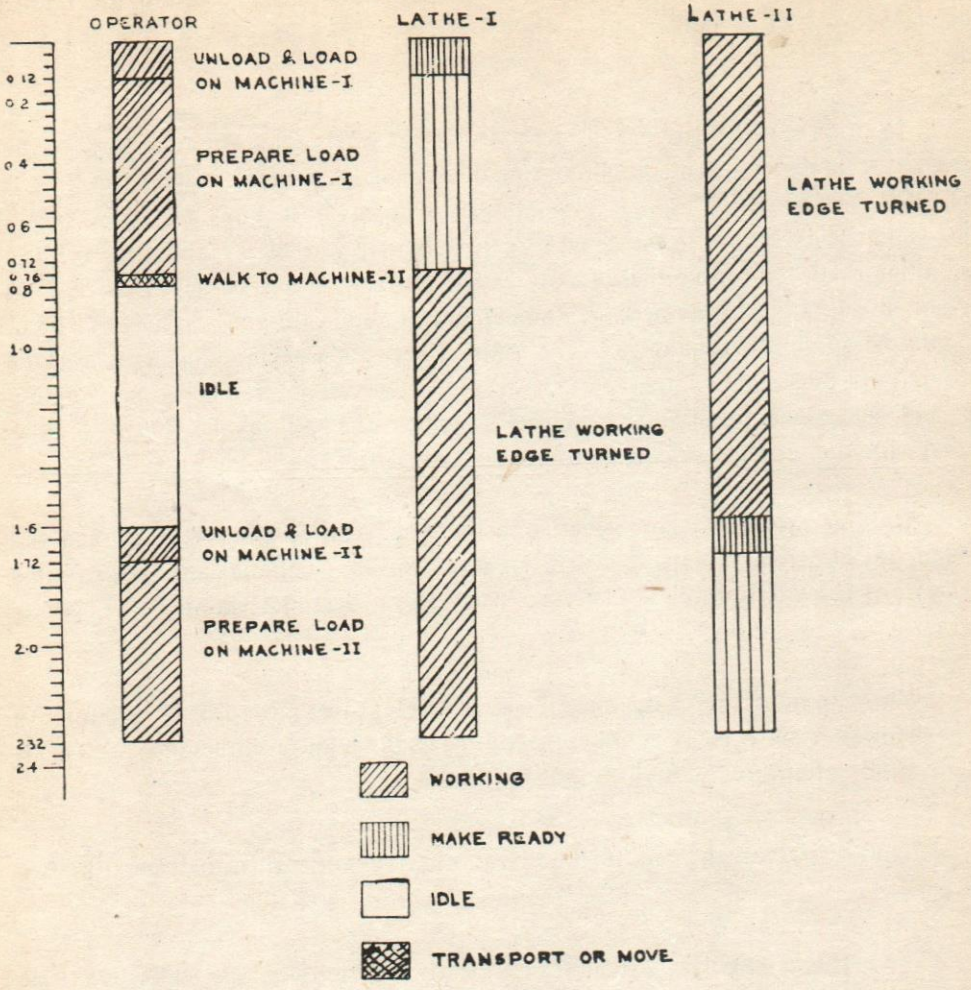
The multiple activity chart shows up clearly the periods of ineffective time and by rearrangement of work it becomes possible to eliminate or reduce the ineffective time. This chart is useful for maintenance work in order to reduce the down time of equipment. It also helps to determine the number of workers for a group job and the number of machines that can be looked after by an operator. This chart is useful to analyse and obtain optimum utilisation of men and machines.

Job: Turn Edge—present Method

Subject of Chart: Operator, Lathe I, Lathe II

Chart Begins: Operator near Machine I—unloading & loading

Chart Ends: Operator near Machine II



SUMMARY

	OPERATOR	TIME (MINUTES)	
		MACHINE I	MACHINE II
WORKING	1·40	2·32	2·32
UNOCCUPIED	0·84	-	-

Fig. 11

The Two-Handed Process Chart

Jobs that are completed at a single work place often consists of a series of activities of the worker's two hands and occasionally the other parts of the body.

The two-handed process chart records the sequence of manual activities in such jobs in a graphical manner.

The two-handed process chart is a process chart recording the work of the operators hands (limbs) in relationships to one another.

A two-handed process chart is made up of two columns in which the activities of the left hand and right hand and the appropriate symbols are respectively recorded in sequence. The activities of the two hands are inter-related by aligning the symbols on the chart so that simultaneous movements by both hands appear opposite each other. Additional columns can be designed to record the activities of the other parts of the body whenever necessary.

The two-handed process chart generally employs the same symbols as the other process charts. In practice only four of the five symbols are used to any extent. "Inspection" is rarely used since "inspections" are a combination of hand movements and operations. Where the inspection is literally a matter of touch or feel this symbol can be used. The storage symbol implies "hold" instead of storage. The transport symbol represents movements of hands, the operation symbol, pick up, positioning, etc., and the delay symbol denotes the waiting of one hand for the completion of work by the other. There is no time scale on this chart and the exact duration of various activities is usually unknown.

Before embarking on a detailed study of this nature it is advisable to first justify activities by recording and examining them on a broad scale.

This chart is usually applicable only to the individual workplace and after the broad methods have been decided and thus most suitable at the later stages of methods improvement.

Work of a fairly short duration is suitable for recording on this type of chart.

Example: Two-handed Process Chart

Job: Assembling washer and nut to bolt

Chart begins: Hands empty, material in bins

Chart ends: Completed assembly aside to bin

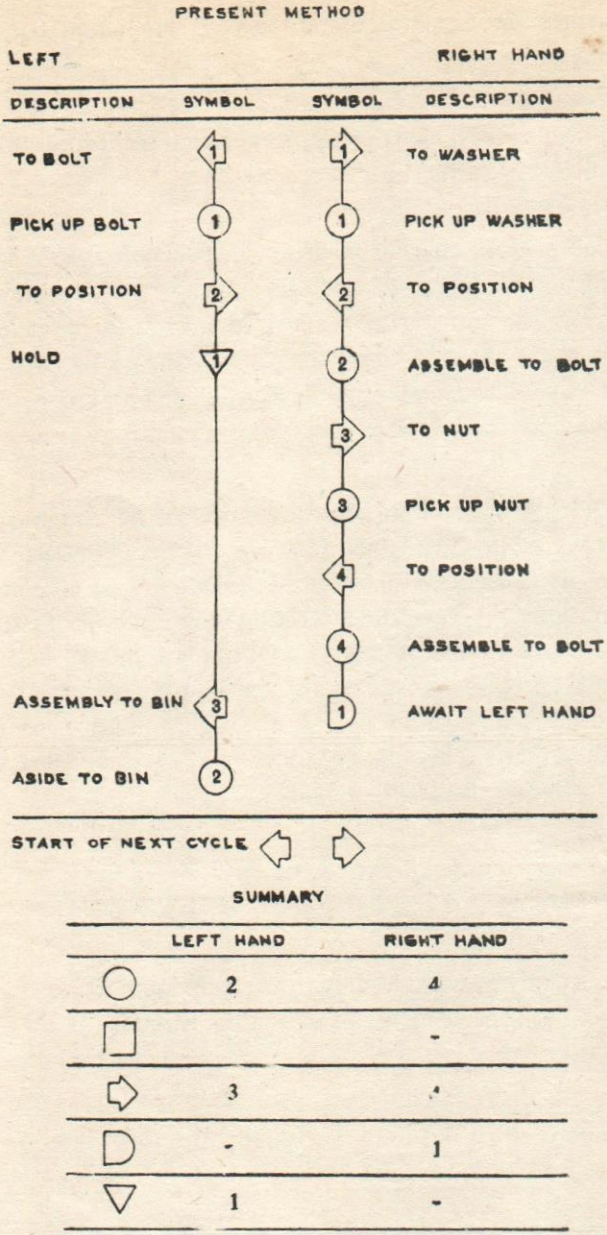


Fig. 12

The Simultaneous Motion Cycle Chart (Simo Chart)

The Simo Chart is a refinement over the two-handed process chart. In the Simo chart the activities of the two hands (or other parts of the workers body) in

relation to each other, during an operation are recorded against a time scale. The activities recorded are in terms of "Therbligs"; which are vary fine basic human motions. Such a chart can be prepared only with the help of photographic aids, involving expensive equipment. Short cycle and highly repetitive jobs are suited for this type of recording. By an analysis it will be possible to identify and remove the idleness and increase the utilisation of both the hands.

An investigation in this detail would be worthwhile only if the expected savings from the improved method justifies the cost of such detailed analysis.

Flow Diagram and String Diagram

The Process Charts show mainly the sequence and nature of activities, the information given regarding the movements involved is very little. The pattern of movements may have features like back-tracking, congestion, long distances, etc. To record these features the flow and string diagrams are used.

The Flow Diagram

A flow diagram is a drawing or a model substantially to scale, which shows the location of the various activities carried out and the routes followed by workers, materials or equipment in their execution.

The various activities on the diagram are identified by their numbered symbols from the corresponding flow process chart either man or material. The routes followed are shown by joining the symbols in sequence by a line.

A flow diagram showing the movement of a paper in an office is given in Fig. 13. The corresponding FPC is partly shown in Fig. 14.

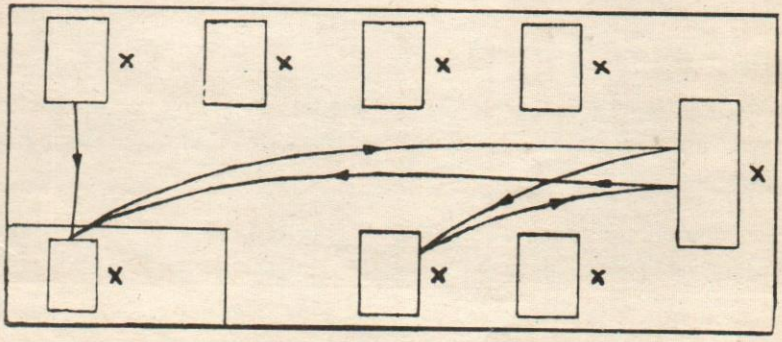


Fig. 13

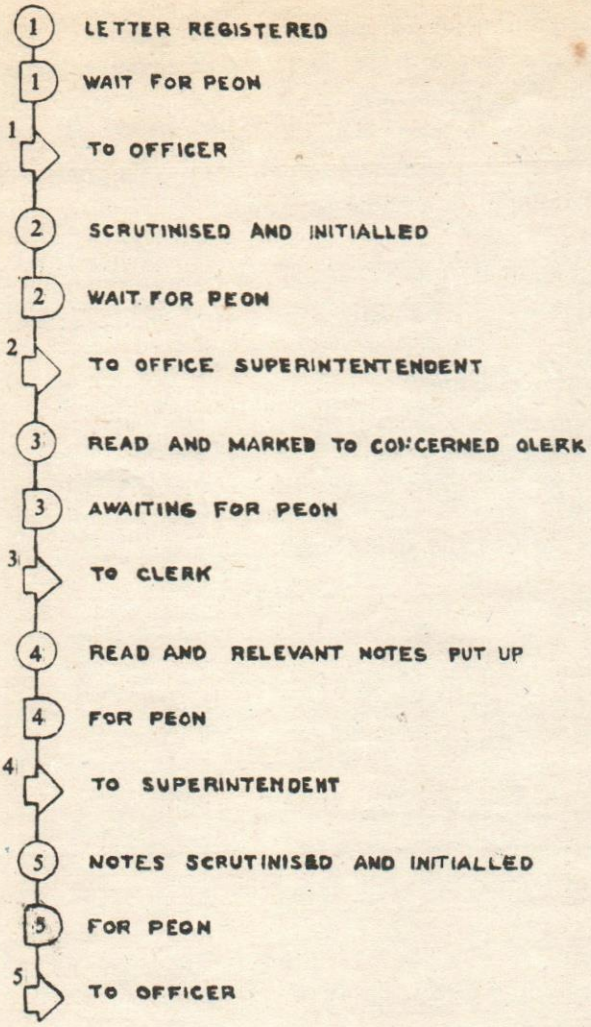


Fig. 14

The String Diagram

The string diagram is a scale plan or model on which a thread is used to trace and measure the path of workers, materials or equipment during a specified sequence of events.

When there is too much of movement involved then a flow diagram may become incomprehensible. In such cases string diagram is used.

The scale layout is fixed to a board and pins are driven into the board to mark the location of various activities and also at points where the direction of move

changes. A thread is then wound round the pins following the various activities in sequence. The distance covered can be calculated oy measuring the length of the thread used.

These diagrams are particularly useful when considering problems of plant layout and design. Proposed improvements can be effectively demonstrated both to manangement and workers.

Features like back-tracking, excessive movement and congestion are clearly shown and helps to take steps to improve the situation.

String diagrams are particularly useful to study the movement of workers in circumstances like, one man tending several machines, processes involving movement of the worker from one place to another, etc.

Figure 15 represents a string diagram of a bearer serving refreshments in a canteen.

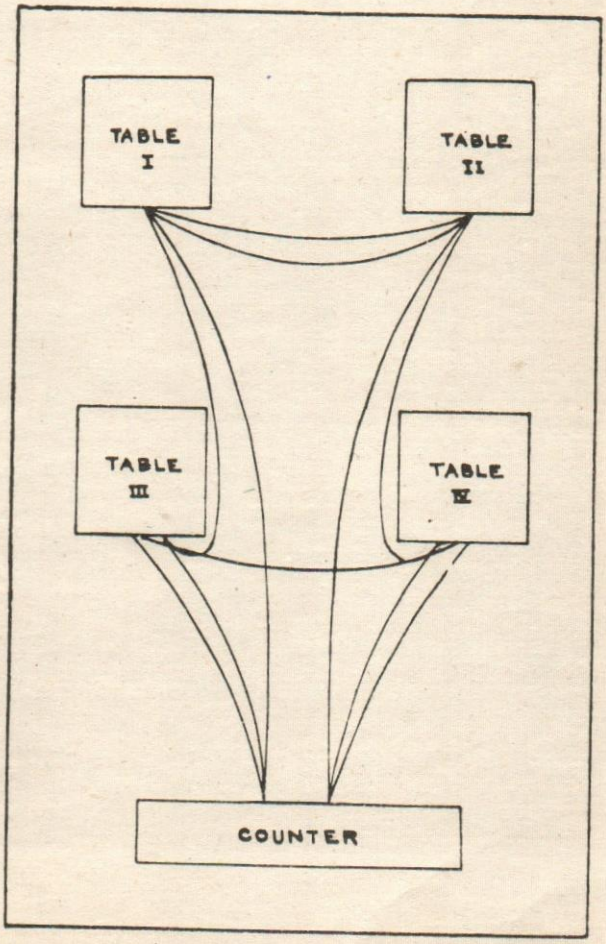


Fig. 15

Photographic Aids

Still and cine photography is employed to record and analyse the operations and procedures. There are different types of analysis such as memo-motion and micro-motion studies, cyclegraphs and chrono-cyclegraphs. All these are very expensive methods involving special photographic equipment. Photographic aids for analysis will be useful for detailed investigation of very short duration, highly repetitive and high speed operations.

CRITICAL EXAMINATION

When the details of the existing method has been recorded through a suitable process chart, the next step in the method study procedure is to examine all the facts. Critical Examination of the recorded data is the crux of method study. It is at this stage that the possible alternatives for each activity are evolved for later development. Each activity is questioned and challenged thoroughly with a view to improving the situation. Critical Examination consists of a well designed questioning pattern in an impartial and objective manner.

Recording—A Prerequisite for Examination

The facts of the method study problem under consideration recorded in the form of a process chart forms the basis for critical examination. Process chart to be used depends on the type of problem being examined. In many cases it may be useful to draw an outline process chart which will give the summary of the whole situation and may form the basis for critical examination without further recording. In case, any more details are required, then the operations and inspections recorded in the outline process chart which are complex can still be amplified and these are then made the subject of further charts. A first order outline process chart depicting the prior and after activities of the situation under review, will help to get a proper perspective of the various processes involved and their relation to each other. In many cases a critical examination of the connected activities will give a lead to the solution of the problem under consideration. Sometimes stepping outside the terms of reference and questioning the activity of the department or organization itself might bring about fruitful results. To illustrate: suppose the problems for method study is the grinding operation of milling cutters in a factory manufacturing various types of tool cutters. And to start with, if the total activity of the department, i.e., ○ milling cutters produced, is subjected to critical examination, it might reveal certain information which may be of immense value to the management, though the investigation called for is only on a small portion of this process. Exam nation of the operation under review may then follow.

Classification of Activities

Before starting the examination it is necessary to decide which activity should be examined first. It is found that maximum improvements are obtained by examin-

ing the operations and inspections first. Any change effected in the operations and inspections will either automatically eliminate the connected transports, storages and delays or modify them. Even among the operations certain priorities can be fixed up for examination in their order of importance. For this purpose operations may be classified into:

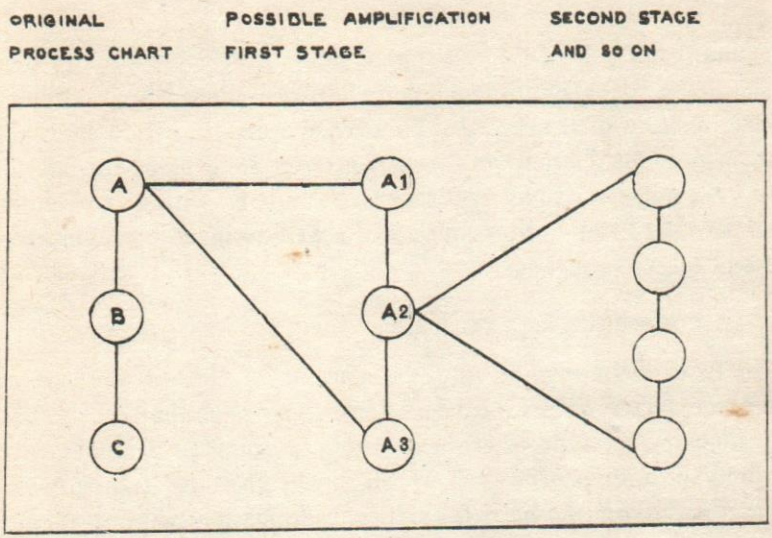


Fig. 16

(i) Key Operations: which represent actual performance of work on the material or machine and may involve change in physical or chemical characteristics of the material.

(ii) Make Ready Operations: which are concerned with preparation of material or equipment and keep them ready for next activity.

(iii) Put Away Operations: which are concerned with the clearing up or disposal after the operation or inspection.

In a turning operation on a lathe, the actual turning operation will be the "key operation", loading will be a "make ready" and unloading will be a "put away" operation.

What the key operation is, depends very much on the subject of the study. A key operation may on amplification divide itself into several "keys". Similarly a make ready or a put away operation may be sub-divided again into make ready, key and put away operations. Inspections are always treated as key operations.

Key operations provide the maximum scope for improvement. All the key operations are examined first before proceeding with the examination of other activities. When any of the key operations are eliminated or modified, the connected make ready and put away operations automatically get eliminated or changed. After examining the key operation, the remaining make ready and put away operations and the transports, delays and storages may be examined.

Examination Approach

The success of any method study depends on the thoroughness with which the Work Study man conducts the critical examination and his ability to dig out information and elicit answers to all questions from appropriate sources. No information is to be overlooked as unimportant till he is satisfied that it is so. While answering the questions true reasons must be unearthed. Often it happens that the answers to the same question obtained from different sources vary in their context. Answers should be accepted only when they are proved to be correct. The facts should be examined with an unbiased and impartial mind. It will always be better to start the examination with a blank but open mind devoid of any preconceived ideas, as they tend to influence the investigation. Bright ideas and hunches which start troubling the Work Study man when he is halfway through the critical examination should be jotted down as and when they occur and should be reserved for consideration to the appropriate place in the investigation lest the examiner should be influenced by them and may be led to answer questions in such a way as to fit in with these ideas and hunches. Evaluation and development of new methods should start only after a systematic examination of the existing method.

Procedure

The essence of critical examination technique lies in that all the details of every activity is examined in isolation with others to establish the facts of the present method and the reasoning behind them. All the possible alternatives are then recorded and among these the most effective one is selected. The questions are so designed, that the answers to the first set of questions give an indication of the facts and the reasons behind them and the answers to the second set suggests all possible alternatives and the means of improvements. The questions challenge the purpose, place, sequence, person and means and thus make the examination exhaustive, and the method study effective.

One of the essential qualities that a Work Study man should possess is the challenging or the questioning attitude. While doing a method study he does question the activities but most of the time mentally and not in any ordered sequence, and hence the chances of some details being overlooked are more. The strongest feature

of the critical examination technique is the systematic and thorough approach given and in addition the pointers provided for each question which if followed properly, leaves no activity of the process unchallenged and also makes the examination simple and quick and at the same time making the methods improvement effective. A guide to the use of Critical Examination Sheet is given at page 32(a).

The answer to the question 'What is achieved?' should be simple and specific and should clearly indicate the achievement of the particular operation rather than the means, which is answered by How is it achieved? While answering the question Why ? the true reasons must be found out by consultation with the persons connected. And thus it becomes necessary that everyone in the organization should co-operate and much depends on the approach of the Work Study man and his knack to elicit information.

The answer to the question 'What else could be achieved?' is never blank, since the answers to this question bring out the different alternatives and suggest means of improvement, this should be carefully answered. In order to get as many alternatives as possible certain pointers are given such as (1) Non-achievement or Don't achieve (2) Avoid the need for the achievement (3) Modify (more or less) (4) Invert (5) Compromise. All these should be answered. Some of the answers might be meaningless in particular situations. But it is worthwhile to note down all the answers and while recording the implications of each of these, those that are not relevant may be discarded. The alternatives particularly suited are divided into long term and short term and are recorded in order of preference in the What should be ? column.

The question 'How is it achieved?' is answered under four main titles: (1) Materials employed (2) Equipment employed (3) Operators' method, posture and environment (4) Operating conditions including safety precautions. Reasons for each item are investigated and all conceivable alternatives for each are considered. The best suited alternative for each is selected in isolation and then combined with others to produce the best, safest and cheapest method.

Most of the major improvements are obtained by answering the questions, What and How? The remaining three questions, When, Where and Who? are fairly simple to answer. Sequence and frequency are the two items .o be considered while answering When? The detailed position and the distances from previous and subsequent activities are required for Where ? The question Who achieves it ? is answered by recording the (a) Number of Operators, (b) Grade, (c) Employment Status, (d) Designation or Name, (e) Wage Scale and Incentive Scheme if appropriate. All possible alternatives for each of the above are considered.

While answering these questions the imagination should be allowed to run wild not minding the cost, time, practicability or any other factor. Ideas, which appear ludicrous and silly should also be given a serious thought as these may in turn emerge other ideas. It is in evolving these ideas that the skill and mental ability of a Work Study man are put to test. The best alternative is chosen after a careful consideration of economics and feasibility of all the alternatives listed. The sequence to be followed in asking these questions may vary according to the situation examined. But invariably the purpose is the first to be considered and thereafter, means, sequence, place and person may follow.

The first attractive solution that comes up should not be accepted without going into the details of all the other practical solutions. The improvements that could be effected with no capital expenditure are considered carefully and compared with other expensive methods. The return on capital expenditure could be used as a convenient criterion for comparison of alternative methods. Though the terms of reference limit the scope of suggestions, those falling outside the terms may also be recommended if they are valuable for future consideration by management. In certain cases it may be worthwhile to get the terms of reference suitably changed if necessary, by consultation with the management, in order to widen the scope for improvements.

Maximum benefit is obtained by eliminating the activity altogether. But this is not possible always in which case modification or combination of the activities or simplification of the means of performance should be resorted to.

It is found by experience that the critical examination to be effective, two persons should work together at least while tackling the secondary questions, since this reinforces the chances of getting as many ideas as possible. Use of critical examination sheets to record the answers will be extremely helpful to ensure that no aspect of the problem is forgotten or overlooked and will also serve as a record for future reference.

The technique of critical examination on the above lines envisages a thorough questioning on all the aspects of each activity and helps to evolve different alternatives out of which effective lines of improvements could be decided and an improved method could be developed.

DEVELOPING THE IMPROVED METHOD

Various alternatives would have been evolved for each activity during the examination stage and depending on the implications, some of the alternatives would be chosen for development. Under each governing considerations like purpose, means, sequence, place and person there may be any number of suitable alternatives generated. In developing the new method the economics and productivity of these suggestions when the job is viewed as a whole must be determined. The activities are examined in isolation at the critical examination stage; during development the alternatives thus obtained are considered in relation to each other and a complete new method is evolved. However if development takes place as the examination proceeds, it would simplify the procedure of development. Certain key operations and inspections in the existing method which are found to be essential may form the framework around which the improved method could be built up. Sometimes work measurement may be necessary to choose between alternative methods or to determine the manpower allocation.

Invariably the 'purpose' is the first governing factor of an activity that is examined. Various alternatives are generated when the question "How else could it be achieved" is answered. Each of these alternatives is evaluated for its advantages and disadvantages and an order of merit is prepared. The next governing factor for examination may be 'means'. The alternatives generated under 'means' would be in the context of the best alternative under purpose. If this is found to be not feasible the next best alternative as per the preference, is selected and so on. This procedure is continued till all the governing factors have been covered.

Each of the developed methods would have to be again evaluated and the best chosen for implementation. In determining the best method, economic considerations such as, cost of implementation and expected savings, feasibility, acceptance and reaction of employees would all have to be taken into account.

It will also be worthwhile to classify each alternative into short-term and long-term, so that depending upon the resultant benefits, the management can decide whether to accept, for example, a short-term plan with less capital expenditure and a small saving or a long-term plan with comparatively high expenditure and a larger saving.

A short term proposal is one which takes a reasonably short period, about two to three months, for implementation. A long-term alternative may take a much longer time which may be due to certain reasons such as the need for research and development, customer education, change in management policy, or modification of governmental regulation.

It is necessary to seek advice and help from everyone concerned during the development of new methods. They may provide useful information and also the acceptance and implementation of the new method becomes a very much easier task.

It may sometimes be necessary to try out these new methods in order to determine the practicability and to assess potential savings from the new method.

PLANT LAYOUT AND MATERIALS HANDLING

Plant Layout and Materials Handling offer very good scope for improvements and cost reduction. While developing improved methods it is necessary to give a careful consideration to the layout and handling aspects. A poor layout involving excessive movement of materials and men and improper utilisation of space can considerably increase the manufacturing costs besides being unsafe.

Some of the advantages of an improved layout and a handling system are:

(*a*) Increased production

(*b*) Savings in time and cost

(*c*) Reduced materials inventory

(*d*) Economy in space

(*e*) Better working conditions, increased safety and greater job satisfaction

(*f*) Improvement in quality and reduced damages to materials

Plant layout and materials handling are very much linked together. A good layout takes all the aspects of materials movement and *vice versa*.

Some of the aspects of plant layout and materials handling with particular reference to an industry are briefly discussed in this chapter.

Plant Layout

Plant layout can be considered as the physical arrangement of industrial facilities. These facilities include (*a*) buildings, (*b*) equipment, (*c*) workplaces, (*d*) storage points, (*e*) offices, and (*f*) employee facilities.

The fundamental objectives of a good layout are that—

(*i*) it should integrate all the factors affecting a layout and should be a best compromise

(*ii*) it should involve minimum movement of materials

(*iii*) there should be a continuous flow of work

(*iv*) the space should be effectively utilised

(*v*) it should ensure satisfaction and safety for employees

(*vi*) it should be flexible to accommodate changes.

There are basically three types of layouts—

(*i*) Fixed position layout

(*ii*) Process layout

(*iii*) Product layout

Fixed Position Layout

A fixed position layout is one where the material or major component remains in a fixed place. All tools, machinery men and other pieces of materials are brought to it and the product is built up into its final shape at the same location. Manufacture of a ship, construction of a building are some of the examples.

Such a layout would be adoptable when the material forming or treating involves only hand tools and small machines or when only a few pieces are made or moving the major component or material is expensive.

Process Layout

In a process layout all machines or processes of the same type are grouped together.

The advantages of a process layout are (*i*) better machine utilization, (*ii*) adoptable to a variety of products and frequent changes in sequence of operations and (*iii*) easier to maintain continuity of production in cases of machine breakdowns and absenteeism.

The disadvantages of a process layout are (*i*) involves more materials handling, (*ii*) occupies more floor space and (*iii*) higher in-process inventory.

A process layout can be used in those situations where the machinery is highly expensive, a variety of products are made, or intermittent or small demand for the product.

Product Layout

In a product layout the arrangement of machinery is according to the sequence of operations of the product. Advantages of such a layout are (i) less material handling, (ii) less in-process inventories and (iii) reduced congestion and less floor space is occupied.

Manufacturing costs are low at high volume of production but the costs

will be very high at lower volumes of production. The capital investment on machines may be quite high and all operational times need to be balanced. A breakdown on any one machine in the line may hold up the complete production time.

A product layout will be economical when the volume of production is large, when the product design is standardised and when the demand is fairly steady.

Most of the layouts in practice are a combination of the above. It may be worthwhile to have a product type of layout for some of the components and others may have a process layout depending on the various factors as discussed above.

Materials Handling

Materials handling may be broadly defined as the movement of materials from one place to another. It may be picking up or putting down, moving horizontally or vertically or in any inclined plane of materials, of any kind in their raw semi-finished or finished state.

Objective

Materials handling often does not add anything to the value of the product but only increases the cost. Handling costs constitute a substantial portion of the total cost of production. Besides materials handling is also found to be responsible for a large percentage of product damage, 80 to 90 per cent of industrial accidents and other disadvantages. In spite of this, materials handling is an essential feature of industrial activity. Materials have to be moved from one place to another without which all the activities would come to a standstill. Materials handling often accounts for improved utilization of men and machines, and provides for specialisation of skills and the related advantages.

Since materials handling cannot be eliminated completely in any organization, the objective of materials handling may be stated as instituting an 'efficient' system of handling eliminating unnecessary and wasteful handling. An efficient materials handling system saves money and time, reduces damage to materials and makes the work safer.

Some Principles

Some of the major principles in the design of an efficient system of materials handling are:

(*a*) *Reduce handling to a minimum*

As far as possible materials should always move towards completion, over the shortest distance without back-tracking. Often materials

move back and forth over large distances unnecessarily. A large amount of handling can be eliminated by planning the location of operations so that one operation finishes right where the next begins. The flow of product should receive top priority in planning of layout.

(*b*) *Avoid re-handling*

It may not be possible to eliminate rehandling completely. Nevertheless rehandling is a wasteful and costly operation. Rehandling can be reduced by (*i*) not keeping anything on floor, (*ii*) avoiding transfers from floor to container or *vice versa* or from container to container and (*iii*) avoiding mixing of materials.

(*c*) *Combine handling with other operations*

Many times handling may be made a productive activity by combining with other operations, such as production, inspection and storage. In process industries, materials undergo physical and chemical changes while in movement, handling devices may be used as live storages or materials may be sorted and inspected while they are being handled.

(*d*) *Ensure safety in handling*

Safety is a key word in handling. A large percentage of industrial accidents are attributed to poor handling practices. Even more costlier in terms of money is the damage to equipment and products due to improper handling methods. A good handling system should ensure safety to workers and materials. Manual handling of heavy objects, materials scattered on floor or projecting into aisles are but a few causes of accidents. Keeping gangways and aisles clear is one of the primary precautions against accidents in handling.

(*e*) *Handle materials in unit loads*

It is easier and quicker to move a number of materials at a unit rather than piece by piece. Modern material handling devices are designed to take advantage of unutilised loads.

(*f*) *Use gravity where possible and mechanical means if necessary*

The simplest and cheapest way to handle materials is by using gravity. Often chutes and inclined boards can be conveniently used to transport materials quickly to the point of use without much investment on costly handling equipment. Where it is not possible to use gravity for various practical reasons, some mechanical means should be considered.

Lifting and carrying of heavy materials mechanically saves time and reduces fatigue of workers.

(*g*) *Select proper handling equipment*

There are as many types of handling equipment available today as the number of materials to be handled. And any single equipment may not solve all handling problems. It is, therefore, necessary to choose the equipment suitable for the job under consideration. The equipment selection needs to be done carefully so that there is an efficient co-ordination of all handling, resulting in overall economy. Use of standardized equipment facilitates maintenance and repair.

Another important factor in the selection of equipment is flexibility. Industrial activity is subject to constant change and handling equipment should provide for this change. In other words the equipment selected should be capable of a variety of uses and applications.

(*h*) *Reduce terminal time of equipment*

The advantage of mechanical and power equipment would be lost if they are made to wait during loading and unloading which may take considerable amount of time. By reducing this waiting time the handing equipment could be released for more productive work. There are various mechanical devices like trailers, tipping arrangements, cranes and hoist attachments, to quicken loading and unloading operations.

(*i*) *Buy equipment for overall savings*

In selecting equipment savings in overall handling cost must be the guiding principle rather than the first costs of equipment. Arriving at handling costs is a difficult problem but a fairly accurate estimate can be obtained by determining the handling elements and applying work measurement.

In India labour is still comparatively less costly and a longer period may have to be allowed for amortizing the handling equipment. All direct and indirect savings are to be taken into consideration while deciding on handling equipment.

(*j*) *Use labour consistent with handling methods*

Manual handling could be done by unskilled labour, whereas mechanical handling may require semi-skilled or skilled workers. Proper allocation of skills helps in overall economy. As far as possible direct production operators should not be used for handling operations. It is preferable

to have a separate gang of material handlers to ensure proper utilization of production workers.

(*k*) *Train workers and maintain equipment*

Careful operation and proper upkeep are essential for getting the maximum out of the handling equipment. Careful selection and training of employees in principles, operation and safety rules and planned maintenance of equipment are worthwhile investments in the long run.

PRINCIPLES OF MOTION ECONOMY & WORKPLACE LAYOUT

There are a set of principles developed in order to achieve economy in movements and reduction in fatigue on the part of the operator. These are known as the "principles of motion economy". These principles are particularly applicable and useful for developing improved methods at the workplace. An understanding of these principles helps in the design of equipment jigs, tools and fixtures, layout of workplaces and development of better methods and form a basis for improving the utilization and reducing the fatigue

Classification of Movements

The movements of the human body have been classified under five groups, based on the pivots under which the body members move.

Class	*Pivot*	*Body members moved*
1	Knuckle	Finger
2	Wrist	Hand and Fingers
3	Elbow	Forearm, Hand and Fingers
4	Shoulder	Upper arm, Forearm, Hand and Fingers
5	Trunk	Torso, Upper arm, Forearm, Hand and Fingers

The lowest classification of movement results in maximum economy and least fatigue. Thus the workplace layout should, as far as possible, be arranged in such a way that the movements involved conform to lower classifications.

The principles of motion economy may be classified under three headings.

(*i*) Use of the human body
(*ii*) Arrangement of the workplace
(*iii*) Design of tools and equipment

Use of the Human Body

1. The two hands should begin as well as complete their motions at the same time.
2. The two hands should not be idle at the same time except during rest periods.

3. Motions of the arms should be made in opposite and symmetrical directions, and should be made simultaneously.

4. Hand motions should be confined to the lowest classification with which it is possible to perform the work satisfactorily.

5. Momentum should be employed to assist the worker wherever possible, and it should be reduced to a minimum if it must be overcome by muscular effort.

6 Smooth continuous motions of the hands are preferable to zig zag motions or straightline motions involving sudden and sharp changes in direction.

7 Ballistic movements are faster, easier, and more accurate than restricted (fixation) or 'controlled' movements.

8. Rhythm is essential to the smooth and automatic performance of an operation and the work should be arranged to permit easy and natural rhythm wherever possible.

Arrangement of the Workplace

9. There should be a definite and fixed place for all tools and materials.
10. Tools, materials, and controls should be located close in and directly in front of the operator.
11. Gravity feed bins and containers should be used to deliver material close to the point of use.
12. "Drop deliveries" should be used wherever possible.
13. Materials and tools should be located to permit the best sequence of motions.
14. Provisions should be made for adequate conditions for seeing. Good illumination is the first requirement for satisfactory visual perception.
15. The height of the work place and the chair should preferably be arranged so that alternate sitting and standing at work are easily possible.
16. A chair of the type and height to permit good posture should be provided for every worker.

Design of Tools and Equipment

17. The hands should be relieved of all work that can be done more advantageously by a jig, fixture, or a foot-operated device.

18. Two or more tools should be combined wherever possible.
19. Tools and material should be pre-positioned wherever possible.
20. Where each finger performs some specific movement, such as in typewriting, the load should be distributed in accordance with the inherent capacities of the fingers.
21. Handles such as those used on cranks and large screw drivers should be designed to permit as much of the surface of the hand to come in contact with the handle as possible. This is particulary true when considerable force is exerted in using the handle. For light assembly work the screw driver handle should be so shaped that it is smaller at the bottom than at the top.
22. Levers, cross-bars, and hand wheels should be located in such positions that the operator can manipulate them with the least change in body position and with the greatest mechanical advantage.

Working Areas

The working areas of an operator can be classified into normal and maximum working areas. The normal working area is the area covered by an arc made by the fingers with the elbow as the pivot. The maximum working area is the semi-circular area covered by the hand when it is fully stretched with shoulder as the pivot. Anything beyond the maximum working area will involve the class 5 movement, i.e., movement of the trunk. There is a normal and a maximum working area for each of the two hands. Figure 17 shows the working areas for the two hands. The immediate area right in front of the operator is the most accessible involving least movements. A knowledge of these working areas will be helpful in arranging the workplace.

Workplace Layout and Design of Tools

Some of the basic principles in the arrangement of workplace and the design of tools, jigs and fixtures from the point of view of motion economy, have been given in a concise form in the I.L.O. publication, *Introduction to Work Study*. They are reproduced below:

NOTES ON WORKPLACE LAYOUT

A few general notes on laying out the workplace may be useful.

1. If similar work is being done by each hand there should be a supply of the same materials or parts for each hand.
2. If the eyes are used to select material the latter should be kept as far as possible in an area where the eyes can locate them without turning the head.

3. The nature and the shape of the material influence its position in the layout.

4. Hand tools should be picked up with the least possible disturbance to the rhythm and symmetry of movements. As far as possible the operator should be able to pick up or put down a tool as the hand moves from one part of the work to the next, without making a special journey. Natural movements are curved, not straight; tools should be placed on the arc of movements, but clear of the path of movement of any material which has to be slid along the surface of the bench.

5. Tools should be easy to pick up and replace; as far as possible they should have an automatic return, or the location of the next piece of material to be moved should allow the tool to be returned as the hand travels to pick it up.

6. Finished work should be —

   (*a*) dropped down a hole or a chute;

   (*b*) dropped through a chute when the hand is starting the first motion of the next cycle;

   (*c*) put in a container placed so that hand movements are kept to a minimum;

   (*d*) if the operation is an intermediate one, the finished work should be placed in a container in such a way that the next operator can pick it up easily.

7. Always look into the possibility of using pedals for operating locking or indexing devices on fixtures or devices for disposing of finished work.

NOTES ON THE DESIGN OF JIGS, TOOLS AND FIXTURES

(*a*) Clamps should be as simple to operate as possible and should not have to be screwed unless this is essential for accuracy of positioning. If two clamps are required they should be designed for use by the right and left hands at the same time.

(*b*) The design of the jig should be such that both hands can load parts into it with a minimum of obstruction. There should be no obstruction between the point of entry and the point from which the material is obtained.

(*c*) The action of unclamping a jig should at the same time eject the part, so that additional movements are not required to take the part out of the jig.

(*d*) Where possible on small assembly work fixtures for a part which does not allow of two-handed working should be made to take two parts, with sufficient space between them to allow both hands to work easily.

(*e*) In some cases jigs are made to take several small parts. This may save loading time if several parts can be clamped in position as quickly as one.

(*f*) The work-study man should not ignore machine jigs and fixtures such as milling jigs. A great deal of time and power is often wasted on milling machines owing to the fact that parts are milled one at a time when it may be quite feasible to mill two or more at once.

(*g*) If spring-loaded disappearing pins are used to position components, attention should be given to their strength of construction. Unless the design is robust such devices tend to function well for a while but then have to be repaired or redesigned.

(*h*) In introducing a component into a jig it is important to ensure that the operator should be able to see what he is doing at all stages; this should be checked before any design is accepted. The figures given on the next page are also taken from the same I.L.O. publication.

NORMAL AND MAXIMUM WORKING AREAS

DIAGRAM - a NORMAL WORKING AREA
FINGER, WRIST AND ELBOW MOVEMENTS

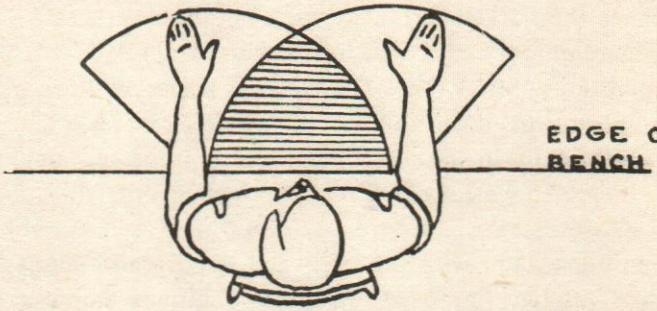


DIAGRAM - b MAXIMUM WORKING AREA
SHOULDER MOVEMENTS

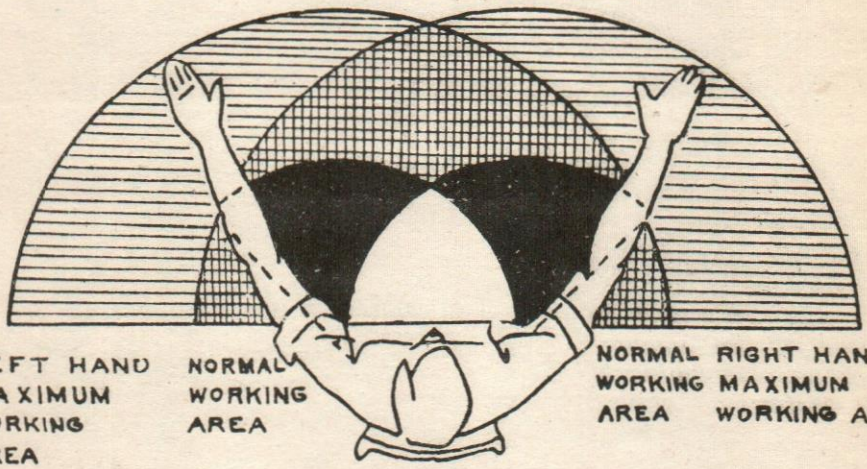


Fig. 17

WORKING CONDITIONS

While developing improved methods, one of the important factors that needs careful consideration is the human factor. It is necessary to ensure that the conditions under which the work is performed are comfortable and safe to the employees. In fact often higher output and cost reduction can be achieved by merely improving the working conditions. Many times this aspect is neglected. Poor working conditions besides being injurious to the health of the workers, increase the personal time of workers and may result in wastage of material and loss in output. The benefits resulting from improved working enviroment are often intangible and indirect. Many times methods improvement studies are carried out with the main objective of improving the job conditions. Improving the safety and reduction of accidents are very much a part of method study. Improved working conditions improve the morale and encourage the workers to give their best. Following are some of the considerations that should be borne in mind:

(*i*) Lighting
(*ii*) Ventilation
(*iii*) Humidity and temperature
(*iv*) Cleanliness and housekeeping
(*v*) Colour
(*vi*) Noise
(*vii*) Seating
(*viii*) Hazards and safety
(*ix*) Amenities such as toilets, canteens, medical facilities, etc.

INSTALLATION AND MAINTENANCE

When the improved method has been developed with the help of all the people concerned, managers, supervisors and the workers, the proposals must be submitted to the higher management for their approval.

A report is prepared giving in detail the proposed method, and expected benefits from the new method. The report should clearly show the anticipated savings and the cost of installing and operating the new method. This information provides a clear picture to the higher management to evaluate the proposals. After the report has been submitted through proper channels and discussed alterations if any are noted on the agréed method is recorded.

Before the new method is introduced it is desirable to prepare a 'written standard practice' also known as an 'operating instruction sheet'. In these sheets, the description of the improved method, tools and equipment to be used, operating conditions, workplace layouts are all given and issued to all concerned. This way everyone will know their responsibilities for the new method.

Installing the New Method

Installation will require the active support of all concerned and it is by no means a simple job. Adequate preparation is necessary before the changes can be introduced. Throughout the course of the study, the opportunity should have been taken to establish good working relationships at all levels to gain acceptance of the change by management, supervision and workers and to create a sense of participation from all regarding the changes. The work of installation is necessarily a co-operative affair.

The installation can be made in two stages: (1) Preparation and (2) Installation.

Preparation may include various stages like (1) Planning — drawing up of a general programme for installation; (2) Arrangements — the necessary detailed arrangements regarding materials, tools, equipment, selection and training of workers etc; (3) Rehearsal — the new method may be given a trial run.

When all detailed preparations have been made and a successful rehearsal has been held, the actual installation can take place.

Maintaining the New Method

It is important that once a method is installed it should be maintained in its specified form. It is necessary to review the practice regularly and in case there are any changes, reasons for these changes must be investigated and if the reasons are valid, these changes can be accepted and the operating instructions can be amended accordingly. But if there are any undesirable changes, then measures should be taken through proper channels to revert back to the authorised procedure.

HUMAN FACTOR IN METHOD STUDY

Method Study means a change for the better. Whenever there is a change from the usual and normal way of things, people resent and resist. The resistance to change exists at all levels in the organization, but the degree of resistance may vary between individuals. No one likes his job to be studied by an outsider. The man on the job naturally thinks that he knows his job best, and that he is performing the job in the most efficient manner. All these and many other factors are responsible for the antagonism and the resistance towards method study. But method study if properly applied, with the participation of all the people concerned this resistance is likely to be considerably less. Method study should be a continuous process integrated into the normal process of management. Everyone should be in a position to appreciate and adopt method study as a normal routine. In many concerns there is an attempt to orient the thinking of all the employees towards method study so that there is better acceptance.

Method Study and Management

Method study can succeed only if it has the full support of the management at all levels especially the top. Unless the top management recognises the need for method study and extends its full backing it is difficult to expect the same at the lower levels. It is necessary that the top executive realises the full implications of method study and has a strong conviction that it is an effective service to management. This can be achieved through appreciation seminars and conferences, publication of case studies and literature. When once the top and the senior management is oriented it will easily flow through the lower levels.

Method Study and the Worker

It is the worker who is ultimately affected in one way or the other as a result of method study. His job may get changed, and the procedure may change or the job may demand a lower skill after method study. Besides the resistance to change, the workers may have certain fears like the fear of unemployment as a result of method study. Many workers feel that they would be made to work harder. It would be necessary to allay these fears. The trade union representatives should be briefed properly, about the objectives and advantages of method study. The workers representatives are often trained in method study to make them more receptive to

new ideas and to bring home to them that the application of method study gives rise to higher employment potential in the long run and the worker will be working only smarter and more effectively and not harder. The representatives in turn should be made to explain to all the workers so that the working class accepts method study and realises its value for their well being. Application of method study to areas, such as materials, plant, equipment, etc. bring much larger results than labour in the present context in our country. Undue concentration on labour aspects are not likely to find favour with trade unions and workers. Many times workers having worked on the job for several years will have some bright ideas. They would be happy to disclose them if somebody cares to consult them. Even otherwise consulting a worker does no harm but brings many advantages.

Method Study and the Supervisor

The role of Supervisor in method study is very important. His position is in between the management and the worker. Supervisor is the man who directly deals with the worker and has the maximum contact with them. His help would be necessary in getting information, in trying out alternative methods, implementation and maintenance of the new method, training of the workers and many other things. Supervisor is in a position who can make or break method study in his section. Unless he is fully convinced about the utility of method study to improve the performance of his section there is every possibility that he will resent it. On the other hand a full acquainted Supervisor can be of very great help. Supervisors should be exposed to method study through training programmes and seminars. Their willing co-operation is essential for the success of method study.

Thus it will be seen that method study should have the full support and co-operation of one and all from top management to the lowest worker. Before the application of method study, conditions conducive for improvements and the necessary climate should be created. Method study becomes a very much easier task when the labour-management relations are good and everyone is prepared to accept method study as a way of life.

QUESTIONS

1. What is Method Study? What are the types of jobs in which Method Study can be applied?

2. What are the objectives of Method Study?

3. Enunciate the basic steps involved in Method Study.

4. Explain how Method Study is useful in the following situations:
   (*a*) A foundry having a high percentage of rejections
   (*b*) A chemical factory with a high incidence of accidents
   (*c*) Frequent breakdown of machines
   (*d*) Considerable wastage of material.

5. Under the present conditions obtaining in India, which are the most worthwhile areas for Method Study.

6. How will you determine the areas that need Method Study application in an Industry?

7. Give two examples of Method Study application involving predominantly the human factor.

8. Indicate the following activities with appropriate symbols:
   (*a*) *Writing* a letter
   (*b*) *Grading* of coffee seeds into different varieties
   (*c*) *Comparing* a typed letter with the manuscript
   (*d*) A letter in out-tray awaiting despatch
   (*e*) *Cooling* of water in a tank
   (*f*) *Making* a keyway on a shaft
   (*g*) Worker *going* to the tool crib for tools
   (*h*) Coal *stacked* in the coal yard for consumption

(*i*) Automobile engines being *lifted* and *carried* to the assembly shop by a folk lift truck

(*j*) *Burning* of tiles in a kiln and subsequent *cooling* before they can be taken out of the kiln

9. What is the difference between an operation process chart and an outline process chart?

10. What are the uses of Flow Process Chart?

11. Draw an FPC (man) for the typist and FPC (material) for the contents of the letter for the following job —

> Typist called by the Superintendent, Superintendent dictates one letter, typist types and checks, Superintendent signs the letter, typist types address on the envelope, puts the letter in the envelope, seals and puts it in out-tray.

12. How does the multiple activity chart help to reduce the idle time of men and machines?

13. "Critical Examination is the crux of Method Study". Explain how and indicate the procedure of examination.

14. "Material Handling does not add anything to the value of the product, it only increases the cost of the product." Explain.

15. What are the advantages of a good layout?

16. What is the difference between product and process layout? How can they be combined to get particular benefits?

17. Explain how Flow Process Charts and Flow Diagrams help in improving a layout.

18. What are the factors indicating the need for improving the layout and handling in an industry.

19. How can rhythm be developed in the work cycle?

20. Give one example each for the following:

(*a*) Opposite and symmetrical movement of hands

(*b*) Use of momentum by the workers hands

(*c*) Combination of two or more tools

(*d*) Smooth continuous motions of the hands

21. Differentiate between normal and working areas. Explain how they are related to the arrangement of workplace.

22. What are the points to be considered while designing a jig or a fixture, from the point of view of motion economy.

23. How will you overcome "the resistance to change" from the workers in a Method Study project.

24. Explain the role of a Supervisor in Methods Improvement studies.

SUGGESTED READING

1. Introduction to Work Study — International Labour Office
2. Workstudy by R.M. Currie — British Institute of Management
3. A Manual of Method Study by Krish Pennathur — National Productivity Council New Delhi
4. Time and Motion Study by R.M. Barnes — John Wiley & Sons, Inc. (U.S.A.) Chapman & Hall Ltd. (U.K.)

ADDRESSES OF NPC HEADQUARTERS AND REGIONAL DIRECTORATES

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National Productivity Council
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