7

WORK STUDY (TIME AND MOTION STUDY)

CHAPTER OUTLINE

7.1 INTRODUCTION

Productivity has now become an everyday watch word. It is crucial to the welfare of industrial firm as well as for the economic progress of the country. High productivity refers to doing the work in a shortest possible time with least expenditure on inputs without sacrificing quality and with minimum wastage of resources.

Work-study forms the basis for work system design. The purpose of work design is to identify the most effective means of achieving necessary functions. This work-study aims at improving the existing and proposed ways of doing work and establishing standard times for work performance. Work-study is encompassed by two techniques, *i.e.*, method study and work measurement.

"*Method study is the systematic recording and critical examination of existing and proposed ways of doing work, as a means of developing and applying easier and more effective methods and reducing costs*."

"*Work measurement is the application or techniques designed to establish the time for a qualified worker to carry out a specified job at a defined level or performance.*"

There is a close link between method study and work measurement. Method study is concerned with the reduction of the work content and establishing the one best way of doing the job whereas work measurement is concerned with investigation and reduction of any ineffective time associated with the job and establishing time standards for an operation carried out as per the standard method.

7.2 PRODUCTIVITY

Productivity is the quantitative relation between what we produce and we use as a resource to produce them, *i.e.*, arithmetic ratio of amount produced (output) to the amount of resources (input). Productivity can be expressed as:

$$\text{Productivity} = \frac{\text{Output}}{\text{Input}}$$

Productivity refers to the efficiency of the production system. It is the concept that guides the management of production system. It is an indicator to how well the factors of production (land, capital, labour and energy) are utilised.

European Productivity Agency (EPA) has defined productivity as,

"Productivity is an attitude of mind. It is the mentality of progress, of the constant improvements of that which exists. It is the certainty of being able to do better today than yesterday and continuously. It is the constant adaptation of economic and social life to changing conditions. It is the continual effort to apply new techniques and methods. It is the faith in progress."

A major problem with productivity is that it means many things to many people. Economists determine it from Gross National Product (GNP), managers view it as cost cutting and speed up, engineers think of it in terms of more output per hour. But generally accepted meaning is that it is the relationship between goods and services produced and the resources employed in their production.

7.2.1 Factors Influencing Productivity

Factors influencing productivity can be classified broadly into two categories: (A) controllable (or internal) factors and (B) un-controllable (or external) factors.

(A) Controllable (or Internal) Factors

1. **Product factor:** In terms of productivity means the extent to which the product meets output requirements product is judged by its usefulness. The cost benefit factor of a product can be enhanced by increasing the benefit at the same cost or by reducing cost for the same benefit.

2. **Plant and equipment:** These play a prominent role in enhancing the productivity. The increased availability of the plant through proper maintenance and reduction of idle time increases the productivity. Productivity can be increased by paying proper attention to utilisation, age, modernisation, cost, investments etc.

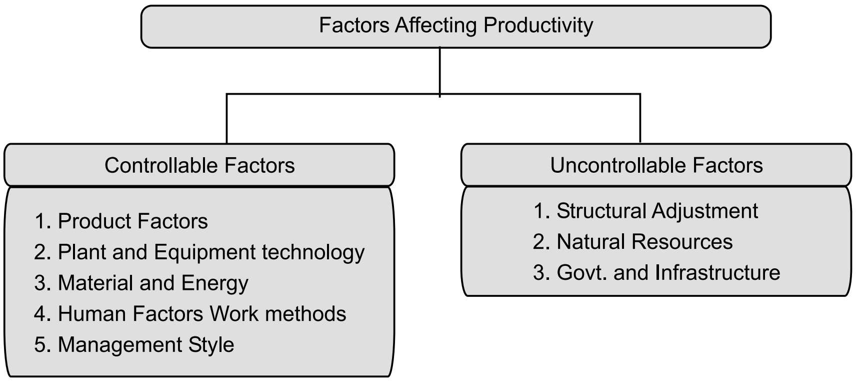


Fig. 7.1 *Factors influencing productivity*

3. **Technology:** Innovative and latest technology improves productivity to a greater extent. Automation and information technology helps to achieve improvements in material handling, storage, communication system and quality control. The various aspects of technology factors to be considered are:

(*i*) Size and capacity of the plant,
(*ii*) Timely supply and quality of inputs,
(*iii*) Production planning and control,
(*iv*) Repairs and maintenance,
(*v*) Waste reduction, and
(*vi*) Efficient material handling system.

4. **Material and energy:** Efforts to reduce materials and energy consumption brings about considerable improvement in productivity.

1. Selection of quality material and right material.
2. Control of wastage and scrap.
3. Effective stock control.
4. Development of sources of supply.
5. Optimum energy utilisation and energy savings.

5. **Human factors:** Productivity is basically dependent upon human competence and skill. Ability to work effectively is governed by various factors such as education, training, experience aptitude etc., of the employees. Motivation of employees will influence productivity.

6. **Work methods:** Improving the ways in which the work is done (methods) improves productivity, work study and industrial engineering techniques and training are the areas which improve the work methods, which in term enhances the productivity.

7. **Management style:** This influence the organizational design, communication in organization, policy and procedures. A flexible and dynamic management style is a better approach to achieve higher productivity.

(B) UN-CONTROLLABLE (OR EXTERNAL) FACTORS

1. **Structural adjustments:** Structural adjustments include both economic and social changes. Economic changes that influence significantly are:

(*a*) Shift in employment from agriculture to manufacturing industry,

(*b*) Import of technology, and

(*c*) Industrial competitiveness.

Social changes such as women's participation in the labour force, education, cultural values, attitudes are some of the factors that play a significant role in the improvement of productivity.

2. **Natural resources:** Manpower, land and raw materials are vital to the productivity improvement.

3. **Government and infrastructure:** Government policies and programmes are significant to productivity practices of government agencies, transport and communication power, fiscal policies (interest rates, taxes) influence productivity to the greater extent.

7.2.2 Total Productivity Measure (TPM)

It is based on all the inputs. The model can be applied to any manufacturing organization or service company.

$$\text{Total productivity} = \frac{\text{Total tangible output}}{\text{Total trangible input}}$$

Total tangible output = Value of finished goods produced + Value of partial units produced + Dividents from securities + Interest + Other income

Total tangible input = Value of (human + material + capital + energy + other inputs) used. The word tangible here refers to measurable.

The output of the firm as well as the inputs must be expressed in a common measurement unit. The best way is to express them in rupee value.

7.2.3 Partial Productivity Measures (PPM)

Depending upon the individual input partial productivity measures are expressed as:

$$\text{Partial productivity} = \frac{\text{Total output}}{\text{Individual input}}$$

1. $$\text{Labour productivity} = \frac{\text{Total output}}{\text{Labour input}}$$

Labour input is measured in terms of man-hours

2. $$\text{Capital productivity} = \frac{\text{Total output}}{\text{Capital input}}$$

3. $$\text{Material productivity} = \frac{\text{Total output}}{\text{Material input}}$$

4. $$\text{Energy productivity} = \frac{\text{Total output}}{\text{Energy input}}$$

One of the major disadvantage of partial productivity measures is that there is an over emphasis on one input factor to the extent that other input are underestimated or even ignored.

7.2.4 Productivity Improvement Techniques

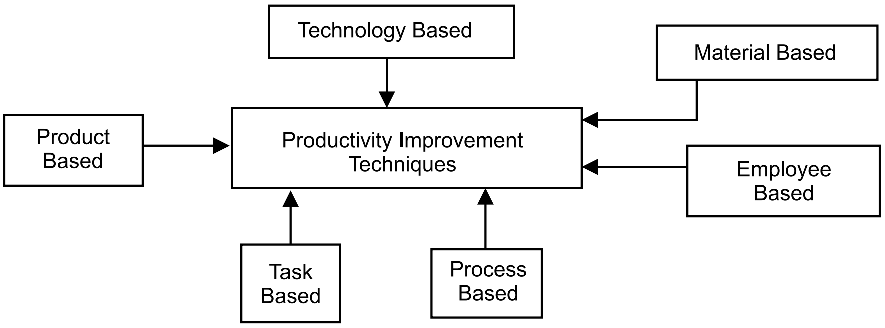
(A) TECHNOLOGY BASED

1. **Computer Aided Design (CAD)**, **Computer Aided Manufacturing (CAM), and Computer Integrated Manufacturing Systems (CIMS):** CAD refers to design of products, processes or systems with the help of computers. The impact of CAD on human productivity is significant for the advantages of CAD are:

(*a*) Speed of evaluation of alternative designs,

(*b*) Minimisation of risk of functioning, and

(*c*) Error reduction.



CAM is very much useful to design and control the manufacturing. It helps to achieve the effectiveness in production system by line balancing.

(*a*) Production Planning and Control

(*b*) Capacity Requirements Planning (CRP), Manufacturing Resources Planning (MRP II) and Materials Requirement Planning (MRP)

(*c*) Automated Inspection.

2. **Computer integrated manufacturing:** Computer integrated manufacturing is characterised by automatic line balancing, machine loading (scheduling and sequencing), automatic inventory control and inspection.

1. Robotics
2. Laser technology
3. Modern maintenance techniques
4. Energy technology
5. Flexible Manufacturing System (FMS)

(B) EMPLOYEE BASED

1. Financial and non-financial incentives at individual and group level.
2. Employee promotion.
3. Job design, job enlargement, job enrichment and job rotation.

4. Worker participation in decision-making
5. Quality Circles (QC), Small Group Activities (SGA)
6. Personal development.

(C) MATERAL BASED

1. Material planning and control
2. Purchasing, logistics
3. Material storage and retrieval
4. Source selection and procurement of quality material
5. Waste elimination.

(D) PROCESS BASED

1. Methods engineering and work simplification
2. Job design evaluation, job safety
3. Human factors engineering.

(E) PRODUCT BASED

1. Value analysis and value enginering
2. Product diversification
3. Standardisation and simplification
4. Reliability engineering
5. Product mix and promotion.

(F) TASK BASED

1. Management style
2. Communication in the organisation
3. Work culture
4. Motivation
5. Promotion group activity.

ILLUSTRATION 1: *A company produces 160 kg of plastic moulded parts of acceptable quality by consuming 200 kg of raw materials for a particular period. For the next period, the output is doubled (320 kg) by consuming 420 kg of raw material and for a third period, the output is increased to 400 kg by consuming 400 kg of raw materal.*

SOLUTION: During the first year, production is 160 kg

$$\text{Productivity} = \frac{\text{Output}}{\text{Input}} = \frac{160}{200} = 0.8 \text{ or } 80\%$$

For the second year, production is increased by 100%

$$\text{Productivity} = \frac{\text{Output}}{\text{Input}} = \frac{320}{420} = 0.76 \text{ or } 76\% \downarrow$$

For the third period, production is increased by 150%

$$\text{Productivity} = \frac{\text{Output}}{\text{Input}} = \frac{400}{400} = 1.0, \textit{ i.e.}, 100\% \uparrow$$

From the above illustration it is clear that, for second period, though production has doubled, productivity has decreased from 80% to 76% for period third, production is increased by 150% and correspondingly productivity increased from 80% to 100%.

ILLUSTRATION 2 : *The following information regarding the output produced and inputs consumed for a particular time period for a particular company is given below:*

Output	–	*Rs. 10,000*
Human input	–	*Rs. 3,000*
Material input	–	*Rs. 2,000*
Capital input	–	*Rs. 3,000*
Energy input	–	*Rs. 1,000*
Other misc. input	–	*Rs. 500*

The values are in terms of base year rupee value. Compute various productivity indices.

SOLUTION:

Partial productivity

1. Labour productivity = $\dfrac{\text{Output}}{\text{Human input}} = \dfrac{10{,}000}{3{,}000} = 3.33$

2. Capital productivity = $\dfrac{\text{Output}}{\text{Capital input}} = \dfrac{10{,}000}{3{,}000} = 3.33$

3. Material productivity = $\dfrac{\text{Output}}{\text{Material input}} = \dfrac{10{,}000}{2{,}000} = 5.00$

4. Energy productivity = $\dfrac{\text{Output}}{\text{Energy input}} = \dfrac{10{,}000}{1{,}000} = 10.00$

5. Other misc. expenses = $\dfrac{\text{Output}}{\text{Other misc. input}} = \dfrac{10{,}000}{500} = 20.00$

6. Total productivity = $\dfrac{\text{Total output}}{\text{Total input}}$

$$= \frac{\text{Total output}}{(\text{Human + Material + Capital + Energy + Other misc. input})}$$

$$= \frac{10{,}000}{3{,}000 + 2{,}000 + 3{,}000 + 1{,}000 + 500}$$

$$= \frac{10{,}000}{9{,}500} = \mathbf{1.053}$$

7. Total factor productivity (TFP) $= \dfrac{\text{Net output}}{(\text{Labour} + \text{Capital})\ \text{Input}}$

$$= \frac{\text{Total output} - \text{Material and services purchased}}{(\text{Labour} + \text{Capital})\ \text{Input}}$$

Assume that the company purchases all its material and services including energy, misc. and equipment (leasing). Then,

$$\text{Total factor productivity} = \frac{10{,}000 - (2{,}000 + 3{,}000 + 1{,}000 + 500)}{3{,}000 + 3{,}000}$$

$$= \frac{3{,}500}{6{,}000} = \mathbf{0.583}$$

7.3 WORK STUDY

"**Work study** is a generic term for those techniques, method study and work measurement which are used in the examination of human work in all its contexts. And which lead systematically to the investigation of all the factors which affect the efficiency and economy of the situation being reviewed, in order to effect improvement."

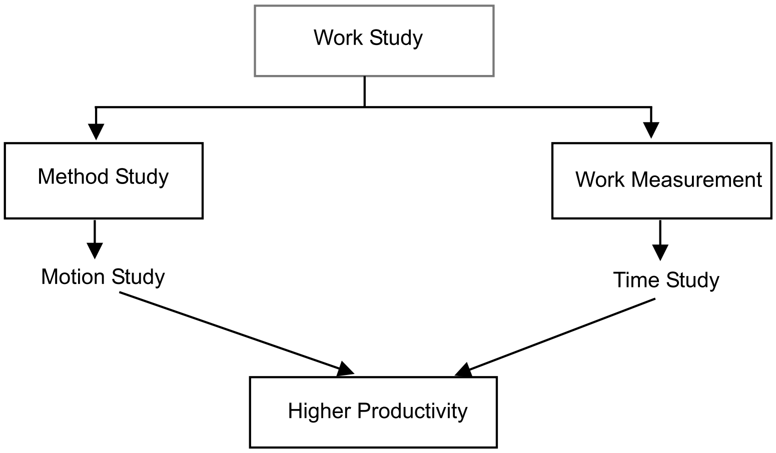


Fig. 7.2 *Framework of work study*

Work study is a means of enhancing the production efficiency (productivity) of the firm by elimination of waste and unnecessary operations. It is a technique to identify non-value adding operations by investigation of all the factors affecting the job. It is the only accurate and systematic procedure oriented technique to establish time standards. It is going to contribute to the profit as the savings will start immediately and continue throughout the life of the product.

Method study and work measurement is part of work study. Part of method study is motion study, work measurement is also called by the name 'Time study'.

7.3.1 Advantages of Work Study

Following are the advantages of work study:

1. It helps to achieve the smooth production flow with minimum interruptions.
2. It helps to reduce the cost of the product by eliminating waste and unnecessary operations.
3. Better worker-management relations.
4. Meets the delivery commitment.
5. Reduction in rejections and scrap and higher utilisation of resources of the organization.
6. Helps to achieve better working conditions.
7. Better workplace layout.
8. Improves upon the existing process or methods and helps in standardisation and simplification.
9. Helps to establish the standard time for an operation or job which has got application in manpower planning, production planning.

7.4 METHOD STUDY

Method study enables the industrial engineer to subject each operation to systematic analysis. The main purpose of method study is to eliminate the unnecessary operations and to achieve the best method of performing the operation.

Method study is also called **methods engineering or work design.** Method engineering is used to describe collection of analysis techniques which focus on improving the effectiveness of men and machines.

According to British Standards Institution (BS 3138): *"Method study is the systematic recording and critical examination or existing and proposed ways or doing work as a means or developing and applying easier and more effective methods and reducing cost."*

Fundamentally method study involves the breakdown of an operation or procedure into its component elements and their systematic analysis. In carrying out the method study, the right attitude of mind is important. The method study man should have:

1. The desire and determination to produce results.
2. Ability to achieve results.
3. An understanding of the human factors involved.

Method study scope lies in improving work methods through process and operation analysis, such as:

1. Manufacturing operations and their sequence.
2. Workmen.
3. Materials, tools and gauges.
4. Layout of physical facilities and work station design.
5. Movement of men and material handling.
6. Work environment.

7.4.1 Objectives of Method Study

Method study is essentially concerned with finding better ways of doing things. It adds value and increases the efficiency by eliminating unnecessary operations, avoidable delays and other forms of waste.

The improvement in efficiency is achieved through:

1. Improved layout and design of workplace.
2. Improved and efficient work procedures.
3. Effective utilisation of men, machines and materials.
4. Improved design or specification of the final product.

The objectives of method study techniques are:

1. Present and analyse true facts concerning the situation.
2. To examine those facts critically.
3. To develop the best answer possible under given circumstances based on critical examination of facts.

7.4.2 Scope of Method Study

The scope of method study is not restricted to only manufacturing industries. Method study techniques can be applied effectively in service sector as well. It can be applied in offices, hospitals, banks and other service organizations.

The areas to which method study can be applied successfully in manufacturing are:

1. To improve work methods and procedures.
2. To determine the best sequence of doing work.
3. To smoothen material flow with minimum of back tracking and to improve layout.
4. To improve the working conditions and hence to improve labour efficiency.
5. To reduce monotony in the work.
6. To improve plant utilisation and material utilisation.
7. Elimination of waste and unproductive operations.
8. To reduce the manufacturing costs through reducing cycle time of operations.

7.4.3 Steps or Procedure Involved in Methods Study

The basic approach to method study consists of the following eight steps. The detailed procedure for conducting the method study is shown in Fig. 7.3.

1. **SELECT** the work to be studied and define its boundaries.
2. **RECORD** the relevant facts about the job by direct observation and collect such additional data as may be needed from appropriate sources.
3. **EXAMINE** the way the job is being performed and challenge its purpose, place sequence and method of performance.

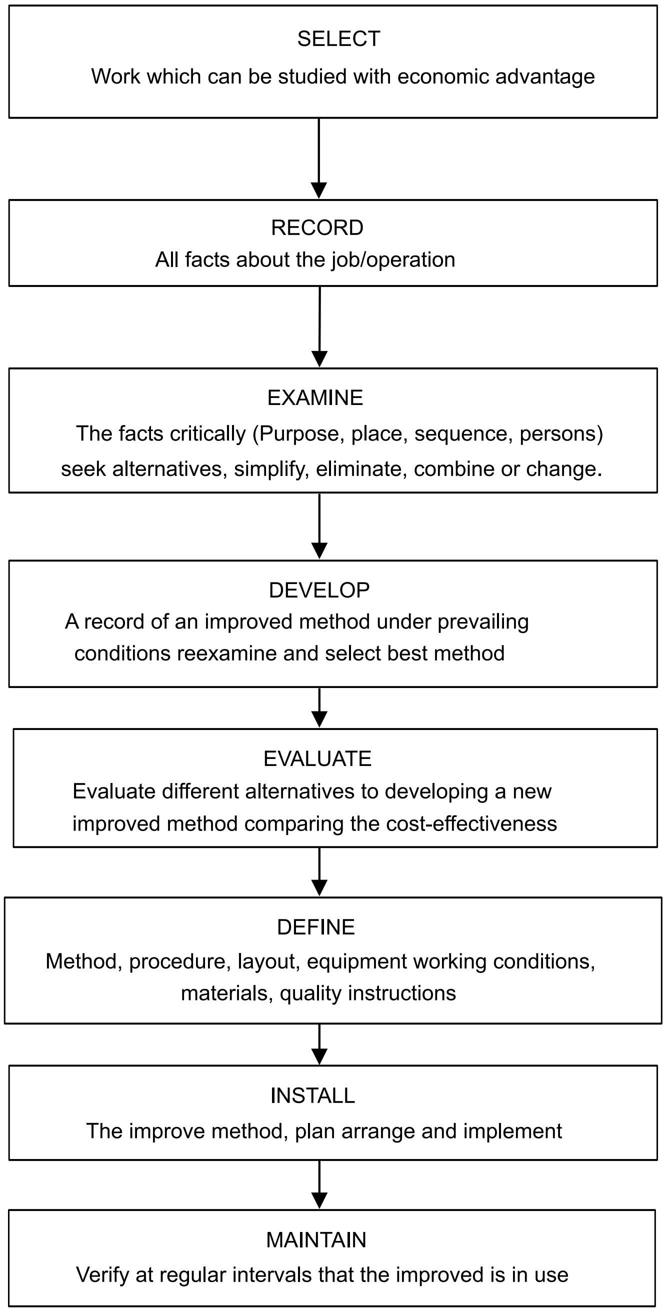


Fig. 7.3. *Method study procedure*

4. **DEVELOP** the most practical, economic and effective method, drawing on the contributions of those concerned.

5. **EVALUATE** different alternatives to developing a new improved method comparing the cost-effectiveness of the selected new method with the current method with the current method of performance.
6. **DEFINE** the new method, as a result, in a clear manner and present it to those concerned, *i.e.*, management, supervisors and workers.
7. **INSTALL** the new method as a standard practice and train the persons involved in applying it.
8. **MAINTAIN** the new method and introduce control procedures to prevent a drifting back to the previous method of work.

Note: Only the first two steps have been dealt in detail.

7.4.4 Selection of the Job for Method Study

Cost is the main criteria for selection of a job, process and department for methods analysis. To carry out the method study, a job is selected such that the proposed method achieves one or more of the following results:

(*a*) Improvement in quality with lesser scrap.

(*b*) Increased production through better utilisation of resources.

(*c*) Elimination of unnecessary operations and movements.

(*d*) Improved layout leading to smooth flow of material and a balanced production line.

(*e*) Improved working conditions.

CONSIDERATIONS FOR SELECTION OF METHOD STUDY

The job should be selected for the method study based upon the following considerations:

1. Economic aspect 2. Technical aspect, and 3. Human aspect.

A. Economic Aspects

The method study involves cost and time. If sufficient returns are not attained, the whole exercise will go waste. Thus, the money spent should be justified by the savings from it. The following guidelines can be used for selecting a job:

(*a*) Bottleneck operations which are holding up other production operations.

(*b*) Operations involving excessive labour.

(*c*) Operations producing lot of scrap or defectives.

(*d*) Operations having poor utilisation of resources.

(*e*) Backtracking of materials and excessive movement of materials.

B. Technical Aspects

The method study man should be careful enough to select a job in which he has the technical knowledge and expertise. A person selecting a job in his area of expertise is going to do full justice.

Other factors which favour selection in technical aspect are:

1. Job having in consistent quality.
2. Operations generating lot of scraps.
3. Frequent complaints from workers regarding the job.

C. Human Considerations

Method study means a change as it is going to affect the way in which the job is done presently and is not fully accepted by workman and the union. Human considerations play a vital role in method study. These are some of the situations where human aspect should be given due importance:

1. Workers complaining about unnecessary and tiring work.
2. More frequency of accidents.
3. Inconsistent earning.

7.4.5 Recording Techniques for Method Study

The next step in basic procedure, after selecting the work to be studied is to record all facts relating to the existing method. In order that the activities selected for investigation may be visualised in their entirety and in order to improve them through subsequent critical examination, it is essential to have some means of placing on record all the necessary facts about the existing method. Records are very much useful to make before and after comparison to assess the effectiveness of the proposed improved method.

The recording techniques are designed to simplify and standardise the recording work. For this purpose charts and diagrams are used.

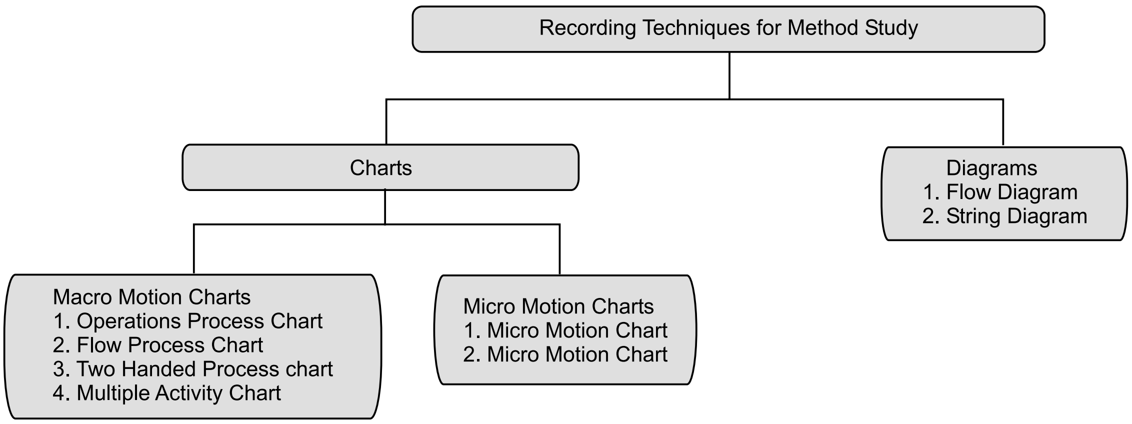


Fig. 7.4 *Recording techniques for method study*

CHARTS USED IN METHODS STUDY

This is the most popular method of recording the facts. The activities comprising the jobs are recorded using method study symbols. A great care is to be taken in preparing the charts so that the information it shows is easily understood and recognized. The following information should be given in the chart. These charts are used to measure the movement of operator or work (*i.e.*, in motion study).

(*a*) Adequate description of the activities.

(*b*) Whether the charting is for present or proposed method.

(*c*) Specific reference to when the activities will begin and end.

(*d*) Time and distance scales used wherever necessary.

(*e*) The date of charting and the name of the person who does charting.

Types of Charts

It can be broadly divided into (A) Macro motion charts and (B) Micro motion charts.

Macro motion charts are used for macro motion study and micro motion charts are used for micro motion study.

Macro motion study is one which can be measured through 'stop watch' and micro motion study is one which cannot be measured through stop watch.

(A) Macro Motion Charts

Following four charts are used under this type:

1. Operation Process Chart

It is also called outline process chart. An operation process chart gives the bird's eye view of the whole process by recording only the major activities and inspections involved in the process. Operation process chart uses only two symbols, *i.e.*, operation and inspection. Operation, process chart is helpful to:

(*a*) Visualise the complete sequence of the operations and inspections in the process.

(*b*) Know where the operation selected for detailed study fits into the entire process.

(*c*) In operation process chart, the graphic representation of the points at which materials are introduced into the process and what operations and inspections are carried on them are shown.

2. Flow Process Chart

Flow process chart gives the sequence of flow of work of a product or any part of it through the work centre or the department recording the events using appropriate symbols. It is the amplification of the operation process chart in which operations; inspection, storage, delay and transportation are represented. However, process charts are of three types:

(*a*) Material type—Which shows the events that occur to the materials.

(*b*) Man type—Activities performed by the man.

(*c*) Equipment type—How equipment is used.

The flow process chart is useful:

(*a*) to reduce the distance travelled by men (or materials).

(*b*) to avoid waiting time and unnecessary delays.

(*c*) to reduce the cycle time by combining or eliminating operations.

(*d*) to fix up the sequence of operations.

(*e*) to relocate the inspection stages.

Like operation process chart, flow process chart is constructed by placing symbols one below another as per the occurrence of the activities and are joined by a vertical line. A brief description of the activity is written on the right hand side of the activity symbol and time or distance is given on the left hand side.

3. Two Handed Process Chart

A two handed (operator process chart) is the most detailed type of flow chart in which the activities of the workers hands are recorded in relation to one another. The two handed process chart is normally confined to work carried out at a single workplace. This also gives synchronised and graphical representation of the sequence of manual activities of the worker. The application of this charts are:

- To visualise the complete sequence of activities in a repetitive task.
- To study the work station layout.

4. Multiple Activity Chart

It is a chart where activities of more than subject (worker or equipment) are each recorded on a common time scale to show their inter-relationship. Multiple activity chart is made:

- to study idle time of the man and machines,
- to determine number of machines handled by one operator, and
- to determine number of operators required in teamwork to perform the given job.

Diagrams Used in Method Study

The flow process chart shows the sequence and nature of movement but it does not clearly show the path of movements. In the paths of movements, there are often undesirable features such as congestion, back tracking and unnecessary long movements. To record these unnecessary features, representation of the working area in the form of flow diagrams, string diagrams can be made:

1. To study the different layout plans and thereby; select the most optimal layout.
2. To study traffic and frequency over different routes of the plant.
3. Identification of back tracking and obstacles during movements. Diagrams are of two types: 1. Flow diagram and 2. String diagram.

1. Flow Diagram

Flow diagram is a drawing, of the working area, showing the location of the various activities identified by their numbered symbols and are associated with particular flow process chart either man type or machine type.

The routes followed in transport are shown by joining the symbols in sequence by a line which represents as nearly as possible the path or movement of the subject concerned.

Following are the procedures to make the flow diagram:

1. The layout of the workplace is drawn to scale.
2. Relative positions of the machine tools, work benches, storage, and inspection benches are marked on the scale.
3. Path followed by the subject under study is tracked by drawing lines.
4. Each movement is serially numbered and indicated by arrow for direction.
5. Different colours are used to denote different types of movements.

2. String Diagram

The string diagram is a scale layout drawing on which, length of a string is used to record the extent as well as the pattern of movement of a worker working within a limited area during a certain period of time. The primary function of a string diagram is to produce a record of a existing set of conditions so that the job of seeing what is actually taking place is made as simple as possible.

One of the most valuable features of the string diagram is the actual distance travelled during the period of study to be calculated by relating the length of the thread used to the scale of drawing. Thus, it helps to make a very effective comparison between different layouts or methods of doing job in terms of the travelling involved.

The main advantages of string diagram compared to flow diagram is that respective movements between work stations which are difficult to be traced on the flow diagram can be conveniently shown on string diagram.

Folloging are the procedures to draw string diagram:

1. A layout of the work place of factory is drawn to scale on the soft board.
2. Pins are fixed into boards to mark the locations of work stations, pins are also driven at the turning points of the routes.
3. A measured length of the thread is taken to trace the movements (path).
4. The distance covered by the object is obtained by measuring the remaining part of the thread and subtracting it from original length.

Symbols Used in Method Study

Graphical method of recording was originated by Gilberth, in order to make the presentation of the facts clearly without any ambiguity and to enable to grasp them quickly and clearly. It is useful to use symbols instead of written description.

(A) Method Study Symbols

O OPERATION

☐ INSPECTION

→ TRANSPORTATION

D DELAY

∇ STORAGE

Operation O

An operation occurs when an object is intentionally changed in one or more of its characteristics (physical or chemical). This indicates the main steps in a process, method or procedure.

An operation always takes the object one stage ahead towards completion.

Examples of operation are:

- Turning, drilling, milling, etc.
- A chemical reaction.
- Welding, brazing and riveting.
- Lifting, loading, unloading.
- Getting instructions from supervisor.
- Taking dictation.

Inspection □

An inspection occurs when an object is examined and compared with standard for quality and quantity. The inspection examples are:

- Visual observations for finish.
- Count of quantity of incoming material.
- Checking the dimensions.

Transportation →

A transport indicates the movement of workers, materials or equipment from one place to another.

Example: Movement of materials from one work station to another.
Workers travelling to bring tools.

Delay D: Delay (Temporary Storage)

A delay occurs when the immediate performance of the next planned thing does not take place.

Example: Work waiting between consecutive operations.

Workers waiting at tool cribs.

Operators waiting for instructions from supervisor.

Storage ∇

Storage occurs when the object is kept in an authorised custody and is protected against unauthorised removal. For example, materials kept in stores to be distributed to various work.

ILLUSTRATION 1. *Develop a Process Chart for making a cheese sandwich.*

SOLUTION. The following chart is one possible solution. The level of detail in process charts depends upon the requirements of the job. Time is often included to aid analysis of value added.

Process Chart

Distance in metre	*Symbol*	*Process description*
10	⇨	Move to cabinet
-	○	Get loaf of bread
-	○	Remove two slices of bread
-	○	Lay slices on counter-top
-	○	Close loaf of bread
	○	Replace loaf of bread on shelf
-	○	Open butter
-	○	Spread butter on top slice of bread
-	□	Inspect sandwich
10	⇨	Move to serving area
-	○	Serve sandwich

ILLUSTRATION 2. *Develop a Multiple Activity Chart for doing three loads of laundry, assume you will have access to one washing machine and one dryer.*

SOLUTION: The followingchart is one possible solution. The level of detail in process charts depends upon the requirements of the job. Time is often included to aid analysis of value added.

Multiple Activity Chart

Time	*Operator*	*Machine 1 Washer*	*Machine 2 Dryer*
	Load clothes and detergent in to Machine 1	Being loaded	Idle
	Idle	Run	Idle
	Remove clothes from Machine 1	Being unloaded	Idle
Repeat	Load clothes into Machine 2	Idle	Being loaded
Cycle	Load clothes and detergent into Machine 1	Being loaded	Run
	Idle	Run	Run
	Remove clothes from Machine 2	Idle	Being unloaded
	Hang clothes	Idle	Idle

(B) Micro-Motion Study Chart

Micro-motion study provides a technique for recording and timing an activity. It is a set of techniques intended to divide the human activities in a groups of movements or micro-motions (called Therbligs) and the study of such movements helps to find for an operator one best pattern of movements that consumes less time and requires less effort to accomplish the task. Therbligs were suggested by Frank O. Gilbreth, the founder of motion study. Micro-motion study was mainly employed for the job analysis. Its other applications includes:

1. As an aid in studying the activities of two or more persons on a group work?
2. As an aid in studying the relationship of the activities of the operator and the machine as a means of timing operations.
3. As an aid in obtaining motion time data for time standards.
4. Acts as permanent record of the method and time of activities of the operator and the machine.

TABLE 7.1 SIMO chart symbols

Sl. No.	*Code*	*Name*	*Description*	*Colour*
1.	SH	SEARCH	Locate and article	Black
2.	F	FIND	Mental reaction at end of search	Gray
3.	ST	SELECT	Selection from a member	Light Gray
4.	G	GRASP	Taking Hold	Red
5.	H	HOLD	Prolonged group	Gold Ochre
6.	TL	TRANSPORTED LOADED	Moving an article	Green
7.	P	POSITION	Placing in a definite location	Blue
8.	A	ASSEMBLE	Putting parts together	Violet
9.	U	USE	Causing a device to perform its function	Purple
10.	DA	DISASSEMBLE	Separating parts	Light Violet
11.	I	INSPECT	Examine or test	Burnt Ochre
12.	PP	PREPOSITION	Placing an article ready for use	Pale Blue
13.	RL	RELEASE LOAD	Release an article	Carmine red
14.	TE	TRANSPORT EMPTY	Movement of a body member	Olive Green
15.	R	REST	Pause to overcome fatigue	Orange
16.	JD	UNAVOIDABLE DELAY	Idle-outside persons control	Yellow
17.	PN	PLAN	Mental plan for future action	—

The micro-motion group of techniques is based on the idea of dividing human activities into division of movements or groups of movements (Therbligs) according to purpose for which they are made. Gilbreth differentiated 17 fundamental hand or hand and eye motions. Each Therbligs has a specific colour, symbol and letter for recording purposes. The Therbligs are micro-motion study involves the following steps:

1. Filming the operation to be studied.
2. Analysis of the data from the film.

The recording of the data through **SIMO chart** is done as micro motion chart.

SIMO Chart

Simultaneous motion cycle chart (SIMO chart) is a recording technique for micro-motion study. A SIMO chart is a chart based on the film analysis, used to record simultaneously on a common time scale the Therbligs or a group of Therbligs performed by different parts of the body of one or more operators.

It is the micro-motion form of the man type flow process chart. To prepare SIMO chart, an elaborate procedure and use of expensive equipment are required and this study is justified when the saving resulting from study will be very high.

7.5 MOTION STUDY

Motion study is part of method study where analysis of the motion of an operator or work will be studied by following the prescribed methods.

7.5.1 Principles of Motion study

There are a number of principles concerning the economy of movements which have been developed as a result of experience and which forms the basis for the development of improved methods at the workplace. These are first used by Frank Gilbreth, the founder of motion study and further rearranged and amplified by Barnes, Maynard and others.

The principles are grouped into three headings:

(*a*) Use of the human body.

(*b*) Arrangement of workplace.

(*c*) Design of tools and equipment.

(A) USES OF HUMAN BODY

When possible:

1. The two hands should begin and complete their movements at the same time.
2. The two hands should not be idle at the same time except during periods of rest.
3. Motions of the arms should be made simultaneously.
4. Hand and body motions should be made at the lowest classification at which it is possible to do the work satisfactorily.
5. Momentum should be employed to help the worker, but should be reduced to a minimum whenever it has to be overcome by muscular effort.
6. Continuous curved movements are to be preferred to straight line motions involving sudden and changes in directions.
7. 'Ballistic' (*i.e.*, free swinging) movements are faster, easier and more accurate than restricted or controlled movements.

8. Rhythm is essential to the smooth and automatic performance of a repetitive operation. The work should be arranged to permit easy and natural rhythm wherever possible.
9. Work should be arranged so that eye movements are confined to a comfortable area, without the need for frequent changes of focus.

(B) ARRANGEMENT OF THE WORKPLACE

1. Definite and fixed stations should be provided for all tools and materials to permit habit formation.
2. Tools and materials should be pre-positioned to reduce searching.
3. Gravity fed, bins and containers should be used to deliver the materials as close to the point of use as possible.
4. Tools, materials and controls should be located within a maximum working area and as near to the worker as possible.
5. Materials and tools should be arranged to permit the best sequence of motions.
6. 'Drop deliveries' or ejectors should be used wherever possible, so that the operative does not have to use his hands to dispose of finished parts.
7. Provision should be made for adequate lightning, and a chair of type and height to permit good posture should be provided. The height of the workplace and seat should be arranged to allow alternate standing and seating.

(C) DESIGN OF TOOLS AND EQUIPMENTS

1. The colour of the workplace should contrast with that of work and thus reduce eye fatigue.
2. The hands should be relieved of all work of 'holding' the work piece where this can be done by a jig or fixture or foot operated device.
3. Two or more tools should be combined where possible.
4. Where each finger performs some specific movement, as in typewriting, the load should be distributed in accordance with the inherent capacities of the fingers.
5. Handles such as those used on screw drivers and cranks should be designed to permit maximum surface of the hand to come in contact with the handle.
6. Levers, cross bars and wheel bars should be in such position that operator can manipulate them with least body change and with greatest mechanical advantage.

7.5.2 Recording Techniques of Motion Study

Most of the techniques mentioned in method study is used in the motion study. They are as follows:

1. Macro Motion Study

(*a*) Flow process chart
(*b*) Two handed process chart.

2. Micro Motion Study

SIMO chart.

[**Note:** Explained earlier in this chapter.]

7.6 WORK MEASUREMENT

Work measurement is also called by the name 'time study'. Work measurement is absolutely essential for both the planning and control of operations. Without measurement data, we cannot determine the capacity of facilities or it is not possible to quote delivery dates or costs. We are not in a position to determine the rate of production and also labour utilisation and efficiency. It may not be possible to introduce incentive schemes and standard costs for budget control.

7.6.1 Objectives of Work Measurement

The use of work measurement as a basis for incentives is only a small part of its total application. The objectives of work measurement are to provide a sound basis for:

1. Comparing alternative methods.
2. Assessing the correct initial manning (manpower requirement planning).
3. Planning and control.
4. Realistic costing.
5. Financial incentive schemes.
6. Delivery date of goods.
7. Cost reduction and cost control.
8. Identifying substandard workers.
9. Training new employees.

7.6.2 Techniques of Work Measurement

For the purpose of work measurement, work can be regarded as:

1. **Repetitive work:** The type of work in which the main operation or group of operations repeat continuously during the time spent at the job. These apply to work cycles of extremely short duration.

2. **Non-repetitive work:** It includes some type of maintenance and construction work, where the work cycle itself is hardly ever repeated identically.

Various techniques of work measurement are:

1. Time study (stop watch technique),
2. Synthesis,
3. Work sampling,
4. Predetermined motion and time study,
5. Analytical estimating.

Time study and work sampling involve direct observation and the remaining are data based and analytical in nature.

1. **Time study:** A work measurement technique for recording the times and rates of working for the elements of a specified job carried out under specified conditions and for analysing the data so as to determine the time necessary for carrying out the job at the defined level of performance. In other words measuring the time through stop watch is called time study.

2. **Synthetic data:** A work measurement technique for building up the time for a job or pans of the job at a defined level of performance by totalling element times obtained previously from time studies on other jobs containing the elements concerned or from synthetic data.

3. **Work sampling:** A technique in which a large number of observations are made over a period of time of one or group of machines, processes or workers. Each observation records what is happening at that instant and the percentage of observations recorded for a particular activity, or delay, is a measure of the percentage of time during which that activities delay occurs.

4. **Predetermined motion time study (PMTS):** A work measurement technique whereby times established for basic human motions (classified according to the nature of the motion and conditions under which it is made) are used to build up the time for a job at the defined level of performance. The most commonly used PMTS is known as **Methods Time Measurement (MTM).**

5. **Analytical estimating:** A work measurement technique, being a development of estimating, whereby the time required to carry out elements of a job at a defined level of performance is estimated partly from knowledge and practical experience of the elements concerned and partly from synthetic data.

The work measurement techniques and their applications are shown in Table 7.2.

TABLE 7.2: Work measurement techniques and their application

Techniques	*Applications*	*Unit of measurement*
1. Time study	Short cycle repetitive jobs. Widely used for direct work.	Centiminute (0.01 min)
2. Synthetic Data	Short cycle repetitive jobs.	Centi minutes
3. Working sampling	Long cycle jobs/heterogeneous operations.	Minutes
4. MTM	Manual operations confined to one work centre.	TMU (1 TMU = 0.006 min)
5. Analytical estimation	Short cycle non-repetitive job.	Minutes

7.7 TIME STUDY

Time study is also called work measurement. It is essential for both planning and control of operations.

According to British Standard Institute time study has been defined as *"The application of techniques designed to establish the time for a qualified worker to carry out a specified job at a defined level of performance."*

7.7.1 Steps in Making Time Study

Stop watch time is the basic technique for determining accurate time standards. They are economical for repetitive type of work. Steps in taking the time study are:

1. Select the work to be studied.
2. Obtain and record all the information available about the job, the operator and the working conditions likely to affect the time study work.
3. Breakdown the operation into elements. An element is a instinct part of a specified activity composed of one or more fundamental motions selected for convenience of observation and timing.
4. Measure the time by means of a stop watch taken by the operator to perform each element of the operation. Either continuous method or snap back method of timing could be used.
5. At the same time, assess the operators effective speed of work relative to the observer's concept of 'normal' speed. This is called performance rating.
6. Adjust the observed time by rating factor to obtain normal time for each element

$$\text{Normal} = \frac{\text{Observed time} \times \text{Rating}}{100}$$

7. Add the suitable allowances to compensate for fatigue, personal needs, contingencies. etc. to give standard time for each element.
8. Compute allowed time for the entire job by adding elemental standard times considering frequency of occurrence of each element.
9. Make a detailed job description describing the method for which the standard time is established.
10. Test and review standards wherever necessary. The basic steps in time study are represented by a block diagram in Fig. 7.5.

7.7.2 Computation of Standard Time

Standard time is the time allowed to an operator to carry out the specified task under specified conditions and defined level of performance. The various allowances are added to the normal time as applicable to get the standard time as shown in Fig. 7.6.

Standard time may be defined as the, amount of time required to complete a unit of work: (*a*) under existing working conditions, (*b*) using the specified method and machinery, (*c*) by an operator, able to the work in a proper manner, and (*d*) at a standard pace.

Thus basic constituents of standard time are:

1. Elemental (observed time).
2. Performance rating to compensate for difference in pace of working.
3. Relaxation allowance.
4. Interference and contingency allowance.
5. Policy allowance.

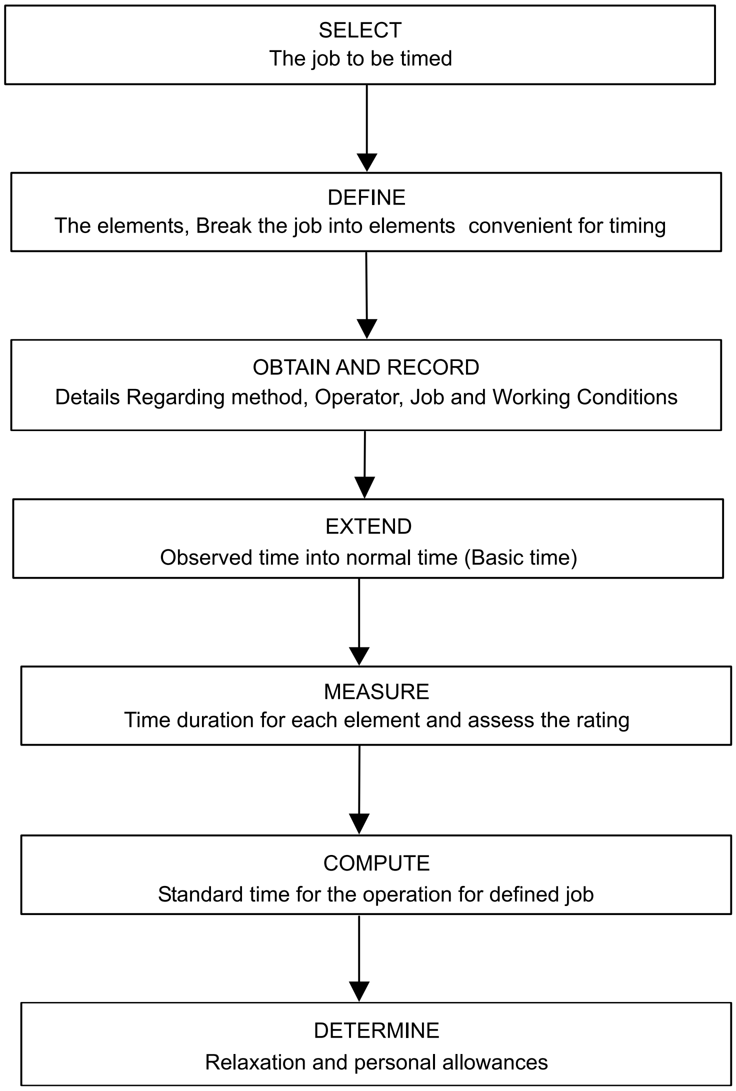


Fig. 7.5 *Steps in time study*

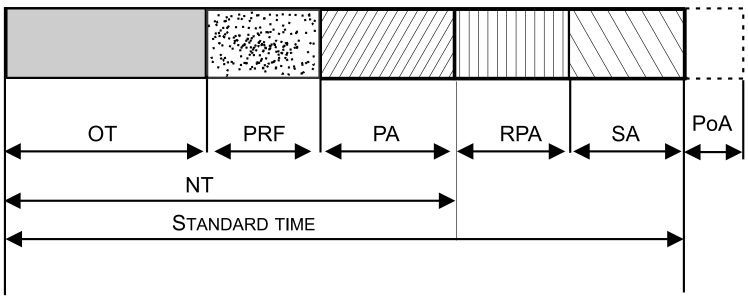


Fig. 7.6 *Components standard time*

OT	–	Observed Time
PRF	–	Performance Rating Factor
NT	–	Normal Time
PA	–	Process Allowances
RPA	–	Rest and Personal Allowances
SA	–	Special Allowances
PoA	–	Policy Allowances

Allowances

The normal time for an operation does not contain any allowances for the worker. It is impossible to work throughout the day even though the most practicable, effective method has been developed. Even under the best working method situation, the job will still demand the expenditure of human effort and some allowance must therefore be made for recovery from fatigue and for relaxation. Allowances must also be made to enable the worker to attend to his personal needs. The allowances are categorised as: (1) Relaxation allowance, (2) Interference allowance, and (3) Contingency allowance.

1. Relaxation Allowance

Relaxation allowances are calculated so as to allow the worker to recover from fatigue. Relaxation allowance is a addition to the basic time intended to provide the worker with the opportunity to recover from the physiological and psychological effects of carrying out specified work under specified conditions and to allow attention to personal needs. The amount of allowance will depend on nature of the job.

Relaxation allowances are of two types: fixed allowances and variable allowances.

Fixed allowances constitute:

(*a*) **Personal needs allowance:** It is intended to compensate the operator for the time necessary to leave, the workplace to attend to personal needs like drinking water, smoking, washing hands. Women require longer personal allowance than men. A fair personal allowance is 5% for men, and 7% for women.

(*b*) **Allowances for basic fatigue:** This allowance is given to compensate for energy expended during working. A common figure considered as allowance is 4% of the basic time.

2. Variable Allowance

Variable allowance is allowed to an operator who is working under poor environmental conditions that cannot be improved, added stress and strain in performing the job.

The variable fatigue allowance is added to the fixed allowance to an operator who is engaged on medium and heavy work and working under abnormal conditions. The amount of variable fatigue allowance varies from organization to organization.

3. Interference Allowance

It is an allowance of time included into the work content of the job to compensate the operator for the unavoidable loss of production due to simultaneous stoppage of two or more machines being operated by him. This allowance is applicable for machine or process controlled jobs.

Interference allowance varies in proportion to number of machines assigned to the operator. The interference of the machine increases the work content.

4. Contingency Allowance

A contingency allowance is a small allowance of time which may be included in a standard time to meet legitimate and expected items of work or delays. The precise measurement of which is uneconomical because of their infrequent or irregular occurrence.

This allowance provides for small unavoidable delays as well as for occasional minor extra work:

Some of the examples calling for contingency allowance are:

- Tool breakage involving removal of tool from the holder and all other activities to insert new tool into the tool holder.
- Power failures of small duration.
- Obtaining the necessary tools and gauges from central tool store. Contingency allowance should not exceed 5%.

5. Policy Allowance

Policy allowances are not the genuine part of the time study and should be used with utmost care and only in clearly defined circumstances.

The usual reason for making the policy allowance is to line up standard times with requirements of wage agreement between employers and trade unions.

The policy allowance is an increment, other than bonus increment, applied to a standard time (or to some constituent part of it, *e.g.*, work content) to provide a satisfactory level of earnings for a specified level of performance under exceptional circumstances. Policy allowances are sometimes made as imperfect functioning of a division or part of a plant.

ILLUSTRATION 1: *Assuming that the total observed time for an operation of assembling an electric switch is 1.00 min. If the rating is 120%, find normal time. If an allowance of 10% is allowed for the operation, determine the standard time.*

SOLUTION:

Obsessed time (or) selected time = 1.00 min

Rating = 120%

Allowance = 10%

As we know that, normal time $= \text{Observed time} \times \dfrac{\text{Rating \%}}{100}$

$$= 1.00 \times \frac{120}{100} = \mathbf{1.20\ min}$$

Allowance @ 10% $= 1.20 \times \dfrac{10}{100} = \mathbf{0.12\ min}$

$\therefore$ Standard time = Normal time + Allowances

$$= 1.20 + 0.12 = \mathbf{1.32\ min.}$$

ILLUSTRATION 2: *An operator manufactures 50 jobs in 6 hours and 30 minutes. If this time includes the time for setting his machine. Calculate the operator's efficiency. Standard time allowed for the job was:*

Setting time = 35 min

Production time per piece = 8 min

SOLUTION:

As standard time = Set up time + Time per piece × No. of pieces produced

∴ Standard time for manufacturing 50 jobs

$$= 35 + 8 \times 50$$
$$= 435 \text{ min}$$
$$= 7 \text{ hours and } 15 \text{ min.}$$

$$\text{Efficiency of operator} = \frac{\text{Standard time} \times 100}{\text{Actual time}}$$

$$= \frac{435 \times 100}{390} = \mathbf{111.5\%.}$$

ILLUSTRATION 3: *Following datas were obtained by a work study. Man from a study conducted by hours.*

(*i*) ***Maintenance time***

(*a*) *Get out and put away tools = 12.0 min/day*

(*b*) *Cleaning of machine* = 5.0 min/day

(*c*) *Oiling of machine* = 5.0 min/day

(*d*) *Replenish coolant supply* = 3.0 min/day

(*ii*) ***Interruption***

(*a*) *Interruption by foreman = 5.0 min/day*

(*b*) *Interruption by porter etc. = 4.0 min/day*

(*iii*) *Delay time due to power failure etc. = 6.0 min/day*

(*iv*) *Personal time = 20.0 min/day*

Calculate total allowances, total available cycle time productive hours, considering a working day of 8 hours.

SOLUTION:

Total allowance (sometimes also known as station time)

= Total maintenance time + Interruption time + Delay time + Personal time

$$= (12.0 + 5 + 5 + 3.0) + (5.0 + 4.0) + 6.0 + 20.0$$
$$= 25.0 + 9.0 + 6.0 + 20.0$$
$$= 60.0 \text{ min per day}$$

∴ Total available cycle time = Total work period – Total allowances

$$= 480 - 60 = \mathbf{420 \text{ min/day}}$$

$$\text{Productive hours} = \frac{\text{Time available}}{\text{Number of hours}}$$

$$= \frac{420}{8} = \mathbf{52.5 \text{ min.}}$$

ILLUSTRATION 4: *Find out the standard time using the following data:*

Average time for machine elements	*= 6 min*
Average time for manual elements	*= 4 min*
Performance rating	*= 110%*
Allowances	*= 10%*

SOLUTION:

Normal time = Machinery time + Manual time × Rating

$= 6 + 4 \times 1.1$

$= 6 + 4.4 =$ **10.4 min**

$\therefore$ Standard time = Normal time + Allowances

$$= 10.4 + 10.4 \times \frac{10}{100}$$

$= 10.4\ (1 + 0.1) =$ **11.44 min.**

EXERCISES

Section A

1. What do you mean by productivity?
2. What is work study?
3. What do you mean by work measurement?
4. How do you ascertain productivity?
5. What do you mean by total productivity measure?
6. What do you mean by partial productivity measure?
7. What is micro-motion study?
8. What is motion study?
9. What is time study?

Section B

1. How do you achieve efficiency?
2. Explain the scope of method study.

Section C

1. Discuss the factors influencing productivity.
2. Discuss the productivity improvement techniques.
3. Discuss the steps involved in method study.
4. Discuss different types of charts and diagrams used in methods study.
5. Discuss the principles of motion study.
6. Discuss the recording technique of motion study.
7. Discuss the various techniques of work measurement.
8. Discuss the steps in making time study.
9. Discuss the different types of allowances.

Skill development

FAST FOOD RESTAURANT VISIT: Get the information for the following questions:

1. Steps involved in the preparation of pizza (method study).
2. Cycle time involved for placing of order till serving (Standard Time Calculation).
3. Process chart used for pizza preparation.

CASELET

1. Toys and Job Design at the Hovey and Beard Company

The following is a situation that occurred in the Hovey and Beard Company, as reported by J. V. Clark.

This company manufactured a line of wooden toys. One part of the process involved spray painting partially assembled toys, after which the toys were hung on moving hooks that carried them through a drying oven. The operation, staffed entirely by women, was plagued with absenteeism, high turnover, and low morale. Each woman at her paint booth would take a toy from the tray beside her, position it in a fixture, and spray on the color according to the required pattern. She then would release the toy and hang it on the conveyor hook. The rate at which the hooks moved had been calculated so that each woman, once fully trained, would be able to hang a painted toy on each hook before it passed beyond her reach.

The women who worked in the paint room were on a group incentive plan that tied their earnings to the production of the entire group. Since the operation was new, they received a learning allowance that decreased by regular amounts each month. The learning allowance was scheduled to fall to zero in six months because it was expected that the women could meet standard output or more by that time. By the second month of the training period, trouble had developed. The women had progressed more slowly than had been anticipated, and it appeared that their production level would stabilize somewhat below the planned level. Some of the women complained about the speed that was expected of them, and a few of them quit. There was evidence of resistance to the new situation.

Through the counsel of a consultant, the supervisor finally decided to bring the women together for general discussions of working conditions. After two meetings in which relations between the work group and the supervisor were somewhat improved, a third meeting produced the suggestion that control of the conveyor speed be turned over to the work group. The women explained that they felt that they could keep up with the speed of the conveyor but that they could not work at that pace all day long. They wished to be able to adjust the speed of the belt, depending on how they felt.

After consultation, the supervisor had a control marked, “low, medium, and fast” installed at the booth of the group leader, who could adjust the speed of the conveyor anywhere between the lower and upper limits that had been set. The women were delighted and spent many lunch hours deciding how the speed should be varied from hour to hour throughout the day. Within a week, a pattern had emerged: the first half-hour of the shift was run on what the women called “medium speed” (a dial setting slightly above the point marked “medium”). The next two and one-half hours were run at high speed, and the half-hour before lunch and the half-hour after lunch were run at low speed. The rest of the afternoon was run at high speed, with the exception of the last 45 minutes of the shift, which were run at medium speed.

In view of the women’s report of satisfaction and ease in their work, it is interesting to note that the original speed was slightly below medium on the dial of the new control. The average speed at which the women were running the belt was on the high side of the dial. Few, if any, empty hooks entered the drying oven, and inspection showed no increase of rejects from the paint room. Production increased, and within three weeks the women were operating at 30 to 50 percent above the level that had been expected according to the original design.

Evaluate the experience of the Hovey and Beard Company as it reflects on job design, human relationships, and the supervisor’s role. How would you react as the supervisor to the situation where workers determine how the work will be performed? If you were designing the spray-painting set-up, would you design it differently?

[From J. V. Clark, “A Healthy Organization,” *California Management Review,* 4, 1962]

2. Productivity Gains At Whirlpool

Workers and management at Whirlpool Appliance’s Benton Harbor plant in Michigan have set an example of how to achieve productivity gains, which has benefited not only the company and its stockholders, but also Whirlpool customers, and the workers themselves.

Things weren’t always rosy at the plant. Productivity and quality weren’t good. Neither were labor-management relations. Workers hid defective parts so management wouldn’t find them, and when machines broke down, workers would simply sit down until sooner or later someone came to fix it. All that changed in the late 1980s. Faced with the possibility that the plant would be shut down, management and labor worked together to find a way to keep the plant open. The way was to increase productivity-producing more without using more resources. Interestingly, the improvement in productivity didn’t come by spending money on fancy machines. Rather, it was accomplished by placing more emphasis on quality. That was a shift from the old way, which emphasized volume, often at the expense of quality. To motivate workers, the company agreed to gain sharing, a plan that rewarded workers by increasing their pay for productivity increases.

The company overhauled the manufacturing process, and taught its workers how to improve quality. As quality improved, productivity went up because more of the output was good, and costs went down because of fewer defective parts that had to be scrapped or reworked. Costs of inventory also decreased, because fewer spare parts were needed to replace defective output, both at the factory and for warranty repairs. And workers have been able to see the connection between their efforts to improve quality and productivity.

Not only was Whirlpool able to use the productivity gains to increase workers’ pay, it was also able to hold that lid on price increases and to funnel some of the savings into research.

Questions

1. What were the two key things that Whirlpool management did to achieve productivity gains?
2. Who has benefited from the productivity gains?
3. How are productivity and quality related?
4. How can a company afford to pay it workers for productivity gains?

(**Source:** Based on "A Whirlpool Factory Raises Productivity-And Pay of Workers:' by Rick Wartzman, from The Wall Street journal, 1992.)

3. State Automobile License Renewals

Vinay, manager of a metropolitan branch office of the state department of motor vehicles, attempted to perform an analysis of the driver's license renewal operations. Several steps were to be performed in the process. After examining the license renewal process, he identified the steps and associated times required to perform each step as shown in table below.

State Automobile License Renewals Process Times

	Job	Average Time to Perform (Seconds)
1	Review renewal application for correctness	15
2	Process and record payments	30
3	Check file for violations and restrictions	60
4	Conduct Eye Test	40
5	Photograph applicant	20
6	Issue temporary license	30

Vinay found that each step was' assigned to a different person. Each application was a separate process in the sequence shown in the exhibit. Vinay determined that his office should be prepared to accommodate the maximum demand of processing 120 renewal applicants per hour.

He observed that the work was unevenly divided among the clerks, and that the clerk who was responsible for checking violations tended to shortcut her task to keep up with the other clerks. Long lines built up during the maximum demand periods.

Vinay also found that general clerks who were each paid Rs.12.00 per hour-handled jobs 1,2,3, and 4. Job 5 was performed by a photographer paid Rs.16 per hour, Job 6, the issuing of temporary licenses, was required by state policy to be handled by a uniformed motor vehicle officer. Officers were paid Rs.18 per hour, but they could be assigned to any job except photography.

A review of the jobs indicated that job 1, reviewing the application for correctness, had to be performed before any other step. Similarly, job 6, issuing the temporary license, could not be performed until all the other steps were completed. The branch offices were charged Rs.20 per hour for each camera to perform photography.

Vinay was under severe pressure to increase productivity and reduce costs, but the regional director of the department of motor vehicles also told him that he had better accommodate the demand for renewals. Otherwise, “heads would roll.”

Questions

1. What is the maximum number of applications per hour that can be handled by the present configuration of the process?
2. How many applications can be processed per hour if a second clerk is added to check for violations?
3. Assuming the addition of one more clerk, what is the maximum number of applications the process can handle?
4. How would you suggest modifying the process to accommodate 120 applications per hour?

(**Source:** P. R. Olsen, W. E. Sasser, and D. D. Wyckoff, *Management of Service Operations: Text, Cases, and Readings,* Pp. 95-96, @ 1978.)

4. MAKING HOTPLATES

Group of 10 workers were responsible for assembling hotplates (instruments for heating solutions to a given temperature) for hospital and medical laboratory use. A number of different models of hotplates were being manufactured. Some had a vibrating device so that the solution could be mixed while being heated. Others heated only test tubes. Still others could heat solutions in a variety of different containers.

With the appropriate small tools, each worker assembled part of a hotplate. The partially completed hotplate was placed on a moving belt, to be carried from one assembly station to the next. When the hotplate was completed, an inspector would check it over to ensure that it was working properly. Then the last worker would place it in a specially prepared cardboard box for shipping.

The assembly line had been carefully balanced by industrial engineers, who had used a time and motion study to break the job down into subassembly tasks, each requiring about three minutes to accomplish. The amount of time calculated for each subassembly had also been “balanced” so that the task performed by each worker was supposed to take almost exactly the same amount of time. The workers were paid a straight hourly rate.

However, there were some problems. Morale seemed to be low, and the inspector was finding a relatively high percentage of badly assembled hotplates. Controllable rejects-those “caused” by the operator rather than by faulty materials-were running about 23 percent.

After discussing the situation, management decided to try something new. The workers were called together and asked if they would like to build the hotplates individually. The workers decided they would like to try this approach, provided they could go back to the old program if the new one did not work well. After several days of training, each worker began to assemble the entire hotplate.

The change was made at about the middle of the year. Productivity climbed quickly. By the end of the year, it had leveled off at about 84 percent higher than during the first half of the year, although no other changes had been made in the department or its personnel. Controllable rejects had dropped from 23 percent to 1 percent during the same period. Absenteeism had dropped from 8 percent to less than 1 percent. The workers had responded positively to the change, and their morale was higher. As one person put it, “Now, it is my hotplate.” Eventually, the reject rate dropped so low that the assembly workers themselves did all routine final inspection. The fulltime inspector was transferred to another job in the organization.

Questions

1. What changes in the work situation might account for the increase in productivity and the decrease in controllable rejects?
2. What might account for the drop in absenteeism and the increase in morale?
3. What were the major changes in the situation? Which changes were under the control of the manager? Which were controlled by workers?
4. What might happen if the workers went back to the old assembly line method?

(**Source:** The Modern Manager, by Edgar F. Huse, copyright @ 1979 by West Publishing Company.)