OPERATIONS MANAGEMENT MODULE V INDUSTRIAL ENGINEERING

INTRODUCTION

Industrial engineering is the branch of engineering that involves figuring out how to make or do things better. Industrial engineers are concerned with reducing production costs, increasing efficiency, improving the quality of products and services, ensuring worker health and safety, protecting the environment and complying with government regulations. They "work to eliminate waste of time, money, materials, energy and other commodities," according to the Institute of Industrial Engineers. For example, industrial engineers may work to streamline an operating room, shorten a roller-coaster line, make assembly lines safer and more efficient, and speed up the delivery of goods.

Industrial engineers are involved in all stages of production and processing. They may design new facilities from the ground up, or they may be responsible for upgrading, expanding or reconfiguring existing facilities. They may be required to design new equipment or write specifications for equipment purchased from outside vendors and ensure that it meets those requirements. They may also need to repurpose existing facilities and equipment, design new processes, and design new tools and fixtures.

In order to maintain these standards, industrial engineers must have a basic working knowledge of many areas of engineering and also be familiar with work processes, equipment, tools and materials in order to design facilities, systems and equipment that meet requirements for cost, quality, safety and environmental protection.

PRODUCTIVITY

Productivity refers to the physical relationship between the quantity produced (output) and the quantity of resources used in the course of production (input). "It

is the ratio between the output of goods and services and the input of resources consumed in the process of production."

Productivity $(P) = \frac{\text{Output}(O)}{\text{Input}(I)}$

Output implies total production while input means land, labour, capital, management, etc. Productivity measures the efficiency of the production system. The efficiency with which resources are utilized is called productive efficiency. Higher productivity means producing more from a given amount of inputs or producing a given amount with lesser inputs.

At the level of a plant or an industry productivity is an output-input ratio. But at the macro level, productivity is a measure of performance of an economy or country. From a nation's viewpoint productivity is the ratio of available goods and services to the potential resources of the country.

Productivity means an economic measure of output per unit of input. Output refers to the total production in terms of units or in terms of revenues while input refers to all the factors of production used like capital, labour, equipment, etc. Productivity is a good indicator of the efficiency with which a factory is operating. If a firm has higher productivity, i.e. it produces more with a given amount of inputs, it means it is utilising the resources properly.

Productivity can be increased by:

i. Generating more outputs from same level of inputs.

ii. Producing same level of outputs with reduced level of inputs.

iii. A combination of both.

"Productivity is the quantitative relation between; what a firm produces and what a firm uses as a resource to produce output, i.e. arithmetic ratio of amount produced (output) to the amount of resources (input)".

"Productivity is an aggregate measure of the efficiency of production; it is the ratio of output to inputs i.e. capital, labor, land, energy and materials".

"Productivity refers to the efficiency of the production system and an indicator to; how well the factors of production (land, capital, labor and energy) are utilized".

Factors Affecting Productivity 1. Human:

Human nature and human behaviour are the most significant determinants of productivity.

Human factors may further be classified into two categories as given below:

(a) Ability to work – Productivity of an organization depends upon the competence and calibre of its people—both workers and managers. Ability to work is governed by education, training, experience, aptitude, etc. of the employees.

(b) Willingness to work – Motivation and morale of people is the second important group of human factors that determine productivity. Wage incentive schemes, labour participation in management, communication system, informal group relations, promotion policy, union management relations, quality of leadership, etc., are the main factors governing employees' willingness to work. Working conditions like working hours, sanitation, ventilation, schools, clubs, libraries, subsidized canteen, company transport, etc., also influence the motivation and morale of employees.

2. Technological:

Technological factors exercise significant influence on the level of productivity.

The main technological factors are as follows:

- (a) Size and capacity of plant
- (b) Product design and standardization
- (c) Timely supply of materials and fuel
- (d) Rationalization and automation measures
- (e) Repairs and maintenance

- (f) Production planning and control
- (g) Plant layout and location
- (h) Materials handling system
- (i) Inspection and quality control
- (j) Machinery and equipment used
- (k) Research and development

3. Managerial:

The competence and attitudes of managers have an important bearing on productivity. In many organizations, productivity is low despite latest technology and trained manpower. This is due to inefficient and indifferent management. Competent and dedicated managers can obtain extraordinary results from ordinary people.

Job performance of employees depends on their ability and willingness to work. Management is the catalyst to create both. Advanced technology requires knowledge workers who in turn work productively under professionally qualified managers. No ideology can win a greater output with less effort. It is only through sound management that optimum utilization of human and technical resources can be secured.

4. Natural:

Natural factors such as physical, geological, geographical and climatic conditions exert considerable influence on productivity, particularly in extractive industries. For example, productivity of labour in extreme climates (too cold or too hot) tends to be comparatively low. Natural resources like water, fuel and minerals influence productivity.

5. Sociological:

Social customs, traditions and institutions influence attitudes towards work and job. For instance, bias on the basis of caste, religion, etc., inhibited the growth of modern industry in some countries. The joint family system affected incentive to work hard in India. Close ties with land and native place hampered stability and discipline among industrial labour.

6. Political:

Law and order, stability of Government, harmony between States, etc. are essential for high productivity in industries. Taxation policies of the Government influence willingness to work, capital formation, modernization and expansion of plants, etc. Industrial policy affects the size, and capacity of plants. Tariff policies influence competition. Elimination of sick and inefficient units helps to improve productivity.

7. Economic:

Size of the market, banking and credit facilities, transport and communication systems, etc. is important factors influencing productivity. Productivity is an economics term which refers to the ratio of product to what is required to produce the product. Productivity is outcome of several interrelated factors. All the factors which are related to input and output components of a production process are likely to affect productivity.

Importance of Productivity

(i) It helps to reduce the cost of production per unit through more economical or efficient use of resources.

(ii) Reduction in costs helps to improve the profits of a business. The enterprise can more successfully compete in the market.

(iii) The gains of higher productivity can be passed on to consumers in the form of lower prices and/or better quality of products.

(iv) Similarly, gains of higher productivity can be shared with workers in the form of higher wages or salaries and better working conditions.

(v) Availability of quality goods at reasonably low prices helps to improve the standard of living in the country.

(vi) Due to higher productivity, a firm can survive and grow better. This helps to generate more employment opportunities.

(vii) A more productive enterprise can better export goods and earn valuable foreign exchange for the country.

(viii) Higher productivity means better utilization of the country's resources, which helps to control inflation in the country.

TOOLS OF INCREASING PRODUCTIVITY

In appraising an organization's potential for improving productivity, its current operations and management practices should be examined to decide how they should function in the future. A large number of techniques have been developed for improving productivity

1. Work Study:

Scientific analysis and improvement of work in all its aspects is a very useful technique of increasing productivity. Work study results in improvements in plant layout, material handling system, process design and standardization, working conditions, etc. These in turn help to minimize defective works and waste.

2. Research and Development:

Continuing research and development (R & D) leads to the discovery of better techniques of production and improvements in existing machinery, equipment, etc. The rate of technological progress is a direct determinant of productivity. That is why companies and countries spend huge sums of money on research and development activities.

3. Incentive Schemes:

Wage incentive schemes seek to motivate employees by paying extra remuneration. Profit sharing or bonus, labour welfare measures and good working

conditions also help in this objective. All these schemes foster sense of belonging and closer human relationships. As a result, there is reduction in idle time caused by absenteeism, labour turnover, accidents and disputes.

4. Production Planning and Control:

Scientific task planning ensures timely supply of inputs, proper maintenance of plant, efficient work scheduling and regulation of day-to-day ' activities in the plant. It facilitates full utilization of plant capacity and achievement of production targets.

5. Workers' Participation in Management:

Labour participation in management is considered an effective tool for improving productivity. It helps in developing mutual understanding and cooperation between management and labour. Joint consultation, suggestion schemes, two-way communication, grievance procedure are the main forms of workers' participation in management.

6. Automation:

Mechanization, automation and rationalization are major breakthroughs for increasing productivity. These schemes are effective provided the productivity gains are equitably shared with workers. Such measures increase the speed and accuracy of work.

7. Management by Objectives (MBO):

MBO is a process whereby the superior and subordinates jointly identify the specific measurable goals, define results expected of each individual and jointly assess the contribution of every individual. It is an approach for integrating the individuals with the organization. The focus of MBO is on participative goal setting, joint evaluation of performance and results to be achieved.

8. Job Enrichment:

Job enrichment is the process of redesigning a job in order to enlarge its scope and to give the worker more to do. Its purpose is to improve job satisfaction, motivation and morale of workers. When the job is engineered to workers the dehumanization element is reduced so as to improve productivity and to reduce cost. It provides an opportunity for the satisfaction of higher level needs.

The following methods can be adopted for job enrichment:

(a) Give workers new and more varied tasks to perform.

- (b) Provide greater freedom and self-control in performing jobs.
- (c) Give opportunity to do the whole task rather than an element of it.
- (d) Give employees greater responsibility for their own work.
- (e) Provide an opportunity to the worker to become an expert on a particular task.
- (f) Supply production reports (feedback) directly to workers.

9. Flexitime—an Alternative Work Pattern:

Flexitime is a relatively new work pattern which is a major departure from tradition. It allows the workers to set their own work hours subject to a minimum number of hours per week. During a particular period all workers are required to be present. Such a period is called 'core hours.' Subject to these limitations workers are given the freedom to decide when they will work.

Flexitime helps to reduce worker alienation and to raise productivity. It reduces the tyranny of supervisors and provides job opportunity to working mothers, aged persons and students. It has greater motivational value than five days' work-week. By permitting workers the right of self-determination, flexitime reduces tardiness, overtime and short-term absenteeism.

10. Quality of Work Life (QWL):

QWL is a new technique for improving productivity and quality of work.

11. Quality Circles (QC):

A quality circle is a small group of workers which regularly meets to discuss problems, investigate causes, recommend solutions and if authorized, to take corrective action. It usually consists of five to fifteen members who collectively identify, analyze and resolve work-related problems and may even implement solutions.

LABOUR PRODUCTIVITY

Labor productivity, also known as workforce productivity, is defined as real economic output per labor hour. Growth in labor productivity is measured by the change in economic output per labor hour over a defined period. Labor productivity should not be confused with employee productivity, which is a measure of an individual worker's output.

Labor productivity measures output per labor hour. Labor productivity is largely driven by investment in capital, technological progress, and human capital development. Business and government can increase labor productivity of workers by direct investing in or creating incentives for increases in technology and human or physical capital.

Labour productivity is concerned with the amount (volume) of output that is obtained from each employee.

Why does measuring and monitoring labour productivity matter?

- Labour costs are usually a significant part of total costs
- Business efficiency and profitability closely linked to productive use of labour
- In order to remain competitive, a business needs to keep its unit costs down

Achieving higher labour productivity is not a simple task. Several factors influence how productive the workforce is: e.g.

- Extent and quality of fixed assets (e.g. equipment, IT systems)
- Skills, ability and motivation of the workforce
- Methods of production organisation
- External factors (e.g. reliability of suppliers)

The Importance of Measuring Labor Productivity

Labor productivity is directly linked to improved standards of living in the form of higher consumption. As an economy's labor productivity grows, it produces more goods and services for the same amount of relative work. This increase in output makes it possible to consume more of the goods and services for an increasingly reasonable price.

Growth in labor productivity is directly attributable to fluctuations in physical capital, new technology, and human capital. If labor productivity is growing, it can usually be traced back to growth in one of these three areas. Physical capital is the tools, equipment, and facilities that workers have available to use to produce goods. New technologies are new methods to combine inputs to produce more output, such as assembly lines or automation. Human capital represents the increase in education and specialization of the workforce. Measuring labor productivity gives an estimate of the combined effects of these underlying trends.

Labor productivity can also indicate short-term and cyclical changes in an economy, possibly even turnaround. If the output is increasing while labor hours remains static, it signals that the labor force has become more productive. In addition to the three traditional factors outlined above, this is also seen during economic recessions, as workers increase their labor effort when unemployment rises and the threat of lay-offs looms to avoid losing their jobs.

Policies to Improve Labor Productivity

There are a number of ways that governments and companies can improve labor productivity.

- **Investment in physical capital**: Increasing the investment in capital goods including infrastructure from governments and the private sector can help productivity while lowering the cost of doing business.
- Quality of education and training: Offering opportunities for workers to upgrade their skills, and offering education and training at an affordable cost, help raise a corporation's and an economy's productivity.
- **Technological progress**: Developing new technologies, including hard technology like computerization or robotics and soft technologies like new modes of organizing a business or pro-free market reforms in government policy can enhance worker productivity.

MACHINE PRODUCTIVITY

It is one of the techniques used in the factories to measure the productivity of the machines. Machine Productivity is the measuring of a machine's proficiency in converting the raw inputs into a useful product. The critical element of cost efficiency is termed as Productivity. It is calculated by dividing the average output each period by the cost incurred in consuming the resources in the same period.

There are several machines that are used in the factories for different purposes. Let us take the example of a sewing machine in the factory. This machine is used for stitching the garments in the factories

Calculation of Machine Productivity:

There are some data essentially required for the calculation of Machine Productivity in the factory. The following data is to be considered while calculating the machine productivity.

1. The total stitching machines in the line must be counted.

2. The output of the line at the end of every day needs to be counted. In other words, the produced garments in the factory need to be calculated.

3. The timing of the shifts in hours and total hours of working in the factory needs to be noted down.

In this case, the machine productivity can be calculated by using the formulae given below:

 $Machine Productivity = \frac{No. of total garnments produced}{No. of total stiching machines used}$

Here, the productivity is the share of a process input and output prescribed in a given time structure. The productivity can be calculated by dividing the line's output by the inputs of the machine. However, in factories of garment production, the company measures its productivity by taking both the labor and machine productivity into consideration.

WORK STUDY

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

The main objective of work study is to improve productivity of men, machines and materials. The aim of work study is to determine the best method of performing each operation and to eliminate wastage so that production increases with less fatigue. The work study is also used in determining the standard time that a qualified worker should take to perform the operation when working at a normal place.

Work study is a technique which deals with the following problems:

(a) As to how should a job be done, and

(b) How much time a job should take for completion.

Answer for the first question is found by Motion Study or Method Study or Work Simplification. Answer for the second question is found by the Time Study or Work Measurement.

Role of Work Study:

- 1. To standardize the method of doing a work,
- 2. To minimize the unit cost of production,
- 3. To determine the standard time for doing a task,
- 4. To minimise the material movement, and operators movement,
- 5. To eliminate unnecessary human movements,
- 6. To utilise facilities such as man, machine and materials most effectively, and
- 7. To a systematic investigation of all factors.

Objectives of Work Study:

The following are the objectives of work study: 1. Increased efficiency,

- 2. Better product quality,
- 3. To choose the fastest method to do a job,
- 4. To improve the working process,
- 5. Less fatigue to operators and workers
- 6. Effective labour control,
- 7. Effective utilisation of resources,
- 8. To decide equipment requirements,
- 9. To pay fair wages,

Advantages of Work Study:

The advantages of work study are the following: 1. Work study ensures higher productivity,

- 2. Better working conditions with less fatigue,
- 3. Higher wages to workers,
- 4. Uniform production flow,
- 5. Job satisfaction and job security to workers,
- 6. Reduction in unit cost of production,

Work measurement

Work measurement is concerned with the determination of the amount of time required to perform a unit of work. Work measurement is very important for promoting productivity of an organization. It enables management to compare alternate methods and also to do initial staffing. Work measurement provides basis for proper planning. Since it is concerned with the measurement of time it is also called 'Time Study'. The exact examination of time is very essential for correct pricing. To find the correct manufacturing time for a product, time study is performed. To give competitive quotations, estimation of accurate labour cost is very essential. It becomes a basis for wage and salary administration and devising incentive schemes.

Work measurement has been defined by British Standard Institution 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". This time is called standard or allowed time. Time study may also be defined as "the art of observing and recording the time required to do each detailed element of an industrial operation".

Objectives of Work Measurement:

1. To compare the times of performance by alternative methods.

2. To enable realistic schedule of work to be prepared.

3. To arrive at a realistic and fair incentive scheme.

4. To analyze the activities for doing a job with the view to reduce or eliminate unnecessary jobs.

5. To minimize the human effort.

6. To assist in the organization of labor by daily comparing the actual time with that of target time.

Techniques of Work Measurement

- **Direct Time Study**: Direct time study refers to the ascertainment of the time needed to carry out a unit of work. In this method, observation and recording of time is necessary for undertaking each unit of an operation are done, with a view to ascertaining, the actual time, in which the work can be accomplished.
- **Synthesis Method**: A work measurement method, in which the job or activity is divided into various parts, after which the time consumed in performing each element of the job is recorded and then combined.
- Analytical Estimating: This method of time measurement is used to ascertain the time values for the tasks that are long and not repetitive in nature.
- **Predetermined Motion Time System (PMTS)**: In PMTS method, basic times are set up for basic human motions. Such time values are used to compute the time required by the job for its completion, with fixed standard. It is a new and improved version of motion study.
- Work Sampling or Ratio Delay Method: A work measurement method, in which the work of several employees is sampled randomly, at periodic intervals, to ascertain the proportion of total operations, of a specific activity.

Steps Involved in Work Measurement

- 1. Divide jobs into elements
- 2. Observe and record each element, any of the work measurement techniques.

3. Set up unit time values, by extending observed time into normal time for each unit. This can be done by applying rating factor.

4. Evaluate relaxation allowance and add the same to the normal time, for each element to get the work content.

5. Ascertain the frequency of occurrence of each element in the job, then multiply the work content to it. After that total the times to reach the work content of the job.

6. Add contingency allowance, wherever required, to get the standard time for performing the job.

Uses of Work Measurement:

1. Wok measurement is used in planning work and in drawing out schedules.

2. Wok measurement is used to determine standard costs.

3. Wok measurement is used as an aid in preparing budgets.

4. It is used in balancing production lines for new products.

5. Wok measurement is used in determining machine effectiveness.

6. To determine time standards to be used as a basis for labor cost control.

7. To establish supervisory objectives and to provide a basis for measuring supervisory efficiency.

8. To determine time standards to be used for providing a basis for wage incentive plans.

METHOD STUDY

Method study is basically conducted to simplify the work or working methods and must go towards higher productivity. It is always desirable to perform the requisite function with desired goal minimum consumption of resources. Method signifies how a work is to be done

Methods are integral part of work accomplishment and signify:

1. How well our methods utilize the limited available resources such as manpower, machines, materials and money.

2. How our methods physically affect production output of the unit.

3. The quality of output obtained by application of our methods.

Thus methods can determine the amount of input materials, time power and money consumed. So methods may be considered the core where one can attempt to reduce the consumption of resources thereby reducing cost per unit output through utilization of proper methods. The method design can decided the cost and quality of output produced.

Method Study may be defined as:

"A procedure for examining the various activities associated with the problem which ensures a systematic, objective and critical evaluation of the existing factors and in addition and imaginative approach while developing improvements".

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 utilization of men, machines and materials.
- 4. Improved design or specification of the final product.

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 labor efficiency.
- 5. To reduce monotony in the work.

- 6. To improve plant utilization and material utilization.
- 7. Elimination of waste and unproductive operations.
- 8. To reduce the manufacturing costs through reducing cycle time of operations.

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 the following figure.

- 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.
- 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.



MOTION STUDY

In this field, pioneering work was done by Frank B. Gilbreth and his wife Lillian M. Gilbreth, around 1910, with the name of Motion Study. Frank Gilbreth. The real founder of motion study as science, defined motion study as the "science of eliminating wastefulness resulting from ill- directed and in-efficient motions". The aim of motion study is to find the scheme of least wastage time of labour.

Later on the scope of Motion Study was enlarged and it was named as Method Study. Method Study is a technique which analyses each operation of a given piece of work very closely in order to eliminate unnecessary operations and to approach the quickest and easiest method of performing each necessary operation. It includes the standardization of equipment, methods and working conditions, and training of the operator to follow the standard method.

Sometimes method study can also be defined as "systematic recording and critical examination of existing and proposed ways of doing work as a means of developing and applying easier and more effective method and thereby reducing cost."

Objectives of Motion Study:

Some important aims of the motion study are:

- 1. To eliminate wastage of time and labour.
- 2. To reduce fatigue and boredom of work by avoiding unnecessary movements.
- 3. To find the best way of doing the job,
- 4. To have more effective utilization of materials, machines and workers.
- 5. To improve the design of work place layout.
- 6. To standardize the method, obtained after conducting the motion study.
- 7. To train the individual worker for its practice as per standardized method.

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. Use of the 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 color 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.

Procedure for Motion Study:

Step I: Break Up the Operation of the Job:

Make a detailed list of all operations in the present method of manufacturing a job. All the material handling, machine work, and hand work are also included in this detail.

Step II: Question Each Detail of the Job:

Following questions should be asked on himself by the motion study engineer about the way in which these operations are to be performed, and about the tools and equipment's needed. The procedure of this questioning is known as 'Critical Examination'.

Step III: Develop a New Method:

After considering the above questions, a new better method is developed.

Step IV: Installing the New Method:

After having developed the method, this is required to install. The new method must first be got approved from the supervisors, workers and management. Then the workers must be trained to work according to this new method and their habits must be developed to follow the correct way. For some-time, close contacts must be maintained with the progress of the job until it runs satisfactorily.

Step V: Maintaining new Method:

Once a method is installed, it should be maintained in its specified form, and not allowed to slip back to old form or introduction of any other unauthorized changes.

TIME STUDY

Time study may be defined as "the art of observing and recording the time required to do each detailed element of an industrial activity or operation."

The famous American Engineer, Frederick Winslow Taylor (also known as the father of scientific management movement) was the man behind the development of time study. In addition to Taylor, Frank Gilbreth (along with his wife Lilian Gilbreth) has made largest contributions in the field of time study. Taylor's time study was further refined by an American Industrial Consultant, Charles E. Bedaux, during 1911. Before undertaking time study, it is necessary to see that product, shop layout, handling system, equipment and tooling, materials and parts, lot-size, working conditions, work place arrangement, work methods and motion sequence, are fully standardized.

Objectives of Time Study:

(1) Target time for each job can be scientifically estimated. With this estimate realistic schedules and manpower requirements can be prepared.

(2) Sound comparison of alternative methods is possible by comparing their basic times.

(3) Useful wage incentive schemes can be formulated on the basis of target times.

(4) In can lead to proper balancing of the work distribution.

(5) It can help to analyze the activities for performing a job with the view to eliminate or reduce unnecessary or repetitive operations so that human effort can be minimized.

(6) To standardize the efficient method of performing operations.

(7) To standardize conditions for efficient performance.

(8) To determine man and machines ratio for effective and efficient utilization of both.

Basic Procedure for Time Study:

1. Select the job for study and define the objective of the study. This needs statement of the use of results, precision required and the desired level of confidence in the estimated time standards.

2. Analyze the operation to determine if the standard method and conditions exist and the worker is properly trained. The method study or training of operator should be completed before starting time study if need be.

3. Select the operator to be studied if more than one can perform the task.

4. Record the information about the standard method, operator, operation, product machine, quality required and working conditions.

5. Divide the operation into reasonably small elements.

6. Time the operator for each of the elements. Estimate the total number of observations to be taken.

7. Collect and record the data of required number of cycles by way of timing and rating the operator.

8. For each element of operation note the representative watch time and calculate the normal time as follows: Normal Time = Observed time x Rating Factors

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9. Determine standard time by adding allowances to normal time of operation. Some allowances such as personal allowance (20%), fatigue allowance (5%) preparation allowance (5%) are generally used or these can be taken from the company's policy book or by conducting an independent study.

Thus standard time = Normal time + Allowances

Advantages of Time Study:

The advantages of time study are the applications to which time standards are put. Generally they are required (a) to plan future production and (b) to evaluate performance of workers or of the production system as a whole.

(a) To plan future production they are required for:

- (1) Estimation of equipment or machinery requirements.
- (2) Estimation of production cost per unit in order to determine/fix selling price.
- (3) Estimating manpower requirements.
- (4) Taking makes or buys decisions.
- (5) Balancing the work of operators constituting a group.
- (6) Estimating delivery dates.
- (7) Estimating times required for a specified inventory level generation.
- (8) Estimation of labour costs.
- (9) Making alternative investment decision in purchasing machines/equipment.

(b) Time standards help in evaluation of performance as in following cases:

(1) The evaluation of productivity of various workstations.

(2) The development of individual or group incentive schemes for above average performance.

Limitations of Time Study:

The followings are the limitations of time study as a technique of setting production standards:

(1) Standards cannot be established by this technique on jobs which are not well defined.

(2) In situations where it is difficult to define quality precisely standards and production incentives may cause deterioration in quality levels.

(3) It is not possible to maintain standards where piece rate system of wage payment exists.

(4) Labor union opposes the application of time study when they are strong.

(5) Time study is applicable only where the work is visible. So it can be applied only in manual job and not for thinking portions of the job.

(6) Only specific type of jobs which have identifiable starting and ending points can be timed accurately.