CHAPTER 5

WORK MEASUREMENT

Definition

- Work measurement is 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
- Work measurement is concerned with investigating, reducing and subsequently eliminating ineffective time, that is time during which no effective work is being performed, whatever the cause.
- Work measurement, as the name suggests, provides management with a means of measuring the time taken in the performance of an operation or series of operations in such a way that ineffective time is shown up and can be separated from effective time.
- Once the existence of ineffective time has been revealed and the reasons for it tracked down steps can usually be taken to reduce it.
- Not only can it reveal the existence of ineffective time; it can also be used to set standard times for carrying out the work.
- Method study can reveal shortcomings of design, material and method of manufacture, and affects mainly technical people.
- Work measurement is more likely to show up management itself and the behavior of the workers.

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.

USES OF WORK MEASUREMENT

- In the process of setting standards it may be necessary to use work measurement

1. To compare the efficiency of alternative methods.
    - Other conditions being equal, the method which takes the least time will be the best method.

2. To balance the work of members of teams, in association with multiple activity charts, as nearly as possible, each worker has task taking an equal time to perform.

3. To determine, in association with workers and machine multiple activity charts, the number of machines an operator can run.

➢The time standards, once set, may be used:

4. To provide the basis for production planning and control for the choice of a better layout and for process planning, and for establishing just-intime inventory control systems.

5. To provide information that can enable estimates to be made for tenders, selling prices and delivery dates.

6. To set standards of machine utilization and labor performance that can be used for incentive schemes.

7. To provide information for labor-cost control and to enable standard costs to be fixed and maintained.

BASIC PROCEDURE OF WORK MEASUREMENT

1. **SELECT** The work to be studied.
2. **RECORD** All the relevant data relating to the circumstances in which the work is being done, the methods and the elements of activity in them.
3. **EXAMINE** The recorded data and the detained breakdown critically to ensure that the most effective method and motions are being used, and unproductive and foreign elements are separated from productive elements.
4. **MEASURE** The quality of work involved in each element, in terms of time, using the appropriate work measurement technique.
5. **COMPILE** The standard time for the operation, which in the case of stop-watch time study will include time allowances to cover relaxation, personal needs, etc.
6. **DEFINE** Precisely the series of activities and method of operation for which the time has been compiled and issue the time as standard for the activities and methods specified.

Work Measurement Techniques

- The following are the principal techniques by which work measurement is carried out:

1. Time Study;
2. Activity sampling, and its extension, rated activity sampling;
3. Synthesis from standard data;
4. Predetermined Motion Time Systems;
5. Estimating;
6. Analytical estimating;
7. Comparative 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 totaling 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.

TIME STUDY

- Time study is 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 analyzing the data so as to obtain the time necessary for carrying out the job at a defined level of performance.
- Once the method of doing the work has been determined by motion study, it is often desirable to find out how much time is used to do the work.
- A time study attempts to find out the amount of work that a qualified operator, properly trained, can do in a given time.
- The operator must do the work according to a certain method, under certain conditions, and at a certain pace which will produce a certain physical reaction.
- Certain allowances for personal and other delays are provided.
- All phases — job method, working conditions, pace, and allowances — must be carefully considered if the time study is to be rational. It is unreasonable to expect a production worker to accept and meet or exceed a production standard that is not based on these phases.
- Taylor developed a method for breaking a job down into its parts, studying each of these parts to determine the best method, and then measuring the time required for the average worker to complete the task according to the defined method.

BASIC TIME STUDY EQUIPMENT

- In order to make time studies certain equipment is essential. Basic time study equipment consists of:
  - ✓A stopwatch;
  - ✓A study board;
  - ✓Pencils;
  - ✓Time study forms.
- This equipment the study man will need with him whenever he makes a time study.
- In addition there should be in the study office slide rules; a reliable clock, with seconds hand; measuring instruments such as tape measure, steel rule, micrometer, spring balance, and tachometer (revolution counter).
- Other measuring instruments may be useful, depending on the type of work being studied.
- It is an advantage to have in the study office also an adding machine, or simple form of calculating machine

1. The Stopwatch

- Two types of watch are in general use for time study, namely the fly back and the non-fly back types.
- A third type the split-hand stop watch is sometimes used.

1. Fly back watch the movement is started and stopped by a slide (A) at the side of the winding-knob (B).

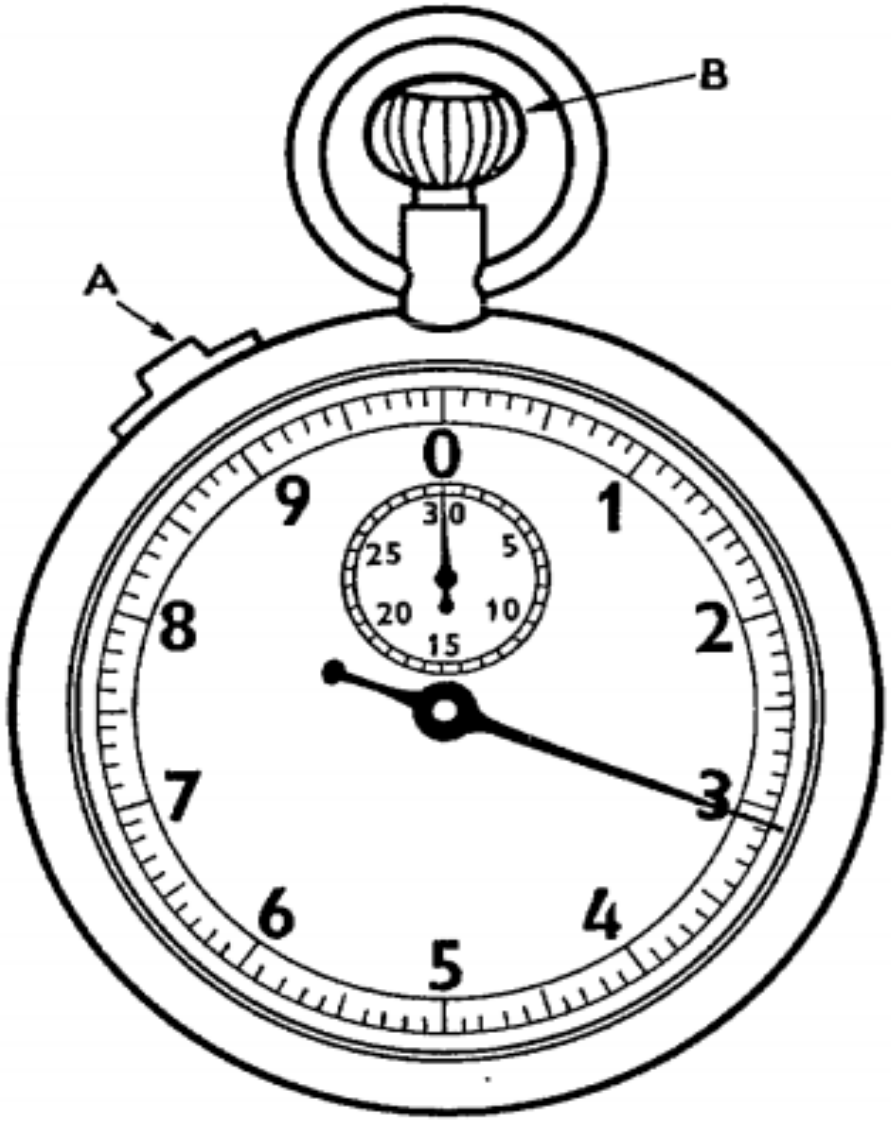
- Pressure on the top of the winding-knob causes both the hands to fly back to zero without stopping the mechanism, from which point they immediately move forward again.
- If the slide is used the hands can be stopped at any point on the dial and restarted without returning to zero as soon as the slide is released.
- This type of watch can be used for either "flyback" or "cumulative" timing

2. The n**on-fly back** type is controlled by pressure on the top of the winding-knob.

- The first pressure starts the watch; the second pressure stops it; the third pressure returns the hands to zero.
- This watch is suitable only for cumulative timing

3. In the **split-hand** type of watch, depressing a secondary knob causes one of the hands to stand still while the other continues to measure time.

- A second depression returns the stopped hand to the moving one and the two go on together.
- In this way a stopped hand is read when a reading is taken instead of a moving one, giving greater accuracy of reading.

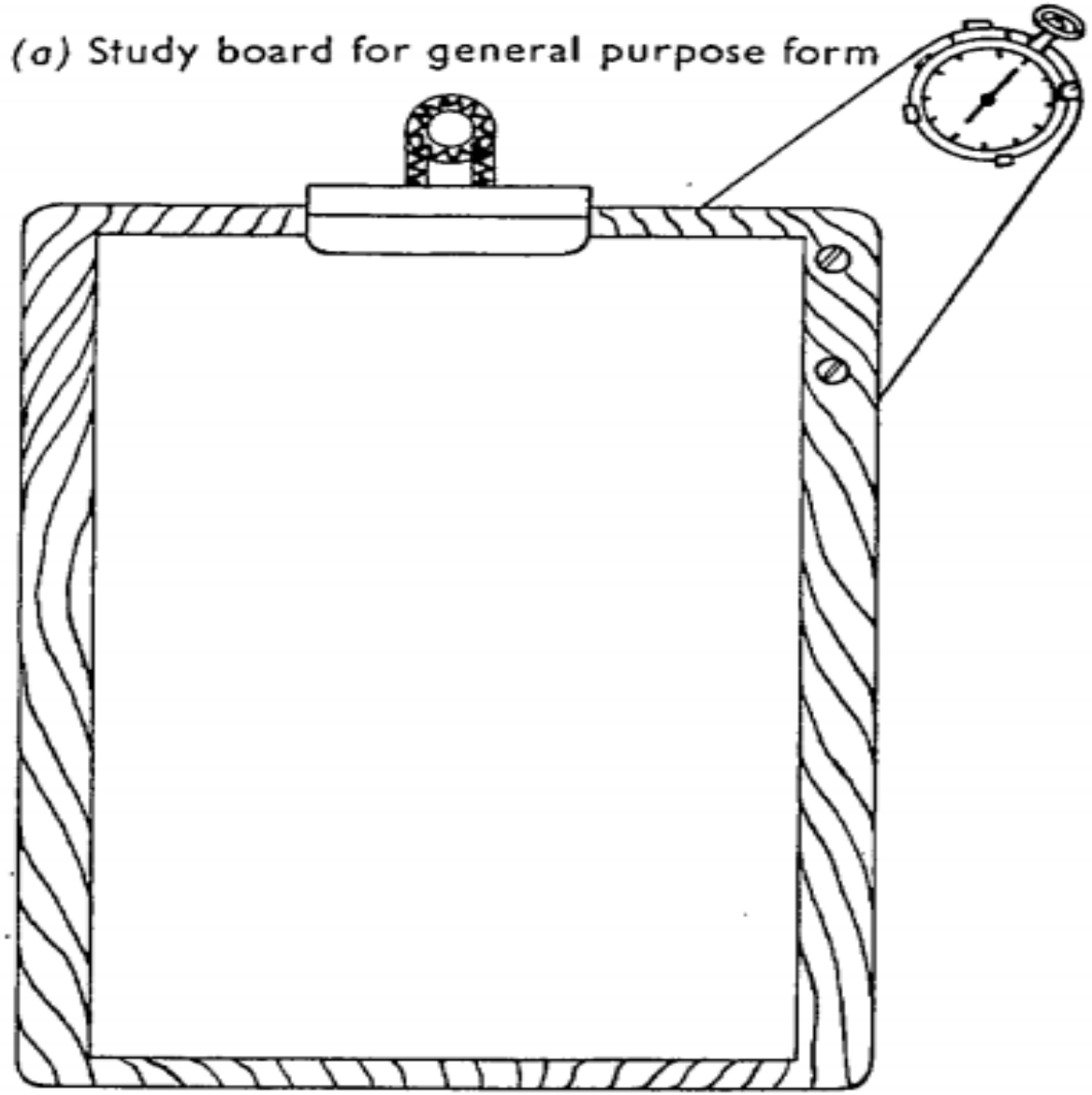


DECIMAL MINUTE STOPWATCH

2. THE STUDY BOARD

- The study board is simply a flat board, usually of plywood or of suitable plastic sheet, needed for placing the time study form.
- It should be rigid and larger than the largest form likely to be used.
- It may have a fitting to hold the watch, so that the hands of the work study person are left relatively free and the watch is in a position to be read easily.
- For right-handed people the watch is normally placed at the top of the board on the right-hand side, so that the board may be rested on the left forearm with the bottom edge against the body and the forefinger or middle finger of the left hand used to press the winding knob when resetting the watch.
- A strong spring clip should also be fitted to the board to hold the forms on which the study is recorded.
- A study board which is either too short for the studyman's arm, or too long, soon becomes tiring to use.

(a) Study board for general purpose form



3. TIME STUDY FORMS

- Studies can be made on plain paper, but it is a nuisance having to rule up new sheets every time a study is made.
- It is a great convenience to have printed forms of a standard size so that they can be filed neatly for reference, an essential feature of well-conducted time study.
- Printed or cyclostyled forms also ensure that time studies are always made in a standard manner and that no essential data are omitted.
- The number of different designs of time study forms is probably not far short of the number of work study departments in the world.
- Most experienced work study men have their own ideas on the ideal layout.
- The examples shown in the next slides represent designs which have been proved in practice to be satisfactory for general work.
- The principal forms used in time study fall into two groups: those used at the point of observation while actually making the study, and which should therefore be of a size to fit conveniently on the study board;
- And those which are used after the study has been taken, in the study office.

Forms Used on the Study Board

1. **Time study top sheet**:
   the top and introductory sheet of a study, on which is recorded all the essential information about the study, the elements into which the operation being studied has been broken down, and the break points used.

- It may also record the first few cycles of the study itself.
- The example shown has spaces in the heading for all the information normally required about a study except the sketch of the workplace layout, which should either be drawn on the reverse of the sheet, if the layout is very simple, or should be drawn on a separate sheet (preferably of squared paper) and attached to the study.

TIME STUDY TOP SHEET

DEPARTMENT:	STUDY No.: SHEET No.: OF
OPERATION: M.S. No.:	TIME OFF: TIME ON: ELAPSED TIME:
PLANT/MACHINE: No.:	
TOOLS AND GAUGES:	OPERATOR: CLOCK No.:
PRODUCT/PART: No.: DWG. No.: MATERIAL QUALITY:	STUDIED BY: DATE: CHECKED:

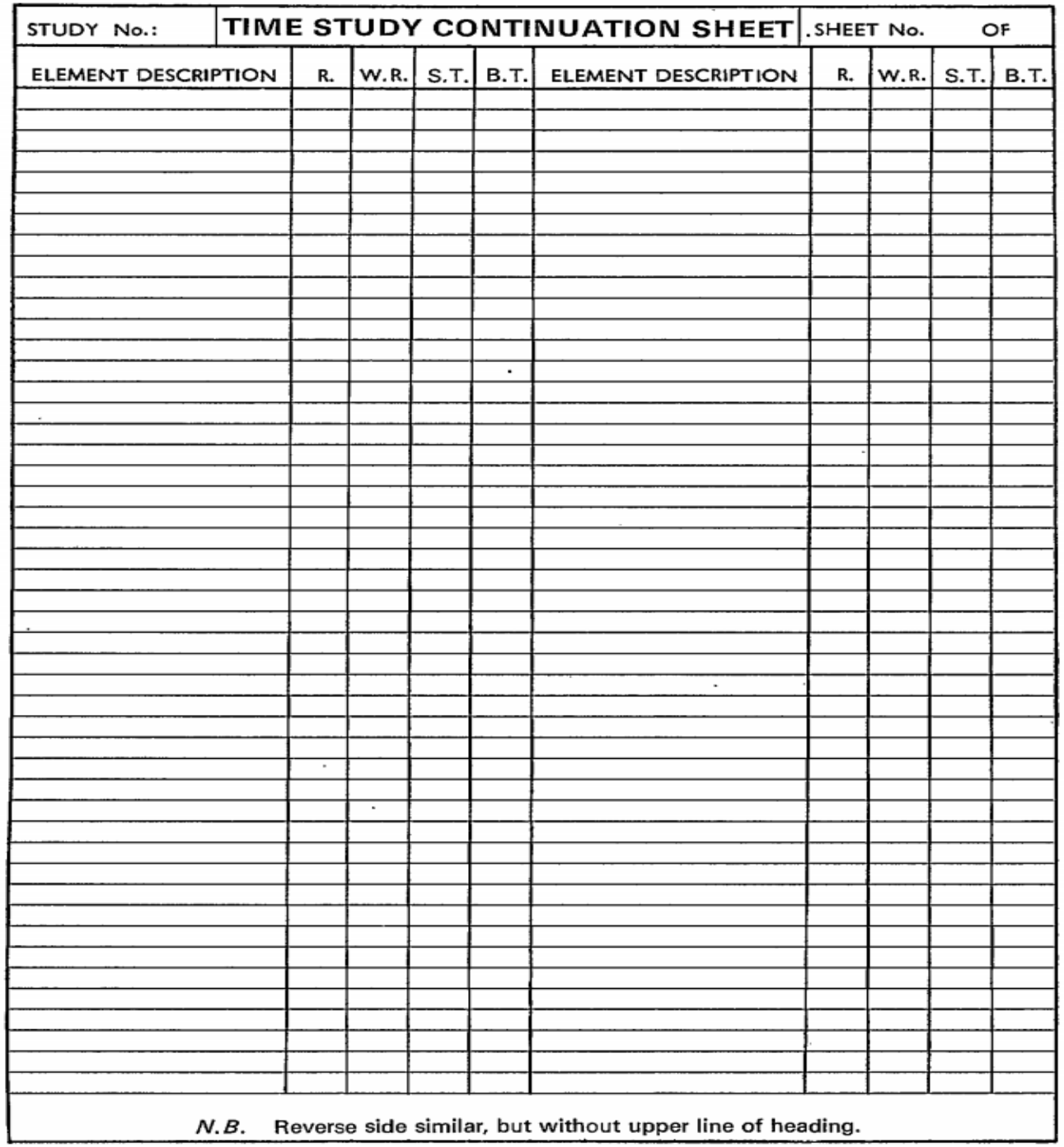
N.B. Sketch the WORKPLACE LAYOUT/SET-UP/PART on the reverse, or on a separate sheet and attach

ELEMENT DESCRIPTION	R.	W.R.	S.T.	B.T.	ELEMENT DESCRIPTION	R.	W.R.	S.T.	B.T.

N.B. R. = Rating. W.R. = Watch Reading. S.T. = Subtracted Time. B.T. = Basic Time.

2. Continuation sheet: for further cycles of the study.

- An example is shown in figure, from which it will be seen that the form consists only of the columns and space for the study and sheet number.
- It is usual to print this ruling on both sides of the paper; on the reverse side the heading is not necessary.
- These two forms are the ones most generally used. Together they are adequate for most general time study work.



STUDY No.:	TIME STUDY CONTINUATION SHEET				.SHEET No. OF				
ELEMENT DESCRIPTION	R.	W.R.	S.T.	B.T.	ELEMENT DESCRIPTION	R.	W.R.	S.T.	B.T.

N.B. Reverse side similar, but without upper line of heading.

3. Short cycle study form.

- For the recording of short cycle repetitive operations, however, it is convenient to use instead a specially ruled form.
- A short cycle form That is shown in figure shows a simple type of form which serves very well for most common short cycle work.

SHORT CYCLE STUDY FORM

DEPARTMENT:	SECTION:	STUDY No. SHEET No.: OF:
OPERATION:	M.S. No.:	TIME OFF: TIME ON: ELAPSED TIME:
PLANT/MACHINE: TOOLS AND GAUGES:	No.	OPERATOR: CLOCK No.:
PRODUCT/PART: DWG. No.	No. MATERIAL:	STUDIED BY: DATE:
QUALITY:	WORKING CONDITIONS:	CHECKED:

N.B. Sketch the workplace overleaf.

El. No.	ELEMENT DESCRIPTION	Observed Time 1	2	3	4	5	6	7	8	9	10	Total O.T.	Average O.T.	R	B.T.

N.B. R = Rating. O.T. = Observed Time. B.T. = Basic Time.

SELECTING THE JOB TO BE STUDIED

- As in method study, the first step in time study is to select the job to be studied.
- Generally speaking, there are few occasions when a work study man can go into a factory or a department and select a job at random.
- There is nearly always a reason why a particular job requires attention. Some possible reasons are

1. The job in question is a new one not previously carried out (new product, component, operation or set of activities).
2. A change in material or method of working has been made and a new time standard is required.
3. A complaint has been received from a worker or workers' representative about the time standard for an operation.
4. A particular operation appears to be a "bottleneck" holding up subsequent operations and possibly (through accumulations of work in process behind it) previous operations.
5. Standard times are required prior to the introduction of an incentive scheme.
6. To investigate the utilization of a piece of plant the output of which is low, or which appears to be idle for an excessive time.
7. As a preliminary to making a method study, or to compare the efficiency of two proposed methods.
8. When the cost of a particular job appears to be excessive.

- If the purpose of the study is the setting of performance standards it should not normally be undertaken until method study has been used to establish and define the most satisfactory way of doing the job.
- The amount and nature of the reduction in work may vary at different times, according to which worker happens to be doing the job and the method he chooses to employ.
- The quantity of work involved in the process or operation may actually increase, if an operative less skilled than the one originally timed does the job later on and uses a method more laborious than that on the basis of which the time was set
- Until the best method has been developed, defined and standardized the amount of work which the job or process involves will not be stable.
- Therefore make sure the method is right, first. Remember, too, that any one time should refer only to one specified method

Time study and approach to the worker

A. One should always speak to the supervisor of the line before approaching the operator that he/she wants to study.

- This is to ensure that everything is OK before going on with the study.

B. One should always be polite, well mannered and friendly to the operator without being familiar.

- He/she should listen with attention to anything that operator may have to say about the operation.

C. Should ask the individual operator's permission to take the study, even though it has been agreed with the supervisor (There are times when it is not convenient even for the willing operator).

D. Stand in full view of the operator, but outside his/her normal vision and path of movement.

E. At the end of the study thank the operator for co-operating and tell the operator that the study is finished.

F. Once the study has been completed, the total time recorded should be compared to the total time taken for the study.

- If there is a difference of more than 2% the study is not sufficiently accurate, it must be redone.

G. It is most important to make the operator relax before and during the study.

- A distinction is made in time study practice between what are termed representative workers and qualified workers.
- A representative worker is one whose skill and performance is the average of the group under consideration. He is not necessarily a qualified worker.
- A qualified worker is one who is accepted as having the necessary physical attributes, who possesses the required intelligence and education, and has acquired the necessary skill and knowledge to carry out the work in hand to satisfactory standards of safety, quantity and quality.
- In setting time standards, especially when they are to be used for incentives, the standard to be aimed at is one which can be attained by the qualified worker, and which can be maintained without causing him excessive fatigue.
- The study of slow or unskilled workers or of exceptionally fast workers will tend to result in the setting of time standards that are either unduly large (known as "loose“ times), and hence uneconomic, or unduly short (known as "tight" times), in which case they are unfair to the worker and will probably be the subject of complaints later.

STEPS IN MAKING A TIME STUDY

- Once the work to be measured has been selected the making of a time study usually consists of the following eight steps

1. Obtaining and recording all the information available about the job, the operator and the surrounding conditions, which is likely to affect the carrying out of the work.
2. Recording a complete description of the method, breaking down the operation into "elements“
3. Examining the detailed breakdown to ensure that the most effective method and motions are being used.
4. Measuring with a timing device (usually a stopwatch) and recording the time taken by the operator to perform each "element" of the operation.
5. At the same time assessing the effective speed of the working of the operative in relation to the observer's concept of the rate corresponding to standard rating.
6. Extending the observed times to "basic times“
7. Determining the allowances to be made over and above the basic time for the operation.
8. Determining the "standard time" for the operation.

BREAKING THE JOB INTO ELEMENTS

- An element is a distinct part of a specified job selected for convenience of observation, measurement and analysis.
- A work cycle is the sequence of elements which are required to perform a job or yield a unit of production. The sequence may sometimes include occasional elements.
- A work cycle starts at the beginning of the first element of the operation or activity and continues to the same point in a repetition of the operation or activity.
- That is the start of the second cycle.
- Elements should be easily identified with definite beginnings and endings, so that once established they can be repeatedly recognized.
- The point at which one element ends and another begins is called a “breakpoint”,
- These breakpoints can be either seen or heard.
- Elements should be no less that 0.05 of a minute and no longer than about 0.6 of a minute.

A detailed breakdown into elements is necessary

1. To ensure that productive work (or effective time) is separated from unproductive activity (or ineffective time).
2. To permit the rate of working to be assessed more accurately than would be possible if the assessment were made over a complete cycle.
   - The operative may not work at the same pace throughout the cycle, and may tend to perform some elements faster than others.
3. To enable the different types of element to be identified and distinguished, so that each may be accorded the treatment appropriate to its type.
4. To enable elements involving high fatigue to be isolated and to make the allocation of fatigue allowances more accurate.
5. To facilitate checking the method and so that the subsequent omission or insertion of elements may be detected quickly. This may become necessary if at a future date the time standard for the job is queried.
6. To enable a detailed work specification to be produced.
7. To enable time values for frequently recurring elements, such as the operation of machine controls or loading and unloading work pieces from fixtures, to be extracted and used in the compilation of synthetic data

Types of Element

- Eight types of element are distinguished:

1. Repetitive
2. Occasional
3. Constant
4. Variable
5. Manual
6. Machine
7. Governing
8. Foreign elements.

- The definition of each, as given in the British Standard Glossary of Terms in Work Study, is listed below

- A **repetitive element** is an element which occurs in every work cycle of the job.
- Examples: the element of picking up a parts prior to an assembly operation; putting aside a finished component or assembly.
- An **occasional element** is an element which does not occur in every work cycle of the job, but which may occur at regular or irregular intervals.
- Examples: clearing machine ; adjusting the tension, or machine setting; receiving instructions from the foreman.
- The occasional element is useful work and a part of the job. It will be incorporated in the final standard time for the job.
- A **constant element** is an element for which the basic time remains constant whenever it is performed.
- Examples: switch on machine; gauge diameter; screw on and tighten nut; insert a particular cutting tool into machine.
- A **variable element** is an element for which the basic time varies in relation to some characteristics of the product, equipment or process, e.g. dimensions, weight, quality, etc.
- Examples: saw logs with handsaw (time varies with hardness and diameter); sweep floor (varies with area); push trolley of parts to next shop (varies with distance).

- A **manual element** is an element performed by a worker.
- A **machine element** is an element automatically performed by a power-driven machine (or process).
- Examples: bar-tacking, button sewing
- A **governing element** is an element occupying a longer time than that of any other element which is being performed concurrently.
- Examples: front and back assembly
- A **foreign element** is an element observed during a study which, after analysis, is not found to be a necessary part of the job.
- Examples: unnecessary movement

Guidelines To Breakdown The Job Into Elements

(a) Elements should be easily identifiable, with definite beginnings and endings.

(b) Elements should be as short as can be conveniently timed by a trained observer.

- The smallest practical unit that can be timed with a stopwatch is 2.4 s.

(c) As far as possible, elements – particularly manual ones – should be chosen so that they represent naturally unified and recognizably distinct segments of the operations.

(d) Manual elements should be separated from the machine elements.

(e) Constant elements should be separated from variable elements.

(f) Elements which do not occur in every cycle (i.e., occasional and foreign elements) should be timed separately from those that do.

TIMING EACH ELEMENT: STOPWATCH PROCEDURE

- There are two principal methods of timing with the stopwatch:
- Cumulative timing;
- Fly-back timing.
- In cumulative timing the watch runs continuously throughout the study.
- It is started at the beginning of the first element of the first cycle to be timed and is not stopped until the whole study is completed.
- At the end of each element the watch reading is recorded.
- The individual element times are obtained by successive subtractions after the study is completed.
- The purpose of this procedure is to ensure that all the time during which the job is observed is recorded in the study.
- In fly back timing the hands of the stopwatch are returned to zero at the end of each element and are allowed to start immediately, the time for each element being obtained directly.
- The mechanism of the watch is never stopped and the hand immediately starts to record the time of the next element.
- The sum of the times of all the elements and other activities noted in the study plus ineffective time plus the check times is known as the "recorded time" and is also noted.

- The experience of I.L.O. missions in teaching and applying time study has in fact shown that, generally speaking, cumulative timing should be taught and used, for the following reasons:
- Experience suggests that trainees achieve reasonable accuracy in the use of the stopwatch more quickly using the cumulative method.
- It does not matter if element times are occasionally missed by inexperienced observers; the over-all time of the study will not be affected. Foreign elements and interruptions are automatically included since the watch is never stopped.
- In assessing the working pace of the operator ("rating") it is less easy to fall into the temptation to adjust the rating to the time taken by the element than with the flyback method, since only watch readings and not actual times are recorded.

- Cumulative timing has the advantage that even if an element is missed or some occasional activity not recorded, this will have no effect on the over-all time.
- Workers and their representatives are likely to have greater faith in the fairness of time studies as a basis for incentive plans if they can see that no time can have been omitted.
- The introduction of time study into an undertaking or an industry may be made easier.
- Continuous timing is therefore likely to be more accurate for short-element short-cycle work, while fly back timing can be more safely used in jobs with long elements and cycles, since the error becomes too small to matter.

HOW MANY CYCLES SHOULD BE TIMED

- Time study is a sampling technique.
- The accuracy with which the final values obtained represent the true time values for the elements of an operation.
- The total time for the operation itself will depend to some extent on the size of the sample.
- Certain general principles govern the number of cycles to be observed to obtain a reasonably representative time for any particular operation.
- These are as follows:

A. It would be unusual for a standard time to be compiled from the recordings made during a single study.

- it is necessary to observe the operation as carried out by different workers, at different times during the day, or on different shifts.

B. The number of cycles through which any particular job should be observed varies directly as the amount of variation in the times of the elements of the job.

- Jobs in which there are variations in material from piece to piece, difficulties in locating workpieces accurately in fixtures, fineness of finish or close tolerances have to be observed through a greater number of cycles than those carried out in standard conditions.

C. The number of cycles to be observed will depend on the degree of accuracy desired.

- This in turn will depend on the length of run of the job and the number of people engaged on it

D. The studies should be continued through a sufficient number of cycles to ensure that occasional elements such as handling boxes of finished parts, periodical cleaning of machines or workplaces, or sharpening tools can be observed several times.

E. Where more than one operative is engaged on the same job it is preferable to make short studies (say ten cycles) of the work of each of several operatives rather than one long one on a single worker.

✓In general at least 50 cycles of short cycle operations and at least 20 or 30 cycles of longer cycle work should be observed.