WORK STUDY

WORK STUDY

The purpose of an industrial enterprise is to MAKE MONEY by utilising all the combined resources available to it to produce goods (manufacturing industries, farming, market gardening, etc.) or to provide services (bus companies, railways, airlines, postal and telegraphic services, electricity, gas and water boards, retail businesses, etc.).

The resources at the disposal of the enterprise are:-
(1) LAND and BUILDINGS
(2) MANPOWER - comprising all the men and women who receive wages and salaries from the enterprise in return for the activities they carry out for the enterprise.
(3) MATERIALS and SERVICES, comprising all the materials and services required by the enterprise to carry out its activities and that are bought by the enterprise.
(4) PLANT, MACHINES and TOOLS, comprising ALL the plant, equipment and tools used in the carrying out of the activities of the enterprise.

These resources are the INPUT to the enterprise, because the enterprise cannot function without them. They must be paid for in MONEY.

The OUTPUT from the enterprise is the money it receives for the goods it sells or for the services it sells.

The way in which all the combined resources available to the enterprise is used determines the PRODUCTIVITY of the enterprise.

PRODUCTIVITY = OUTPUT/INPUT

When the productivity of an enterprise is greater than unity the enterprise can survive, but if it is less than unity the enterprise will fail and become bankrupt unless steps are taken to increase the productivity. -There is only one course of action open to an ailing concern in a competitive market if it is to remain solvent. It cannot raise its prices above those of its competitors because it would no longer be competitive but it must INCREASE PRODUCTIVITY BY BECOMING MORE EFFICIENT. Consequently, HIGHER PRODUCTIVITY MEANS MORE OUTPUT FROM THE SAME RESOURCES. It results in lower costs per unit of output and higher net money returns per unit of output.

In the long term it is only through increase in productivity that higher living standards can be attained because the results of higher productivity are:-
(a) Larger supplies of goods at lower real costs and lower real prices.
(b) Higher real earning power of wages with consequent improvement in living conditions.
(c) Improved working conditions and shorter working hours.
(d) Higher purchasing power of the dividends of shareholders, resulting in further investment and industrial growth.
(e) A strengthening of the economies of enterprises and countries.

Many factors affect the productivity of an enterprise. Some of these factors, such as the taxation policies of governments and interest rates, the availability of raw materials, suitable equipment and manpower and the general level of the demands for goods are outside the control of any one enterprise. Other factors, however, can be controlled from inside an enterprise and it is these that can be investigated by WORK STUDY.

The term WORK STUDY is used for the techniques which are employed to achieve the best possible use of available resources in carrying out a specified activity. Work study is concerned with productivity and is a major weapon of attack on the problem of increasing productivity. The purpose of work study is to increase the amount produced from given resources. In many cases, this increase can be achieved without (or with only a very small) further capital expenditure.

It is the responsibility of MANAGEMENT to make use of these techniques in order to make sure that the best use really is made of all the combined resources available to the enterprise. Since most companies pay approximately the same for their resources of staff, labour, plant, materials, subcontractors, etc., the reason why some are more competitive than others is that they use more efficient and economical methods in the offices and on the shop floor.

Work study is the most penetrating tool of investigation available to management and is also the most penetrating tool for investigating management. The work-study specialist's job is to lay bare the activities of the company, whether good or bad, at all levels from the top executive to the shop floor. His job is one that requires great tact since it will always mean that some people, perhaps at high management level, will be 'shown up'. If he makes enemies of these people, he will be unable to do his job properly.

WORK STUDY embraces the two techniques of WORK MEASUREMENT and METHOD STUDY.

WORK MEASUREMENT is concerned with the application of techniques to establish the WORK CONTENT of a specified task by determining the TIME required for carrying out a DEFINED STANDARD OF PERFORMANCE BY A TRAINED WORKER. We note that WORK CONTENT is measured in terms of TIME and that TIME is measured, ultimately, in terms of MONEY.

METHOD STUDY is concerned with the reduction of the work content of the operation (process) and is the systematic recording, analysis and critical examination of existing and alternative ways of carrying out an operation (process) and the development and application of more efficient methods.

Work study is really as old as man, being always practised as an unconscious art by any person who succeeds in making a job easier by using his reason. However, credit for introducing strictly systematic and analytical approaches to ensure the best possible use of human and material resources in carrying out a specified activity, which is really 'finding the best way of doing the job', is given to the Americans, F.W. Taylor and the Gilbreths (F.B. Gilbreth and his wife, Lillian), who started introducing their techniques during the latter part of the 19th century. Much of their work had, in fact, been anticipated in the United Kingdom and to a lesser extent in France by men whose ideas were ignored by industrialists in Europe.

WORK STUDY

The vital factor in dealing with the question of productivity is TIME and time is measured in MAN HOURS and MACHINE HOURS.

A MAN HOUR is the labour of one man for one hour.

A MACHINE HOUR is the running of a machine or a piece of plant for one hour.

If a machine is available for production or ancillary work but is not used owing to shortage of work, materials or workers, it is said to be IDLE and the time it remains out of use is MACHINE IDLE TIME. Note that a machine must be available for use but not in use if it is to be considered idle. Thus machines that are being prepared for production, are being dismantled after production or are out of operation because of maintenance requirements are not to be classed as idle.

An idle machine means money wasted because the work it could have done if it had been running during its idle time is lost.

TIME is required to carry out any job and any operation (process) and we talk about the WORK CONTENT of a product or operation; the work content is measured in terms of man-hours and machine-hours.

The manufacturing time of a product or the time required to carry out an operation is almost inevitably greater than the work content because of INEFFECTIVE TIME.

The MANUFACTURING TIME or TIME OF AN OPERATION = WORK CONTENT + INEFFECTIVE TIME.

INEFFECTIVE TIME is the time when man or machine, or both, is/are not working; it is clear that productivity will be increased if ineffective time is reduced or, if possible, eliminated.

If all things were as good as they could possibly be (i.e. if the design of the product were perfect; if the best methods and machines were used, etc.) then it is clear that the least amount of 'work' (time) would be required to produce a product (or to carry out an operation). This minimum time can be considered as the IDEAL WORK CONTENT.

In practice, nothing is perfect, so:-
WORK CONTENT = IDEAL WORK CONTENT + WORK CONTENT ADDED BY ALL DEFECTS
(of design methods, etc.).

The ideal content is an unattainable ideal minimum time, but all possible attempts should be made to strive to attain it by eliminating as much as possible of the added work content since this leads, once again, to an increase in productivity.

We must bear in mind that the ideal work content at any given time may not be the ideal work content at a later time. It can be decreased as new processes and new materials are developed.

We now list the factors that influence INEFFECTIVE TIME and EXCESS WORK CONTENT. This will give us some idea of the scope of METHOD STUDY

INEFFECTIVE TIME

Most ineffective time results from the shortcomings of management and the rest is in the control of the workers. All ineffective time resulting from management shortcomings can be investigated by method study. Ineffective time in the control of the workers is influenced to some extent by the attitude of management to the well-being of workers

Management shortcomings may lead to ineffective time by:-.

(1) Manufacturing too wide a range of products. It is not possible to optimise production because too many short runs of each type are needed. Machines are too often not working because of the frequent setting up and dismantling required to change them over to manufacturing different products. Workers don't have the opportunity to acquire speed and efficiency in their actions.

(2) Failing to standardise component parts as much as possible. This has the same effect as (1), because too many different parts serving essentially the same purpose are manufactured.

(3) Bad planning and control of work and orders so that one order does not follow immediately on another. Plant and labour are not, therefore, working all the time.

(4) Changing component designs while the parts are in the course of production. Changes of design cause stoppages of work and loss of working time as well as waste of materials the 'old' parts have to be scrapped.

(5) Failing to ensure the supplies of raw materials, tool and other requirements necessary to do the work so that plant an labour are kept waiting.

(6) Failing to maintain plant and machines in good working conditions so that machine breakdowns occur; work may be scrapped or have to be rectified because machines are in poor working order.

(7) Failing to provide good working conditions in which operatives can work efficiently.

(8) Failing to take proper precautions for the safety of workers. Accidents cause lost time.

Workers can cause ineffective time by:-

(1) Taking time off without good cause; by starting late and finishing early; by idling or deliberately 'going slow'; by taking tea breaks longer than allowed.

(2) Careless workmanship. This results in work which must be either scrapped or done gain.

(3) Failing to observe, or by deliberately disobeying, safety regulations so that accidents occur to themselves or others.

WORK CONTENT ADDED BY MANAGEMENT SHORTCOMINGS

The management is responsible for all causes of excess work content and all these causes can be investigated by METHOD STUDY. They can be classified into two groups:- (a) defects in the design and specification of the product,
and (b) inefficient methods of manufacture or operation.

(1) Work content added by defects in design, etc., may be caused by:

(a) Bad design, so that it is impossible to use the most economical processes or manufacturing methods; or unnecessary work must be carried out because the design is unnecessarily complicated.

(b) Manufacturing an excessive variety of products or by lack of standardisation of components, so that batches of work have to be small and cannot be put on special-purpose high-production machines (but have to be done on slower, general purpose machines).

(c) Incorrect quality standards, whether too high or too low. Unnecessary precision must be paid for. It results in unnecessary increase in work content as well as resulting in more defective items and wasted material than necessary. The general rule nowadays is 'good enough is good enough'. Material of too low a quality may be difficult to work to the required finish or, in the case of plate, say, the surface may require additional operations, such as cleaning, to make it usable; or it may be difficult to machine.

(d) Too much excessive material having to be removed. This has been a frequent cause of excess work content in the past and may result from poor design (e.g. shafts with very large and very small diameters designed on one piece) and from the use of bar stock larger than that necessary. In addition to the excess work content there is also the loss of money resulting from the wasted material. Although scrap metal can be collected and sold, the price obtained for it is much lower than the price that has to be paid for the material into which it is processed.

(2) Work content added by inefficient methods of manufacture or operations may be caused by:

(a) Using the wrong type or size of machine, or one which has a lower output than the correct one.

(b) Not operating the process properly; or by using a machine or plant when it is in poor condition.

(c) Using the wrong hand tools, e.g. the wrong type, cut or size of file or the wrong type of hammer.

(d) Poor layout of factory or workshop or workplace so that unnecessary movements (and therefore wasted movements) must occur. Movement takes time and effort and unnecessary movement increases excess work content.

(e) The operator using bad working methods involving wasted movements, time and effort. The cause is either bad planning of the working methods or poor training of the operator.

We must remember that the factors that influence excess work content and ineffective time can be investigated in OFFICES as well as on the shop floor. Since work goes on in offices year in and year out, it is evident that inefficient use of office staff, office equipment and office materials represent a waste of money. Thus the productivity of an enterprise can be increased by improving office procedures and by making better use of office staff as well as by improving manufacturing methods and procedures. The co-ordinated procedure for work study is shown in figure (1). Method study results in more efficient use of available resources; work measurement results in improved planning and control and consequent reduction in ineffective time.

METHOD STUDY

The ESSENTIAL steps and ESSENTIAL sequence of steps in a method study are:

SELECT the work to be studied. It may affect an individual job, a section of an establishment, or an entire establishment.

DEFINE the objectives of the study. Their achievement may involve a sequence of events, the utilisation of capital, materials, people, equipment or space, or the location of events and activities.

RECORD all relevant facts about the present method by DIRECT OBSERVATION, using any combination of charts indicating process sequence; charts using a time scale; diagrams indicating movement; filming techniques.

EXAMINE these facts CRITICALLY and in ordered sequence, using critical analysis and economy of human movement and the techniques best suited to the purpose.

DEVELOP the most practical, economic and effective method, having due regard to all contingent circumstances; and examine critically to make sure that this is the best method.

DEFINE the new method so that it can always be identified, using written descriptions and any necessary sketches of special tools, etc.; and diagrams of workplace layout.

INSTALL the new method as standard practice.

MAINTAIN that standard practice by routine checks.

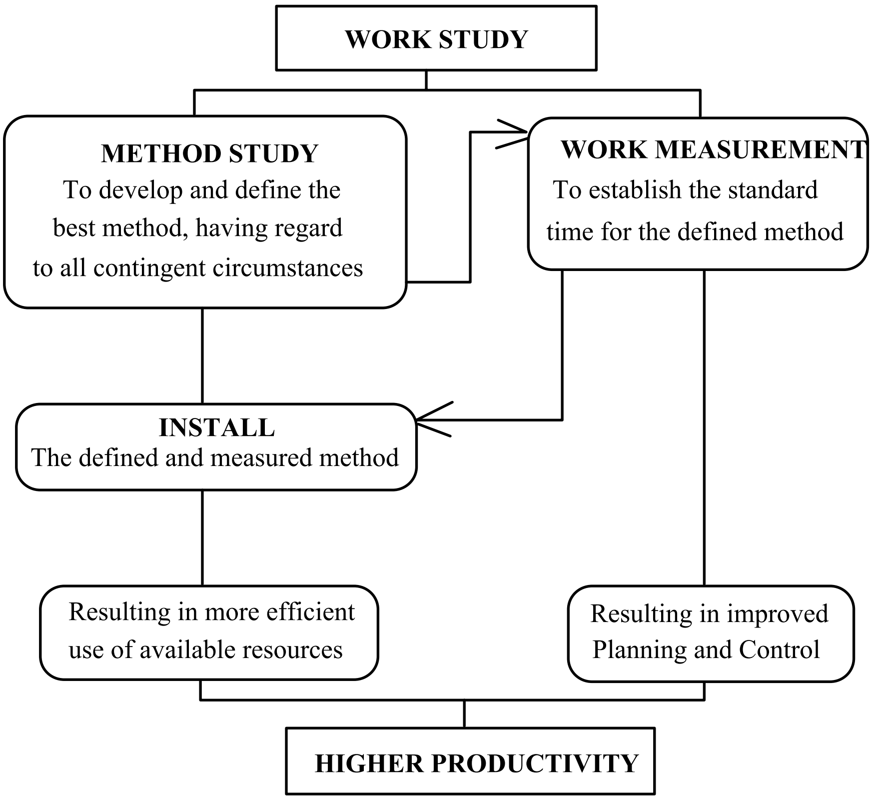


FIGURE 1

The co-ordinated procedure for work study is shown in Figure 1. Method study results in more efficient use of available resources; and work measurement results in improved planning and control and consequent reduction ineffective time.

SELECTION OF WORK TO BE STUDIED AND DEFINING OF THE OBJECTIVES

The first step in the problem-solving procedure is often the need to recognise that a problem exists. Sometimes there are cases when it is clear that some action is needed (e.g. a 'bottle-neck' in some part of a production line holding up other production operations; cost of production too high to be competitive; need to increase output, etc.) In many cases, however, it is not easy to appreciate at first glance that a problem exists.

The FIRST consideration must be ECONOMIC. It is a waste of time and money to start a long investigation of a job if the economic importance o the job is small and it is not expected to run for long; so the first question must always be "Will it pay to begin a method study of this job?".

If it is decided to proceed with a method study then information is obtained from the management on such factors as the importance of the problem and the time available for its solution. The objectives of the study should be defined as broadly as possible, because this gives greater freedom for the use of imagination and creativity in finding a solution. The tentative means by which the work study analyst will attempt to arrive at the goal are also considered.

It is most important that adequate technical knowledge is available with which to carry out the study. The analyst must be in a position to seek advice of experts on any matters encountered in the study. Precise information is required and not "perhaps it could be done".

The work study specialist provides a service to the management and his role is an advisory one. The management has to select the work it is going to have studies on the evidence presented to it and it should be in a position to list the objectives for study in order of importance. It does this in the light of the advice it receives from the work study department and the decision on whether or not the cost of a method study is worthwhile will depend on whether a change from present methods will:

1. Increase production and reduce costs.
2. Maintain the same production with less labour, materials or equipment
3. Improve quality without additional labour and equipment.
4. Improve safety conditions
5. Improve standards of cleanliness
6. Reduce scrap.

'Bottlenecks', as mentioned above, clearly need to be investigated, and other early choices are repetitive work which runs for a long time and uses a great deal of labour; and movements of materials over very long distances when a great deal of manpower and equipment is used.

If work study is being introduced into a factory for the first time, item 5 may be worth considering first of all. People are afraid of change but if considerable improvement in working conditions of a dirty job, or a job involving the handling of heavy loads, can be brought about by work study, then they will accept more readily changes in procedures of more pleasant jobs.

It is always important to keep all persons concerned informed about the general principles and objectives of a method study, in order to lessen the chance of serious labour disputes.

RECORDING THE FACTS

All the relevant facts concerning the existing method must be recorded clearly and concisely. Written descriptions are usually too long to be fully understood without very careful study; and the means used to record facts clearly and concisely are CHARTS and DIAGRAMS.

These charts and diagrams may, in general, be classified into the following groups:

a. Charts indication PROCESS SEQUENCE, or SEQUENCE OF OPERATIONS. These are commonly called PROCESS CHARTS, but some authorities use this name for other types of chart as well;
b. Charts using TIME SCALE;
c. Charts and diagrams indication MOVEMENT of MEN, MATERIALS or EQUIPMENT.

These charts lend themselves equally well to the routines of production, selling, accounting, office work, etc., so their use is not restricted solely to production processes.

(a) Process Charts (Charts indication process sequence)

The actions which occur during process sequences are represented by the following symbols:

OPERATION

An operation occurs when an object is intentionally changed in any of its physical or chemical characteristics, is assembled or disassembled from another object, or is arranged for another operation, transportation, storage or inspection.

An operation also occurs when information is given or received, or when planning or calculating takes place.

The terms ‘object’ and ‘material’ are to be interpreted in a very broad way: they may refer to solid materials that are changed in any way - by machining, heat treatment, etc.; or they may refer to chemicals that are changed during a chemical process; or they may refer to a sheet of paper on which a letter is written; or to the information contained in the letter; and so on.

INSPECTION

An inspection occurs when an object is examined for identification or is verified for quality or quantity in any of its characteristics. An inspection does not take the material or task any nearer to completion. It merely verifies that an operation has been carried out correctly.

TRANSPORT

A transportation occurs when an object is moved from one place to another, except when such movements are a part of an operation or are caused by the operator at the work station during an operation or inspection. Transport indicates the movement of worker, materials, or equipment from place to place.

DELAY (OR TEMPORARY STORAGE)

A delay occurs to an object when conditions, except those which intentionally change the physical or chemical characteristics of the object, do not permit or require immediate performance the next planned operation. Delay is incurred when work is waiting between consecutive operations; or when an object is laid aside temporarily WITHOUT RECORD until required (on benches; on the floor of a workshop, etc.); or when cases or cartons await unpacking; or when a letter is waiting to be signed; etc.

STORAGE (OR PERMANENT STORAGE)

A storage occurs when an object is kept and protected against unauthorised removal; or when an item is retained for reference purposes.

The difference between storage and temporary storage, or delay, is that a formal authorisation (a requisition or chit) is required to get an article out of storage but not out of temporary storage.

When unusual situations outside the range of the definitions are encountered the intent of the definitions summarised below can be used.

Classification	Predominant Results
Operation	Produce or accomplishes
Inspection	Verifies
Transportation	Moves
Delay	Interferes
Storage	Keeps

IMPORTANT POINTS

1. Each activity symbol must be numbered. In almost all cases the FIRST symbol of any one kind is numbered 1; the SECOND of the SAME kind is numbered 2, etc.

2. Loading and Unloading Operations and Transportations
When several of the same part are loaded (for transportation) or unloaded (after transportation) and when several of the same part are transported the loading (or unloading) time per unit and transportation time per unit (THE UNIT TIME) are the loading (or unloading) time/number of parts loaded (or unloaded); and transportation time/number of parts transported.

   Similarly, when bar stock is loaded, or unloaded, or transported, the UNIT TIME is the (loading time; or unloading time; or transportation time)/number of components the bar stock is expected to produce.

3. Written alongside each symbol must be the data shown below. Note that is not usual to allocate times to inspections. In mass production work the amount of inspection is kept to a minimum by suing quality control techniques.

OPERATION	Measured Time for operation & Description of operation.
LOADING/UNLOADING	Distance Unit time moved & Description of operation.
OPERATION INSPECTION	Description of inspection
TRANSPORT	Distance moved & Unit time & Purpose of transportation.
DELAY	Delay time & Reason for delay.
STORAGE	The storage time & Where stored (except, perhaps, for first storage)
COMBINED ACTIVITIES	Measured time & Description of operation & inspection.

4. ALL charts MUST carry the following IDENTIFYING INFORMATION:

   SUBJECT CHARTED.
   Whether PRESENT or PROPOSED method.
   DRAWING NUMBER, PART NUMBER: or OTHER IDENTIFYING NUMBER.
   DATE CHARTED.
   The NAME or INITIALS of the person who charted it.

   In most cases, the initials or name of the person who approves the NEW method will be necessary.

   Each of the various kinds of charts we consider MUST also carry appropriate ADDITIONAL information.

The Outline Process Chart (or Operation Process Chart) is a chart showing the POINTS AT WHICH MATERIALS ARE INTRODUCED INTO A PROCESS; and the SEQUENCE of INSPECTIONS AND ALL OPERATIONS EXCEPT THOSE INVOLVED IN MATERIAL HANDLING. Sometimes the inspections are not included in the chart.

The outline process chart gives the very concise picture of a whole process or activity that is generally necessary before a detailed study can be started. It gives the overall picture by recording in sequence only the main operations and (usually) inspections.

Figures 2, 3 and 4 are the outline process charts for (i) a bolt; (ii) a washer; and (iii) a nut, produced by a man using a centre lathe.

Figure 5 illustrates the procedure for drawing the outline process chart for an assembly: in this case, the bolt, washer and nut assembly.

The sequence of operations and inspections for the main component (the bolt) is drawn near the right-hand edge of the chart. This sequence is the same as that shown in Figure 2.

The sequences of operations and inspections for the subsidiary components are then drawn to the left of that for the main component, in the order in which the subsidiary components are assembled to the main component. In the present case the washer is assembled first and then the nut.

OUTLINE PROCESS CHARTS

BOLT

SUMMARY

Operations	7	0.292 hrs
Inspections	4	

20 mm A/F Hex Steel Bar

Time (hrs)		
0.016	1	End faced
0.100	2	Shank turned
	$\boxed{1}$	Diameter checked
0.016	3	End chamfered
0.050	4	Thread cut with die
	$\boxed{2}$	Thread checked
0.040	$\boxed{3\text{-}5}$	Parted off; Head thickness checked
0.035	6	Chamfer cut
0.035	7	Deburred
	$\boxed{4}$	Final check

WASHER

SUMMARY

Operations	6	0.151 hrs
Inspections	1	

20 mm Dia Steel Bar

Time (hrs)		
0.016	1	End faced
0.020	2	Chamfer cut
0.020	3	End centre-drilled
0.025	4	Hole drilled
0.035	5	Parted off
0.035	6	Deburred
	$\boxed{1}$	Inspected

NUT

SUMMARY

Operations	7	0.199 hrs
Inspections	1	

20 mm A/F Hex Steel Bar

Time (hrs)		
0.016	1	End faced
0.020	2	Chamfer cut
0.020	3	End centre-drilled
0.030	4	Hole drilled
0.045	5	Thread cut with taps
0.035	6	Parted off
0.035	7	Deburred
	$\boxed{1}$	Inspected

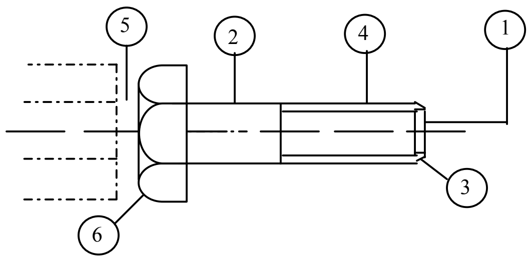


FIGURE 2

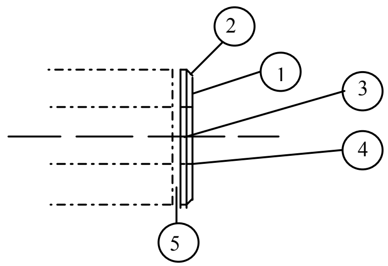


FIGURE 3

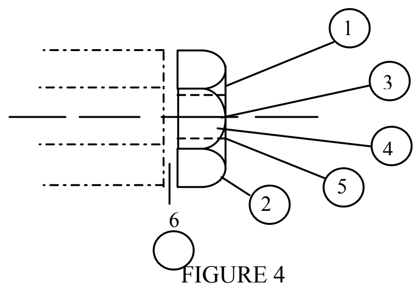


FIGURE 4

OUTLINE PROCESS CHARTS

BOLT, WASHER& NUT ASSEMBLY

SUMMARY
Operations 22 0.656 hrs
Inspections 6

1

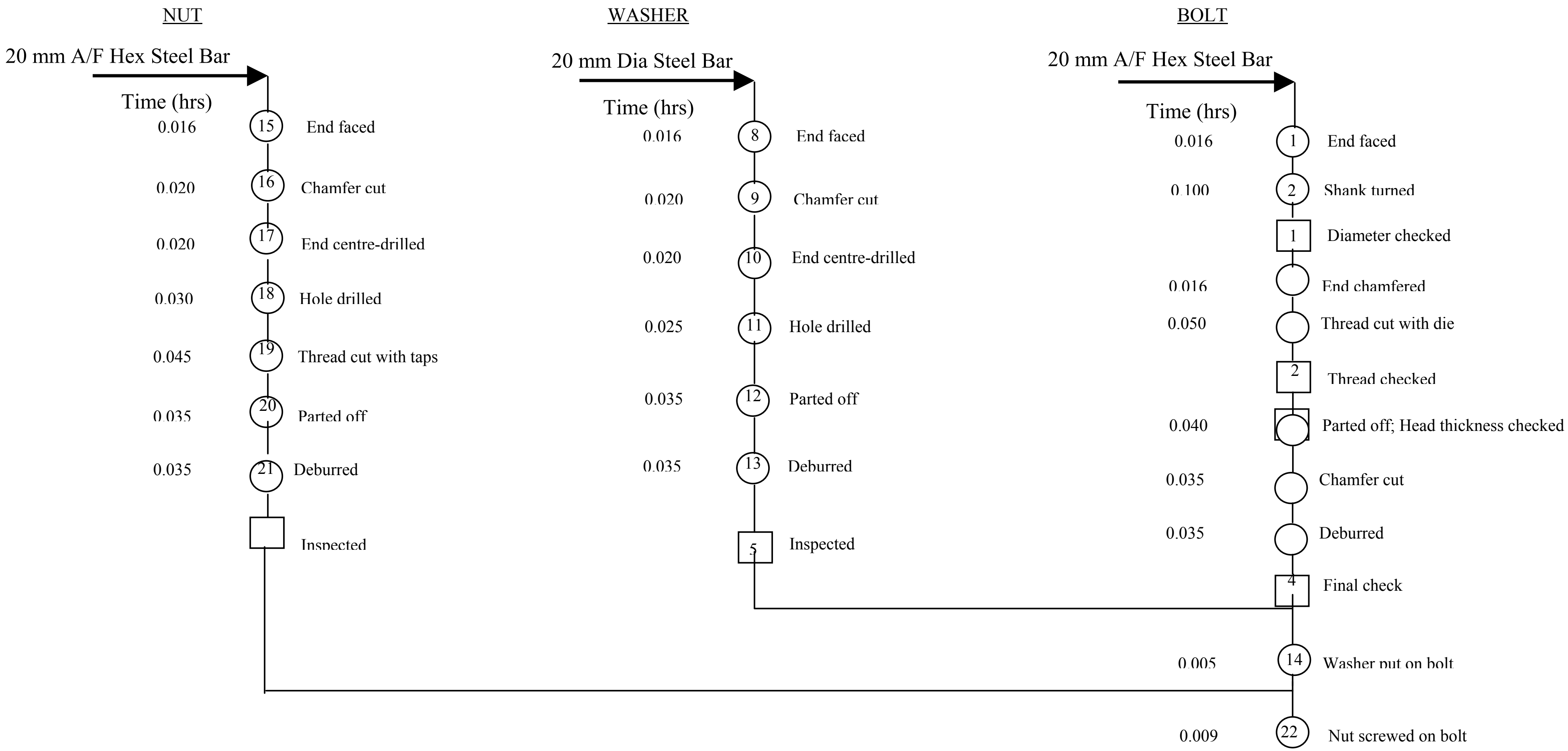
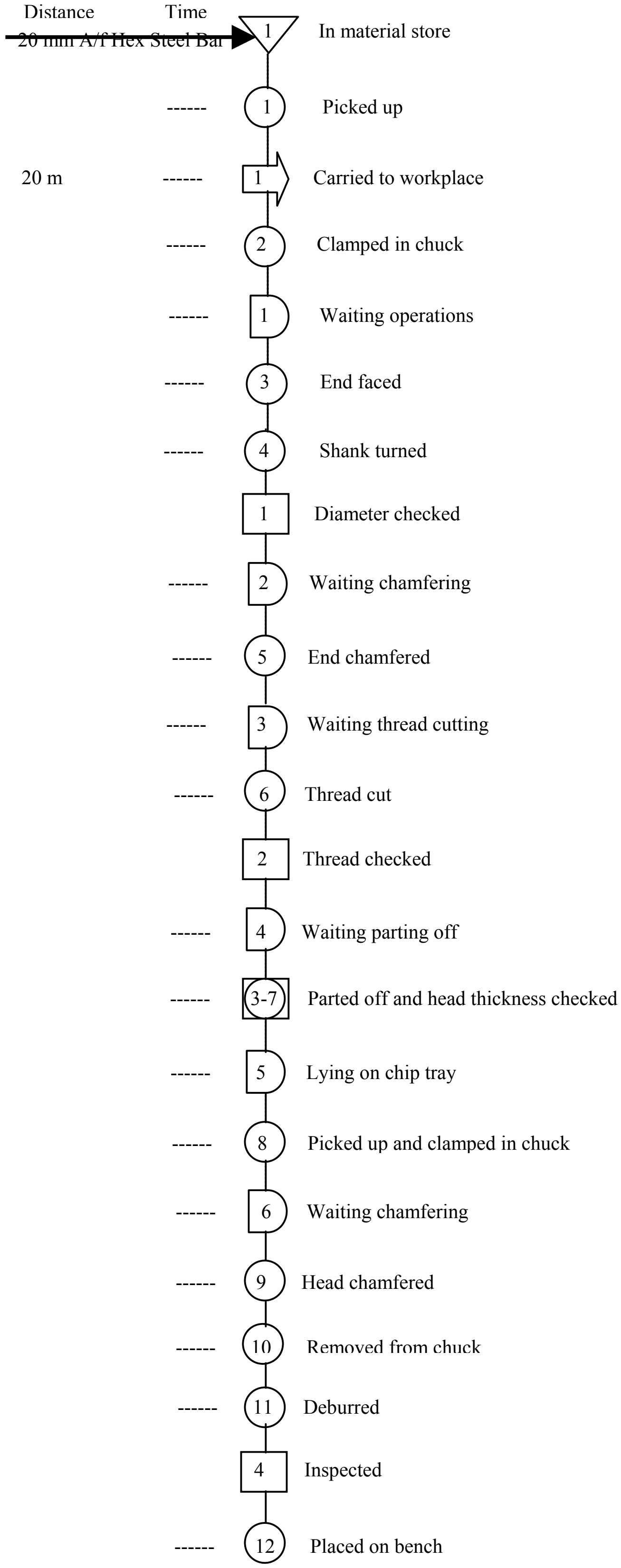


FIGURE 5

FLOW PROCESS CHARTS

BOLT

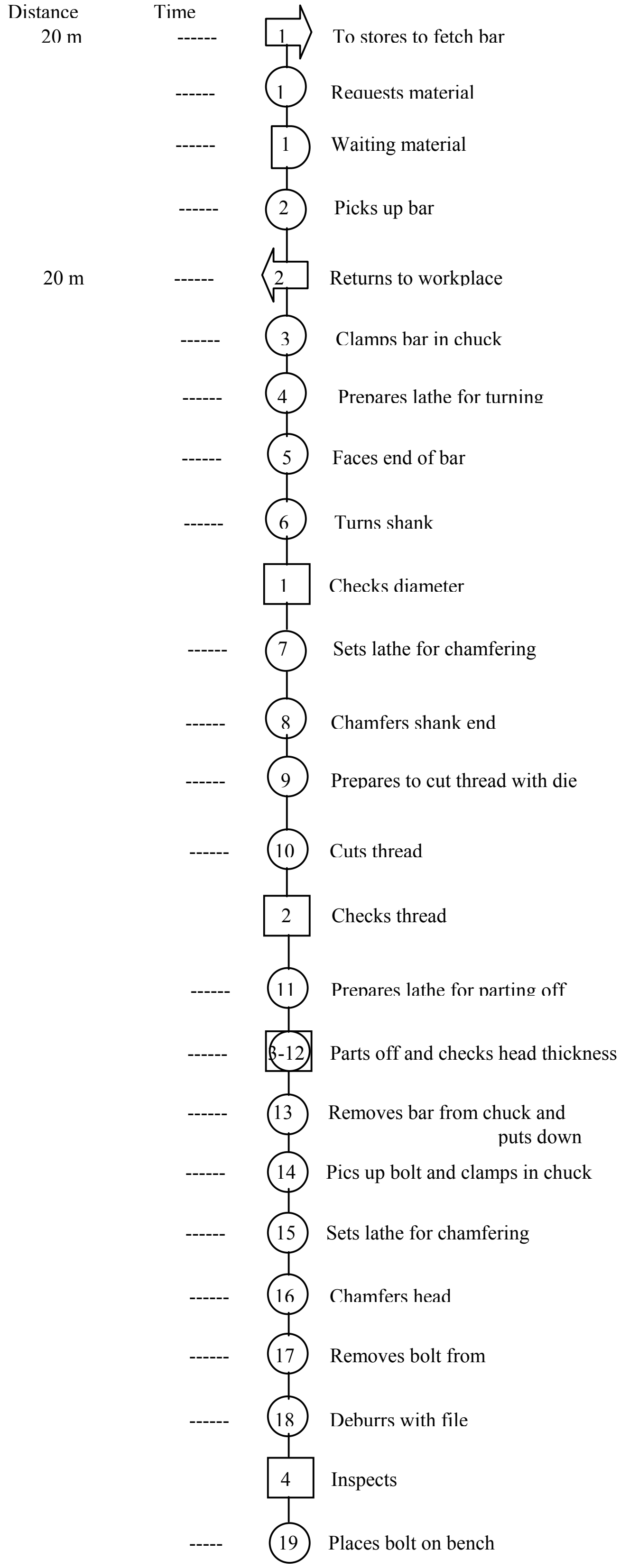


SUMMARY:

OPERATIONS	12	---- hrs	
INSPECTIONS	4		
TRANSPORTATIONS	1	---- hrs	20 m
DELAYS	6	---- hrs	
STORAGES	1		

FIGURE 6

MAN MAKING BOLT



SUMMARY:

OPERATIONS	19	---- hrs	
INSPECTIONS	4		
TRANSPORTATIONS	2	---- hrs	40 m
DELAYS	1	---- hrs	

FIGURE 7

Operations 8-13) in Figure 5 correspond to (operations 1-6

Inspection 5) (inspection 1in Figure 3

Operations 15-21) in Figure 5 correspond to (operations 1-6
Inspection 6) (inspection 1 in Figure 4.

The Flow Process Chart shows the sequence of all operations, inspections, transportations, delays and storages occurring during a process or procedure; and therefore includes distances as well as times.

Flow process charts are classified into three basic types:

(a) MAN type, which records what a worker does.
(b) MATERIAL type, which records what happens to materials.
(c) EQUIPMENT type, which records how the equipment is used.

The following ADDITIONAL information is ESSENTIAL on A FLOW PROCESS CHART: the CHART SPAN; i.e. the point in the process at which the CHART BEGINS; and the point in the process at which the CHART ENDS.

Figure 6 is the flow process chart for the bolt shown in Figure 2; and Figure 7 is the chart for the man making the bolt.

Flow process charts for assemblies are drawn in the same way as outline process charts for assemblies.

Repetition of Same Operations and Insertion of Notes

Process charts for most jobs met with in practice are very long and very complex.

When the same set of operations are repeated CONSECUTIVELY several times (e.g. putting in bolts and tightening the nuts on them, one after another) the charting conventions shown in Figure 8 can be used to ‘shorten’ the chart.

When the shape, size or nature of a ‘material’ is so changed that its handling properties from then on are altered, notes may be inserted in the ways illustrated in Figure 9 as an aid to understanding what is happening to the ‘material’. Notes are also useful on process charts for assemblies, especially when they are very complex.

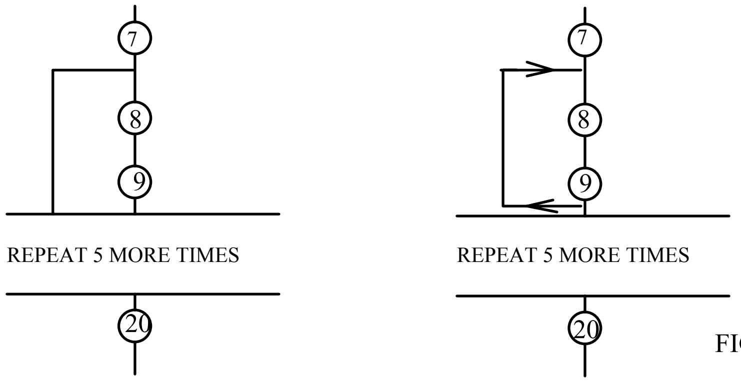


FIGURE 8

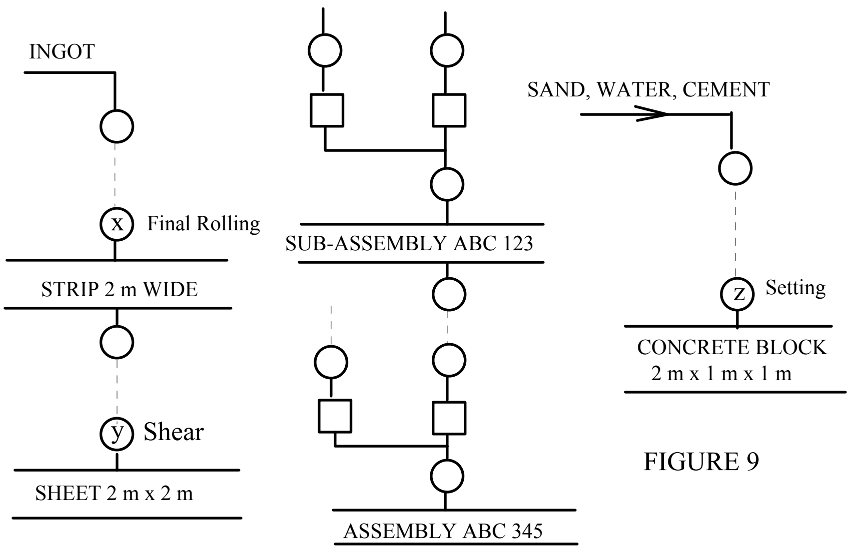


FIGURE 9

ACTIVITY CHARTS (Charts using Time Scales)

Although a process chart gives the general picture of the various steps in a process that is generally necessary before improvements in the process can be considered, it is often desirable to have a breakdown of the process or of the series of activities plotted against a TIME scale; and charts which use time scales are called ACTIVITY CHARTS.

The most useful kind of activity chart is the MULTIPLE ACTIVITY chart, which is a chart on which the activities of more than one subject (worker, equipment or material) are recorded on a common time scale to show their inter-relationship.

Multiple-activity charts are often of the man-machine type and show the periods of activity and idle times of men and the machines they supervise. Figure 10 shows the simplest chart for a man supervising one machine and Figure 11 shows a more complex chart for a man supervising two machines.

Multiple Activity Chart (Man-Machine Type)

JOB:	Fork end
DRW.No`	PQR 567
Present Method	
PROCESS:	Mill slot
MACHINE(S)	Horizontal Miller
SPEED	100 rev/min
FEED	45 mm/min
OPERATOR	T.Brown
CHARTED BY	NAB
DATE	20/1/2001

SUMMARY

	PRESENT	PROPOSED	SAVING
CYCLE TIME	minutes	minutes	minutes
Man	2.0		
Machine	2.0		
WORKING			
Man	0.9		
Machine	1.1		
IDLE			
Man	1.1		
Machine	0.9		
UTILISATION			
Man	45%		
Machine	55%		

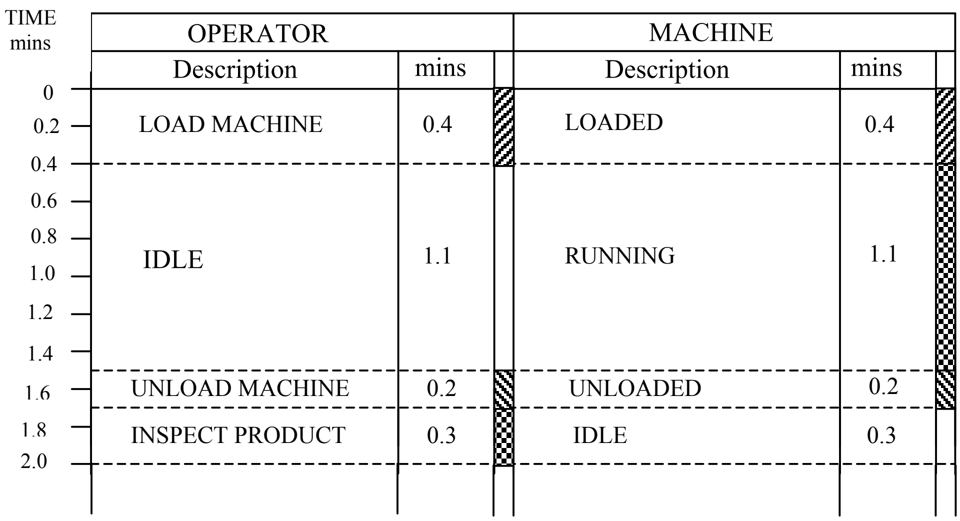


FIGURE 10

Multiple Activity Chart (Man-Machine Type)

SUMMARY

JOB:	Fork end
DRW.No`	PQR 567
Present Method	
PROCESS:	Mill slot
MACHINE(S)	Horizontal Miller
SPEED	100 rev/min
FEED	45 mm/min
OPERATOR	T.Brown
CHARTED BY	NAB
DATE	20/1/2001

	PRESENT	PROPOSED	SAVING
CYCLE TIME	minutes	minutes	minutes
Man	2.0	2.0	0
Machine	2.0	2.0	0
WORKING			
Man	0.9	1.8	0.9
Machine	1.1	1.1	0
IDLE			
Man	1.1	0.2	0.9
Machine	0.9	0.9	0
UTILISATION			GAIN
Man	45%	90%	45%
Machine	55%	55%	0

TIME mins

OPERATER Description	mins	MACHINE 1 Description	mins	MACHINE 2 Description	mins
LOAD MACHINE 1	0.4	LOADED	0.4	RUNNING	0.4
UNLOAD MACHINE 2	0.2	RUNNING	1.1	UNLOADED	0.2
INSPECT PRODUCT OF MACHINE 2	0.3			IDLE	0.3
LOAD MACHINE 2	0.4			LOADED	0.4
IDLE	0.2			RUNNING	
UNLOAD MACHINE 1	0.2	UNLOADED	0.2		
INSPECT PRODUCT OF MACHINE 1	0.3	IDLE	0.3		
LOAD MACHINE 1		LOADED			

FIGURE 11

RECORDING IN DETAIL OF MOVEMENTS AT A WORKPLACE

The recording techniques considered so far have been concerned with the overall aspects of a process, or of an operation, or of a sequence of operation. Any one operation will involve several movements by an operator working at a workplace. The analysis of these movements will clearly involve more precise techniques than those considered so far: and some of the techniques in use at the present time are extremely 'refined' and require the use of expensive equipment.

Some people regard the use of very refined techniques with scepticism, sine the results of an investigation carried out on one operator may not apply to another operator, because no two person are alike and it is very difficult to design an 'average' worker.

If several operators are trained to carry out the same operation the same way, it will usually be found that after they have been carrying out the operation for a long time they will, either consciously or unconsciously, have improved on the method by making changes to suit better their own individual physical characteristics. Thus detailed analyses of the movements of these operators after they had been carrying out the same operation for a long time would show that they were all using different sets of movements.

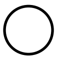
We shall consider the two principal recording techniques only.

The worker chosen for the study should be a least 'average' or slightly 'above average' and should be a person who does not mind being watched. He or she must be guaranteed no loss of earning during the investigation. The selection of the worker should be left to the foreman. The selected worker should be shown the work study equipment, told how the equipment is used and the purpose of the investigation, and treated as one sharing in the investigation, in order to obtain his or her interest and co-operation.

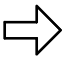
The Two Handed Process Chart

A two handed process chart is a process chart in which the activities of a worker's hands (or limbs) are recorded in relationship to one another.

We shall consider the symbols used in this country, noting that some authorities feel that these symbols are not entirely suitable for recording hand and body movements. However, since a description of each activity should be written alongside each symbol there seems no reason for considering the symbols to be unsuitable; and furthermore if a more detailed analysis is desired then the second technique we consider can be used.

 OPERATION

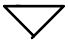
is used to denote the activities of grasp, position, use, release, etc. of a tool, component or material.

 TRANSPORT

is used to denote the movement of the hand (or limb) to or from the work, or a tool., or material.

 DELAY

is used to denote time during which the hand (or limb) being charted is idle.

 HOLD

is used to denote when the hand being charted is holding work, or a tool, or material.

The inspection symbol is not usually used because the hand movements involved when inspecting an article (whether turning it round for visual inspection or checking it with instruments or gauges) can be classified as operations.

Two handed process charts may be drawn on printed forms or plain paper. A sketch of the workplace layout is necessary and spaces are provided on printed forms for the necessary sketches.

Figure 12 shows how a two handed process chart would appear when drawn on plain paper; and Figure 13 how it would appear when drawn on a printed form. Note that activity times would be included on the charts in an actual work study.

The two handed process chart is used when motions can be studied by visual observation and the use of a stopwatch. The smallest time interval that can be measured accurately be a trained observer using a stopwatch is about 0.03 to 0.04 minute (1.8 to 2.4 seconds).

<u>TWO-HANDED PROCESS CHART (DRAWN ON PAPER)</u>

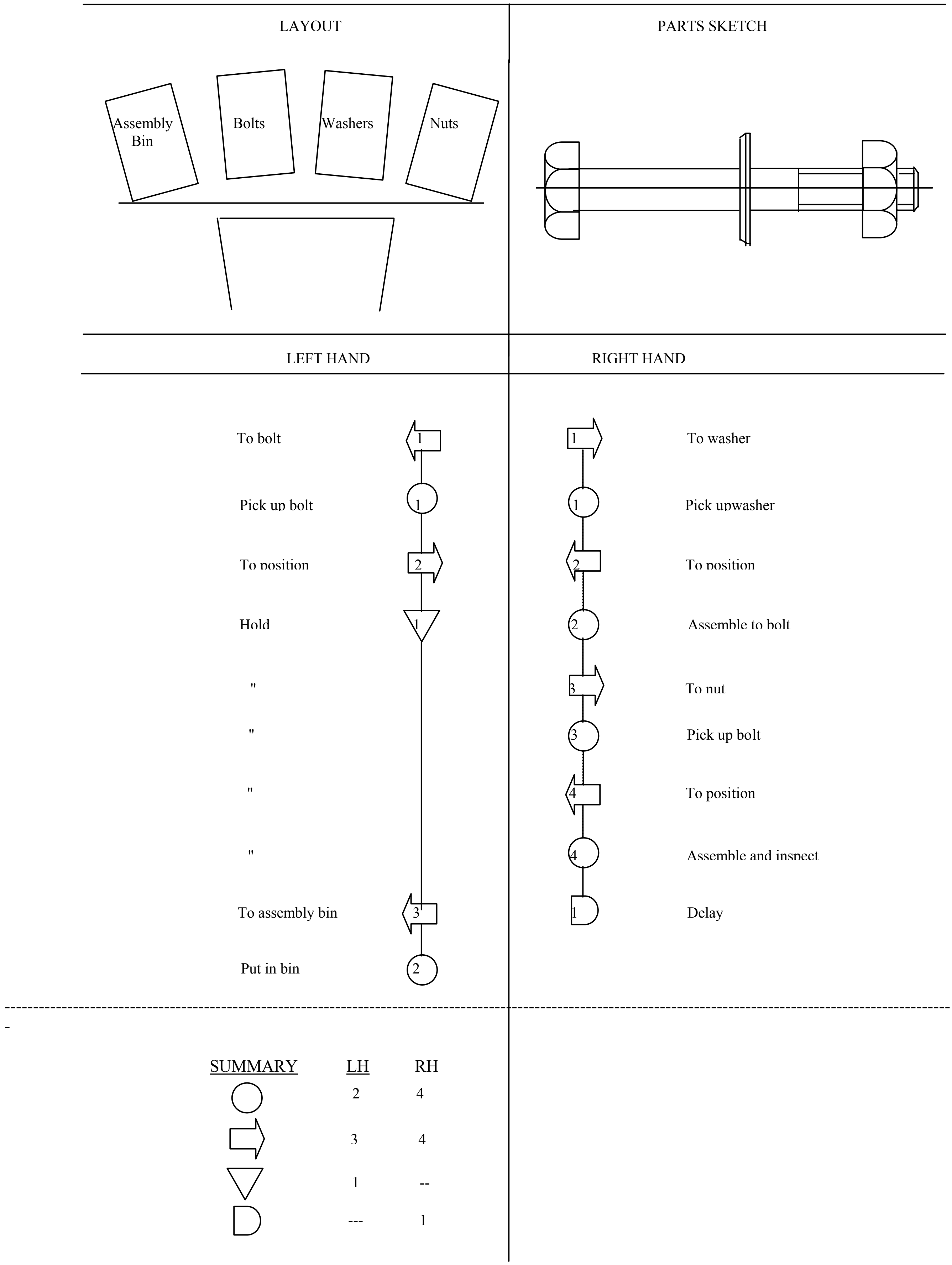


FIGURE 12

TWO-HANDED PROCESS CHART (PRINTED)

	Present		Proposed		Difference	
	LH	RH	LH	RH	LH	RH
OPERATION	2	4				
TRANSPORT	3	4				
DELAY	1	-				
HOLD	-	1				

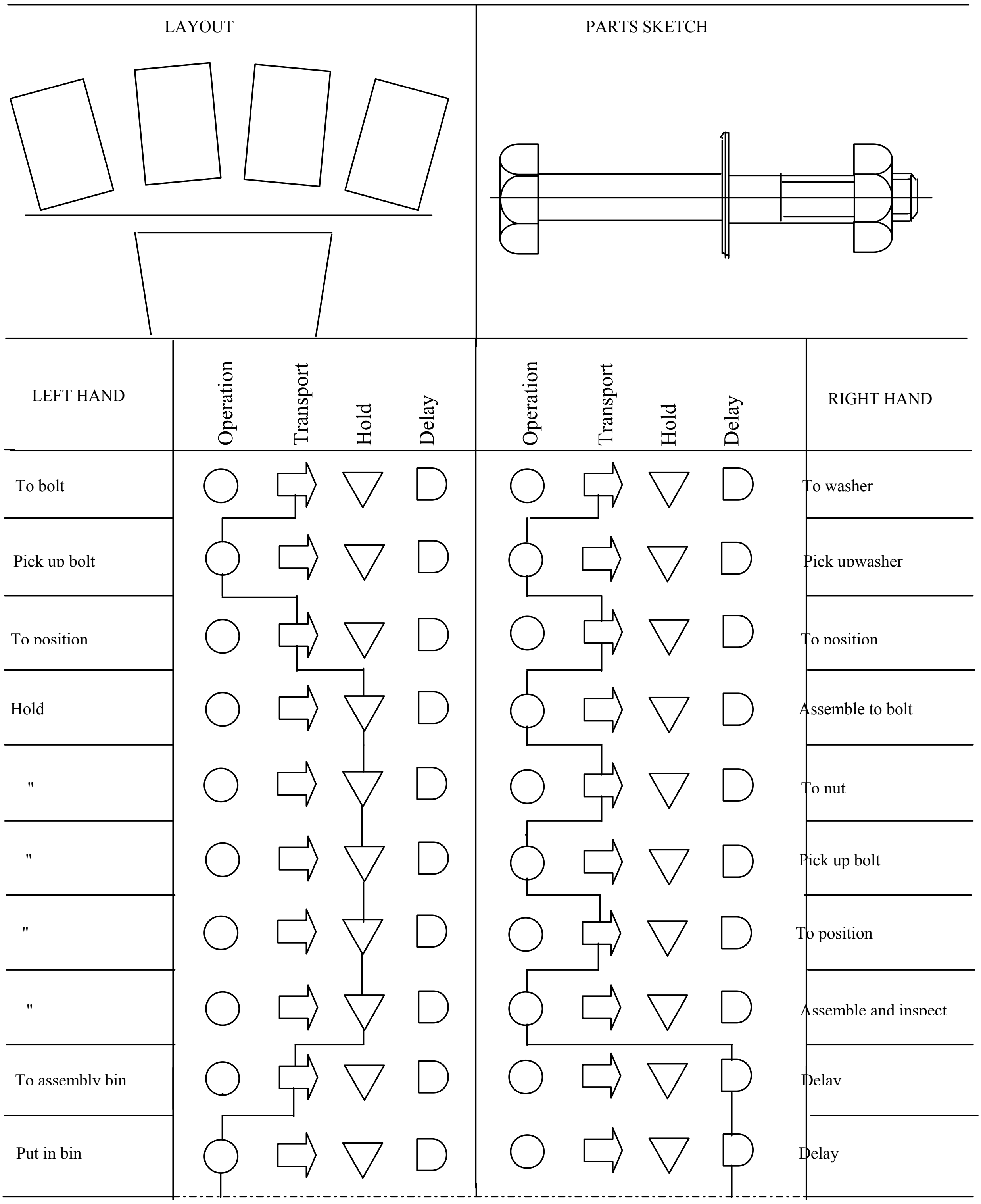


FIGURE 13

<u>Micromotion Study</u>

When it is desired to analyse motions in greater detail than is possible by visual observation and the use of a stopwatch it is necessary to make use of micromotion photography. This is one of the photographic techniques introduced by Gilbreth and consists of taking a cine-film of the activity in question and examine the film frame by frame. Special electrically driven clocks, called WINK COUNTERS, are always in the field of view of the camera, so that times of activities can be determined from the readings of the wink counter shown in the frames. The unit of time is the WINK, which is equal to 1/2000 minute.

We have noted that Gilbreth found that he could classify all movements into seventeen different elements, which he call THERBLIGS. At the present time eighteen therbligs are defined in BS 3138; and these are shown in Figure 14, which also gives the abbreviations and colour schemes used to represent the therbligs on charts. The colours are given because the time occupied' by a therblig can be represented by an area on a chart shaded with a pencil of the appropriate colour.

The beginning of one therblig is the end of the preceding therblig; and, conversely, the end of one therblig is the beginning of the following therblig.

SEARCH (Sh)	Is that part of a cycle during which the eyes or the hands are hunting or groping for the object. This therblig is often dispensed with in favour of SELECT, for reasons given below.
FIND (F)	is when the object searched for has been located. It is not really an essential therblig and is seldom used, since it is a mental reaction which occurs at the end of the therblig search.
SELECT (St)	is the choice of one object from among several. Since it is often impossible or extremely difficult to distinguish between search and select, it is common practice to combine the two as SELECT.
GRASP (G)	is taking hold of an object and closing the fingers round it.
HOLD (H)	is the retention of an object after it has been grasped, NO MOVEMENT of the object taking place.
TRANSPORT LOAD (TL)	is moving an object from one place to another, either by carrying it in the hand or fingers, or by pushing, pulling, sliding or dragging it. Transport load can also refer to moving the empty hand against resistance.
POSITION (P)	is turning or locating an object in such a way that it will be properly oriented to fit into the location for which it is intended. It is possible to position an object during the therblig transport load.
ASSEMBLE (A)	is placing an object on another object with which it becomes an integral part.
USE (U)	is manipulating a tool, device, or piece of equipment for the purpose for which it was intended. USE represents the motion for which the preceding motions have been more-or-less preparatory and for which the ones that follow are supplementary.
DISASSEMBLE (DA)	is separating one object from another object, of which it is an integral part.
INSPECT (I)	is examining an object to determine whether or not it complies with the standard required. Inspection may be carried out by seeing, smell, touch, taste, hearing, blowing or counting. Inspect is predominately a mental reaction and may occur at the same time as other therbligs.
PRE-POSITION (PP)	is locating an object in a predetermined place, or locating it in the correct position for some subsequent motion. Pre-position is similar to position, except that the object is located in the approximate position that will be needed later. Most often a holder, bracket, or special container of some kind holds the object in a way that permits it to be grasped easily in the position in which it will be used later. In some cases pre-position eliminates the therblig position.
RELEASE LOAD (RL)	is letting go of an object.
REST FOR OVERCOMING FATIGUE (R)	is a fatigue factor or allowance provided to permit the worker to recover from the fatigue incurred by his work.
UNAVOIDABLE DELAY (UD)	is delay beyond the control of the worker. It may result from either (i) a failure or interruption in the process; or (ii) an arrangement of the operation that prevents one part of the body from working while other parts are busy; i.e. if one hand is inactive while the other one is busy.
AVOIDABLE DELAY (AD)	is any delay on the part of the operator for which he is responsible and over which he has control.
PLAN (Pn)	is a mental reaction which precedes the physical movement. It is deciding how to proceed with the job. Plan should not occur in repetitive work. Plan will occur when a worker is on a non-repetitive job and has to think out how to proceed; or when a person has to think out the next step in a calculation, etc. Plan begins at the point when the worker begins to think out the next step of the operation and ends when the procedure to be followed has been determined.

The system of symbols considered here is that in BS 3131. Other systems are in use, which include therbligs for walk, bend, sit, stand-up and kneel. Some of these systems go into very fine detail for each therblig.

Furthermore, some people interpret therbligs in different ways. For example, they regard HOLD as UNAVAILABLE DELAY, on the grounds that a hand experiencing 'hold' ought to be doing something more useful than simply 'holding'. This is sound reasoning, because the method study analyst would try to reduce or eliminate 'hold' periods in an improved method.

SYMBOL	NAME	ABBR.	EXPLANATION SUGGESTED BY	COLOUR

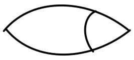
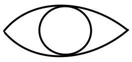
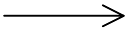
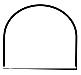
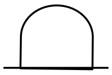
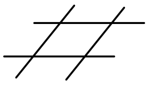
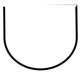
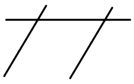
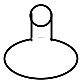
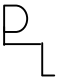
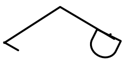
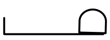
	Search	Sh	Eye turned as if searching	Black
	Find	F	Eye finds what it is looking for	Grey
	Select	St	Reaching for object	Light grey
	Grasp	G	Hand open for grasping object	Red
	Hold	H	Magnet holding iron bar	Gold ochre
	Transport loaded	TL	A hand with something in it	Green
	Position	P	Object being placed by hand	Blue
	Assemble	A	Several things put together	Violet
	Use	U	Word 'USE'	Purple
	Disassemble	DA	One part of an assembly removed	Light violet
	Inspect	I	Magnifying lens	Burnt ochre
	Pre-position	PP	A nine-pin set up in a bowling all	Pale blue
	Release load	RL	Dropping content out of hand	Carmine red
	Transport empty	TE	Empty hand	Olive green
	Rest for overcoming fatigue	R	Man seated as if resting	Orange
	Unavoidable delay	UD	Man bumping his nose unintentionally	Yellow
	Avoidable delay	AD	Man lying down on job voluntarily	Lemon yellow
	Plan	Pn	Man with fingers at brow thinking	Brown

FIGURE 14 LIST OF THERBLIGS IN USE AT THE PRESENT TIME

The most common recording technique of a micromotion study is the SIMULTANEOUS MOTION CYCLE CHART (SIMO CHART), which records on a common time scale the therbligs or groups of therbligs performed by different parts of the body of one or more workers.

Figure 15 shows the simo chart for the bolt, washer and nut assembly considered in Figure 12 and Figure 13.

DECRIPTION LEFT HAND	Therblig symbol	Time in 1/2000 mins	Therblig colour	CLOCK READING 1/2000 mins	Therblig colour	Time in 1/2000 mins	Therblig symbol	DESCRIPTION RIGHT HAND
				400				
Reach for bolt	TE	8		410		8	TE	Reach for washer
Select and grasp bolt	St G	6				6	St G	Select and grasp washer
Transport bolt	TL	15		420		15	TL	Transport washer
Position bolt	P	5		430		5	P	Position washer
				440		12	A RL	Assemble washer and release
				450		8	TE	Reach for nut
				460		6	St G	Select and grasp nut
				470		15	TL	Transport nut
				480		4	P	Position nut
Hold bolt	H	135		490 500 510 520 530 540 550 560		90	A	Assemble nut, Inspect
							RL	and Release
To assembly bin	TL	15		570		18	UD	Delay
Release assembly	RL	3		580				
				590				
				600				

FIGURE 15 SIMO CHART

EXAMINE THE FACTS CRITICALLY AND DEVELOP THE IMPROVED METHOD

When all the relevant facts have been recorded they are all subjected to critical examination. This is the crux of a method study.

A critical examination is the systematic analysis of information about a problem, process procedure, or activity, by which it is subjected to exhaustive questioning and criticism. Everything is questioned and nothing is omitted.

The questioning technique, by which the critical examination is conducted, involves the use of two sets of detailed questions:

(a) primary questions or first stage of the questioning technique, in which the fundamental need for performing each activity is recorded and its means, sequence, place and person are questioned and justification sought for each reply. If no justification of an activity can be found then there is no point in considering this activity further and it can be eliminated.

(b) secondary questions or second stage of the questioning technique, in which the remaining essential activities are subjected to further questions to determine alternatives and to select those which are practicable and preferable.

The Primary Questions, which must be asked in the order given below, are:

PURPOSE What is achieved?
Why is it done there?

If the answers are that nothing is achieved and the activity isn't necessary then it will not be included in the new method.

PLACE Where is it done at present?
Why is it done there?

SEQUENCE When is it done?
Why is it done then?

PERSON Who does it now?
Why does this person do it?

Critical examination of 'place', 'sequence' and 'person' reveals ways of combining or rearranging activities to give a more effective method.

MEANS How is it done now?
Why is it done that way?

Critical examination of 'means' reveals possible ways of simplifying the activity.

The Secondary Questions, which, as mentioned above, are used to determined alternative and to select those which are practical and preferable are, in the order in which they must be asked:

PURPOSE What else could be done?
What should be done?

PLACE Where else could it be done?
Where should it be done?

SEQUENCE When might it be done?
When should it be done?

PERSON Who else might do it?
Who should do it?

MEANS How else might it be done?
How should it be done?

The principle whereby no alternative is decided upon until ALL possible alternatives have been recorded is known as deferred evaluation; and this principle should be followed in all method studies.

The full extent of the questioning procedures covers all the shortcomings listed. Sets of questions are available to the method study analyst. The question of saleability must always be given careful consideration: Will higher quality standards lead to increased sales? What should be done to the general appearance and finish of the product to increase sales? All aspects of accident prevention must be thoroughly investigated.

All the charts and diagrams we have considered are used when the new method is being developed. Thus there will be charts of present and proposed methods, which is why it is so important to have this information and the date on each chart.

The principles of motion economy formulated by Gilbreth and given previously, together with the rules given below, are followed when the new method is being developed.

(a) Ideally the hands should not have idle or hold time. The hands should not have idle or hold time occurring at the same time.

(b) The operation method should have the fewest number of therbligs possible.

(c) The hands should not do work which can be assigned to other members (e.g. feet) through the use of jigs, fixtures, vices, etc., as long as the hands have other work to perform.

(d) The tools and parts should be pre-positioned in definite locations and so located that the hands travel the least possible distance and perform the fewest activities.

(e) The workplace should be arranged to permit smooth, continuous motions with a natural rhythm.

(f) The classification of body members (muscle groupings) used should be kept to the lowest feasible for the work. (Fingers are lowest, progressing through wrist, elbow, full arm and body).

(g) The motions of the hands should be arranged to take advantage of body-momentum created through either previous motion or ballistic activity.

(h) The number of eye fixations (focusing) required in an operation method should be reduced to a minimum. Ideally there should be no eye fixations.

(i) The workplace height should be arranged to permit the elbows of the operator to be above the table and allow the operator either to stand or sit while performing the work.

(j) Handles, foot pedals, tools, etc., should be designed to permit the fewest number of muscle groupings to be used for activating the object.

(k) Gravity should be used wherever possible to deliver parts to the operator and to remove parts or place them aside.

(l) When eye-hand co-ordination is required for grasping, positioning, assembling, etc., parts in a simultaneous, symmetrical hand pattern, the points at which the simultaneous activities take place should be as close together as possible.

(m) Reduce the total skills and amount of work involved, so that the operation may be made into an automatic or machine operation, if at all possible.

DEFINE THE NEW METHOD INSTALL AND MAINTAIN IT

When the new method has been developed, a full report giving all details of the method, together with the cost of installing it, changes in tooling and workplace layout, actions required to bring about the change and estimated savings expected by using the new method, is submitted for approval.

When the new method has been approved, the person responsible for installing it must ensure that ALL persons who will be involved in the change are put completely in the picture well before the change is brought about. If this is not done there is likely to be resistance to the change and serious labour disputes.

The new method is defined in writing with diagrams of the workplace layout and any special tools. The amount of detail in the written description must be as large as necessary for the operator to follow the method completely. In practice, standard forms are used and the written description is known as Written Standard Practice or Written Standard Procedure (WASP).

The workers concerned with using the new method must be given the opportunity to learn the method. The training programme may range from a few words when the change in method does not entail very radically different operations to those which the operator was carrying out with the old method to extensive training of the operator when very different operations are involved. Thus the training time may range from a few minutes to many hours.

The training instructor must keep in close touch with the operator during the training period, in order to ensure that the latter is developing speed and skill and that there are no unexpected snags. When the operator has settled down to the job the close supervision still being used. These routine checks are know as FOLLOW-UP, and follow-up is somewhat like insurance on the investment of time and effort put into the development of the new method by the work study analyst.

WORK MEASUREMENT

The measurement of human work has always been and almost certainly always will be a controversial matter. Management must, however, have techniques for measuring it as accurately as possible, because production schedules, estimates of delivery dates and production costs, etc. depend on it; because industrial unrest will occur if workers consider that the time allowed for a job is unfair; and because, once a time for a job has been agreed between management and workers' representatives it is virtually impossible for the management to reduce it if it has been not too high.

WORK MEASUREMENT is 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.

It should be appreciated that there is a clear distinction between the measurement of work and the methods by which payment in made for work. The aim of work measurement is to find the time in which a job should be completed at a stated level of performance; and work measurement is equally applicable where there in incentive payment; or where there in no quest-ion of incentive payment; or even where there in no payment at all. Work measurement ends with the obtaining of the standard time or work content.

A QUALIFIED WORKER is defined an 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.

Work may be either repetitive or non-repetitive. Repetitive work occurs in mass production when the same work cycles are repeated over and over again. It may also occur in a few office procedures.

Non-repetitive work includes constructional work, maintenance work and work in toolrooms, where work cycles are hardly ever repeated identically or repeated identically only a few times.

It is clear that some of the techniques used for measuring the work content of a repetitive job will be very different from those used to determine the work content of a non-repetitive job, since in the latter case the work content must be obtained by some method of estimating, whereas in the former case it may be determined by direct measurement.

Some of the difficulties involved in any method based on estimation of times can be seen when we try to give quantitative values to:

concentration - intensity of attention;
dexterity - the manipulative ability achieved through good motor and perceptual co-ordinations
effort the physical and/or mental exertion expended by the worker:
skill the ability, innate or acquired, which enables a worker to perform a job proficiently.

There are other factors that influence the time taken by a human being to do a job, whether repetitive or non-repetitive.

Environmental conditions - Ventilation and heating; noise level; pleasantness of workplace and surroundings, etc.

Rest periods - Because of the cumulative nature of fatigue, it is natural for workers to seek relief in pauses of various kinds. The critical question concerns the length and frequency of rest pauses and their distribution in the working day. Repeated starts must be avoided, because new effort is required each time a start in made and interest in the work tends to decline. The length of rest pauses must be limited, in order not to lone the advantage of 'drive' acquired during the course of production a long pause leads to a long ,warming up' period of a worker before he reaches full speed again. Pauses should occur at the times of day when output begins to diminish.

No measure of boredom can be made, since boredom in a personal experience. The existence of boredom can be detected by decreasing productivity, variable output, absenteeism, or general dissatisfaction on the part of a worker.

The general procedure of work measurement is an follows; but we shall consider in detail only two of the measuring techniques - Time Study and Synthesis.

WORK MEASUREMENT to provide a yardstick for human effort:
SELECT the work to be measured.
RECORD all the data and break job down into elements.
MEASURE the quantity of work involved by Time Study; or Synthesis; or Activity Sampling; or Predetermined Motion Time Systems (P.M.T.S.); or Analytical Estimating.

ADD RELAXATION ALLOWANCES and other justifiable allowances to give STANDARD TIME.

DEFINE precisely the activities covered and ISSUE THE STANDARD TIME:

TO Achieve: Improved Planning and Control; More efficient manning of plant; Reliable indices
for labour performances Reliable basis for labour cost control;

RESULTING IN HIGHER PRODUCTIVITY.

TIME STUDY

Time study is the most common and most important means of measuring repetitive work and was originated, an we have already noted, by F. W. Taylor. It 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 analysing the data so as to determine the time necessary for carrying out the job at a defined level of performance.

An element in a distinct part of a specified job selected for convenience of observation, measurement and analysis.

Job breakdown is the listing of the content of a job by elements. Thus a work cycle is broken down into elements and the cycle time is the total time to complete the elements constituting the work cycle.

The instant at which one element in a work cycle ends and the next one begins to called a break point.

Eight elements are defined in BS 3138 but as far as we are concerned we need consider only two:

A manual element in an element performed by a worker; and

A machine element is an element performed automatically by a power-driven machine (or process),

To note that manual and machine elements must be considered separately.

Elements should be so chosen that they have definite beginnings and endings, are easily identifiable and are as short as can be timed with accuracy by a trained observer. The shortest time that can be measured accurately by a trained observer using. a stopwatch in about 2 seconds (0.03 to 0.04 minutes). If element times shorter than this are to be measured then micromotion photography must be used. Whenever possible, elements are defined so that they can be measured by means of a stopwatch.

There is a degree of arbitrariness about the ways in which a job can be broken down into elements and we choose the breakdown to give element times which will be most useful to us in the future. Since elements occurring in one job will occur In other jobs an well it is clear that once the element times have been measured in one job those times are known. and there is no need to measure them again in other jobs. This, as we see later, in the basis of determining job times by synthesis.

Although ordinary stopwatches may be used, it is much more convenient in time study to have either:

a Decimal Minute Stopwatch, recording one minute per revolution of the large hand and graduated in 0.01 minute; or

or a Decimal Hour Stopwatch, recording 0.01 hour per revolution of the large hand and graduated in 0.000 1 hour.

Pressure on the winding knobs of these watches causes the hands to return to zero without stopping the mechanisms of the watches, so that the hands start moving again as soon as the pressure is removed. A watch may be stopped completely by moving a slide or pressing a knob alongside the winding knob.

The watches may be used either for:

<u>Flyback Timing</u> (or Snapback Timing) , a method in which the hands of the stopwatch are returned to zero at the <u>end of each</u> element and are allowed to restart immediately, the time for the element being obtained directly; or

<u>Cumulative Timing</u> (or Continuous Timing) , a method in which the hands of the stopwatch are allowed to continue to move without returning to zero at the end of each element and are stopped only at the end of a work cycle, the time for each element being obtained subsequently by subtraction.

Cumulative timing gives the most satisfactory results in general on most operations. A major disadvantage of flyback timing is the bias caused by the time taken by the observer to manipulate the watch at the end of each element, and there In also the possibility that the observer may anticipate individual readings after a number of readings have been taken.

The stopwatch in secured at the top of a small board by a spring clip, the work study forms on which the analyst will record his results being clipped to the board. Thus the board can be supported on the left forearm (for a right-handed person) with the left hand operating the stopwatch, while the right hand can record results with a pencil.

Before the timing of the job under investigation is started, several complete work cycles are watched and the investigator breaks the job down into suitable elements. The description of these elements are written on the work study sheet and the word ‘breakpoint’ is written at the end of each element. A clear description of what constitutes a breakpoint is written down. Thus the precise scope of each element is defined by its beginning (the breakpoint of the preceding element), its description and its end point (its breakpoint

After the elements and breakpoints have been written down, the timing can start. The number of timed cycles should be as large as necessary for a good sample of times to be obtained.

In cases of doubt another operator should be studied, perhaps by another investigator. Any fumbling on the part of the operator should be noted and so should any rest pauses and any" other ineffective times.

The results of a time study will obviously consist of acts of OBSERVED TIMES for the elements of the work cycle (no account is taken of rest pauses and any other ineffective times). In general, the times for any one element will vary, although not by too much unless the worker fumbled or a faulty part was encountered, in which cases the times are not included in the final reckoning.

It is from now on that difficulties arise, because the work study investigator must use his own judgement to assess the rate of working, for each element of the work cycle, of the operator he is studying against the performance of a hypothetical normal (or standard, or average) operator for each element of the work cycle. This assessment in known an RATING and RATINGS MUST BE ASSESSED AT THE TIMES STOPWATCH READINGS ARE TAKEN AND NOT AFTERWARDS.

The first step in obtaining a standard performance is the selection of the average worker who does not mind being watched; but this is only the first step because the average worker does not work at average speed all the time.

If a very large number of operators all doing the same job could be studied then the average or standard performance could be obtained from statistical methods; but this is not possible and the assessment must, in practice, depend solely on human judgement.

S<u>TANDARD RATING</u> is the rating corresponding to the average rate at which <u>qualified workers</u> will work naturally at a <u>job</u>, provided they adhere to the specified method and provided they are motivated to apply themselves to their work, and is nowadays given the number 100.

This is the rating of our hypothetical normal operator and the work study observer must attempt to assess the worker's rate of working relative to his concept of the rate of working of the hypothetical operator. He has to take into account, separately or in combination, one or more factors necessary to the carrying out of the job, such as: speed of movement, effort, dexterity and consistency. The assessment he makes is the <u>OBSERVED RATING</u> or <u>RATING</u>.

The <u>BASIC TIME</u> (or Extended Time, or Converted Time, or Standardised Time) for carrying out an ELEMENT of work at STANDARD RATING is then calculated from:

BASIC TIME = (OBSERVED TIME x RATING) /.100

or BASIC TIME = (OBSERVED TIME x OBSERVED RATING) / 100

A rating with the number 0 corresponds to no activity at all.

Ratings lower than 100 correspond to 'below average' rates of working; and ratings greater than 100 correspond to 'above average' rates of working. The calculation of BASIC TIME from OBSERVED TIME and RATING in known as EXTENSION.

As we have already noted, a work cycle will be studied several times so that there will be several observed times and corresponding ratings for each element of the work cycle.

If the observer could assess rating with absolute consistency then OBSERVED TIME x RATING would be constant for every pair of observed time and rating for any one element and this constant divided by 100 would be, by definition, the BASIC TIME for the element.

No observer can assess ratings with absolute consistency so there will be several 'basic times' for any one element. The question which must now be considered in what basic time should be selected an representative of this group of 'basic times’.

Although several methods have been evolved for choosing the representative basic time, the simplest method is usually adequate; that is to say, the SELECTED BASIC TIME for an element is the average of the set of 'basic times’ for the element..

Even If an observer could assess ratings with remarkable consistency, there in another factor that has to be considered. The observer may rate too high or too low, in other words, his assessment of standard performance may be faulty.

An inaccurate rating which is TOO LOW is' called a TIGHT RATING, because . it results in a basic time which is shorter than it should be.

INCONSISTENT RATINGS is a mixture of LOOSE and TIGHT (and ACCURATE) ratings.

FLAT RATINGS is a set of ratings in which the observer has UNDERESTIMATED the VARIATIONS in a worker's rate of working.

For example, suppose the set of observed times for an element of work is 0.05 min, 0.035 min, 0.045 min, 0.055 min; and the corresponding set of ratings is 95, 95, 95, 95; then this is a set of flat ratings.

STEEP RATINGS is a set of ratings in which the observer has OVERESTIMATED the VARIATIONS in a worker's rate of working.

For example, suppose the set of observed times for an element of work is 0.04 min, 0.04 min, 0.04 min, 0.04 min; and the corresponding set of ratings is 105, 85, 95, 100; then this is a set of steep ratings.

It will now be apparent that the determination of basic times is not a simple business and that reliable assessment of ratings can only be made by an observer who has considerable experience and is wide awake.

The difficulties do not end here, however, because the SELECTED BASIC TIME is the time in which a qualified worker should do a job or element of work at the standard rate of working when no account is taken of NECESSARY pauses for rest and personal needs.

Fatigue in varying degrees is a normal part of every manually controlled operation and is manifested during the course of a day in the gradual reduction in rate of output, brought about by an increase both in the work cycle time and in the number and length of avoidable delays. The influence of fatigue on net cycle time and on the length and frequency of rest pauses may be investigated to some extent by extending the length of a time study to a period of at least a day.

Since fatigue is an extremely complex physiological and psychological influence about which medical authorities cannot agree as to the cause, the effects or the recuperative requirements, it is an extremely difficult item to measure or agree upon. The point to be borne in mind is that a worker should be no more than <u>healthily</u> tired (and how can we measure this factor?) at the end of his day's work and not reduced to the point of exhaustion.

In order to take account of the effects of fatigue and to allow time for personal needs a <u>RELAXATION ALLOWANCE (RA)</u> or <u>COMPENSATING REST ALLOWANCE</u> is added to the selected basic time; and

the WORK CONTENT (Basic) - SELECTED BASIC TIME + RELAXATION ALLOWANCE.

In view of the difficulties involved in measuring the effects of fatigue and in spite of the work that has been done and is still being done on the subject of fatigue, relaxation allowances are still largely a matter of guesswork.

A relaxation allowance is intended to cater for:

- The physiological and psychological effects of carrying out specified work under specified conditions; (I.e. rest for recuperation from fatigue).
- Attention to personal needs.

Women require longer personal needs allowances than men but shorter rest allowances than men when carrying out very tedious repetitive work.

The average man can exert much larger forces than the average woman, so there must be heavy work that can only be done by men. When work involving considerable physical exertion can be done by both men and women, the rest allowances required by women are longer than those required by men.

We have now arrived at the WORK CONTENT (Basic), which in the time, in Standard Minutes (SMs) or Standard Hours (SHs), in which an average qualified worker should complete a specified job at a rate of working which should leave him only healthily tired at the end of his day's work, provided there are no other LEGITIMATE and EXPECTED items of work to be accounted for.

These other legitimate and expected items of work cannot be parts of the work cycle, otherwise they would be included in the basic time, and occur at irregular and infrequent intervals. They include rectification of rejects; occasional inspection or gauging in the case of automatic machine work; effects of faulty material and faulty tools, etc.

A SMALL allowance of time, known an the <u>WORK CONTINGENCY ALLOWANCE</u> and intended to cater for such legitimate and expected items of work, is ADDED to the WORK CONTENT (Basic) to give the WORK CONTENT.

WORK CONTENT = WORK CONTENT (Basic) + WORK CONTINGENCY ALLOWANCE.

Another SMALL allowance of time, known as the DELAY CONTINGENCY ALLOWANCE and intended to cater for LEGITIMATE and EXPECTED DELAYS, MAY be added to the WORK CONTENT to give the STANDARD TIME.

STANDARD TIME = WORK CONTENT + DELAY CONTINGENCY ALLOWANCE.

The delay contingency allowance is introduced to account for time consumed by necessary and unavoidable delays not related to any function of the production operation and which are random in occurrence. Such a case occurs if the foreman interrupts the operator occasionally during the work period. Another case would be when one operator supervises a group of machines that are subject to unpredictable stoppages. If two or more machines are stopped at the same time the operator can only work on one at a time and the other or others must remain idle. This is known an machine interference and the time a machine in idle to known as machine delay.

In no circumstances should a delay contingency allowance be included solely for the purpose of increasing the standard time. If there is no legitimate reason for including this allowance it should not be included.

We have now arrived at the STANDARD TIME, the to al time in which a job should be completed at STANDARD PERFORMANCE; and this in the end as far an work measurement is concerned. Any further addition to the standard time to give the ALLOWED TIME depends on c company policy and what scheme of incentive payment in used; but this is not the responsibility of the work study department.

The steps in computing the standard time are summarised in Figure 16.

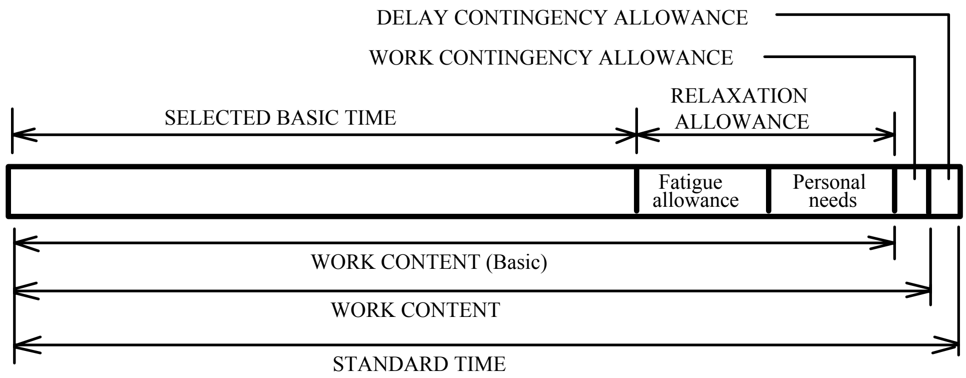


FIGURE 16

It will be apparent that all rating demands some sort of judgement on the observer's part, and that the rating procedure cannot possibly be a scientific process, so that accuracy in rating has a questionable objective meaning, because there is no true objective standard, independent of human judgement, by which to evaluate a given operator's performance.

Since judgement is the essential feature of rating, accuracy can have meaning only in the sense of a statistical average of the numerical rating indices made by a large number of independent observers of a given operator's performance. Then precision in rating would be related to the variability of the indices around this average. It is not, however, possible and would in any case be uneconomical, to have a. large number of independent observers studying the same operator during the same period. Consequently, consideration must be given to what are the predominant requirements of good rating practice, bearing in mind that the object of time study is to find out what constitutes a fair day's work.

The predominant requirements of good rating practice are consistency of rating assessments by each observer and consistency of rating between all observers.

The assessment of the absolute rating index is less important than consistency in rating because there is generally a significant range within which the absolute rating Index is acceptable to everyone concerned and because the assessment of standard performance can be changed as the result of experience. In other words, there. are generally several hypothetical standard operators whose performances will satisfy everyone concerned; and work study observers can eventually, as a result of experience, select the most suitable one.

Inconsistent ratings, however, indicated by significant variations in the standard times between like operations performed in a factory, will result in unrest among those operators who are earning significantly less money than others for doing like work.

It is necessary, therefore, to check the consistency of rating assessments between work study observers at regular intervals. There are several way! of doing this but we will only consider the most convenient one.

Two or more observers study the same operator at the same time, then repeat the studies on other operators who are known to work at different rates. Their ratings and notes are then compared after the studies have been completed. The operators must be informed that the purpose of the studies is to check the observer's ratings and no, to change the standard times and it is convenient to make the studies on operators who know the observer and who don't mind being watched by them.

SYNTHESIS

Synthesis is a work measurement technique for building up the time for a job or part of a 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.

Synthetic Data (or Standard Data) are tables and formulae derived from the analysis of accumulated work measurement data, arranged in a form for building standard time or basic time by synthesis.

Since any job is made up of elements and since the same elements will often occur in different jobs, then if an element time has been found from a work study on one particular job we can use this time as that for the an element in any other job.

Thus if sufficient data have been accumulated as a result of time studies, it becomes possible to build up the basic times for jobs, by using these data. This provides a convenient way of determining the basic time for a non-repetitive job, or for a job that is of the batch type (short-term repetitive job).

Sometimes no data are available on certain operations that occur in a job but information in available on similar operations in other jobs. It sufficient information is available then a graph may be drawn and the time for the operation in the job in question estimated by using the graph.

The ideas involved here are not new, since methods such an these have been used for a long time for estimating job times. What is new is the use of more reliable data. compared with the 'rough' data used in the past.

PREDETERMINED MOTION TIME SYSTEMS (P.M.T.S.)..

A Predetermined Motion Time System is a work measurement technique whereby times established for basic human motions (classified according to the nature of the notion and the conditions under which it is made) are used to build the time for a job at a defined level of performance.

The successful application of such a technique for establishing the basic time for a job, depends on the availability of reliable data on the times for carrying out the basic human motions under conditions identical to (or very similar to) those which prevail during the job, or on having methods by which the measured time for basic human motions under given conditions can be modified to account for factors which differ in the actual job from those which prevail when the measured times were obtained.

A predetermined motion time system is not a technique that should be used by anyone who has not had a very long training in the use of the system with, preferably, practical experience of doing jobs similar to those to which the technique is to be applied.

Predetermined Motion Time Systems were first used in the USA in 1924 when Motion-Time Analysis (MTA) was introduced; and the other principal systems are. the Work-Factor System (USA); Methods-Time Measurement (MTM), (USA'.); and Basic Motion Time Study (BUT), (Canada).

ACTIVITY SAMPLING (or WORK SAMPLING)

(Also known as Ratio-Delay Study; Observation Ratio Study., Snap-Reading method; and Random Observation Method).

Activity Sampling is a technique in which a large number of observations are made over a period of time of one or a 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 the time during which that activity or delay occurs.

Activity sampling was first used Ii Great Britain in 1934 by L. H. C. Tippett and is based upon the laws of probability. It depends upon the facts that a sample taken at random from a large group tends to have the same pattern of distribution as the large group, and that if the sample is large enough the characteristics of the sample will differ but little from the characteristics of the group.

ESTIMATING METHODS

Methods of estimating times for jobs are used for determining time for non-repetitive work as occurs, for example, in maintenance operations, tool-rooms and construction work, when there are insufficient recorded data to enable basic times to be built up by synthesis.

The estimated times may be subject to considerable uncertainty unless the estimator is a person who is very familiar with the kind of work involved. For example, a man who has been (or is) a toolmaker and who has had some training in work study methods will certainly be able to estimate times for tool-room jobs more accurately than a person who has had no tool-room experience.

A feature of the type of work for which methods of estimating are the only practical ways is that the unexpected or unforeseen may happen. The overall time taken for a job may, consequently, be well in excess of the estimated time but this does not matter because all the worker has to do in to ask for extra time, giving in detail why this extra time in needed. In this way it is possible to accumulate data on unusual circumstances and to anticipate them at future dates. The point to note is that maintenance work, tool-room work and construction work are so important that they cannot be rushed.